Canadian Astronomical Society
La Société Canadienne d'Astronomie

Annual General Meeting

Emerging Fields in Astrophysics

17 - 20 June 2019

Montréal, Québec

Conference Program

Contents

Thank You to
Our Sponsors

Local Organizing Committee

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Email: casca2019@physics.mcgill.ca

Website: http://www.physics.mcgill.ca/casca2019/

Time	Monday	Tuesday		Wednesday			Thursday	
08:30		Welcome (CMR Mont-Royal I & II): Haggard, Cowan, Medicine Bear Drummers, .calSES						
09:00	**Graduate Student Workshop** McGill University, Trottier Building (room 100)	CMR Mont-Royal I & II (Moderator: Thacker) Richer Prize Talk: **Cowan** (45 min) Petrie Prize Talk: **González** (45 min)		CMR Mont-Royal I & II (Moderator: Barmby) Martin Prize Talk: **Gaensler** (45 min) LRP Information 2 (45 min): Ground-based Astronomy Committee Equity and Inclusivity Committee LRP Implementation Committee		Teacher Training (CMR Mansfield #5)	CMR Mont-Royal I & II (Mods: Hložek & Gaensler) Plaskett Prize Talk: **Tetarenko** (45 min) LRP Information 3 (45 min): Joint Committee on Space Astronomy Education and Public Outreach Committee Computation and Data Committee	
10:30		Break		Break			Break	
11:00		Intensity Mapping and 21cm Cosmology (MR I) **Raul Monsalve** H.C. Chiang A. Liu K. Lee-Waddell T. Pinsonneault-Marotte P. Boubel	ISM/SF/GMCs (MR II) R.E. Pudritz J. Keown S. Benincasa E. Peeters S. Coudé A. Ordog C. Matzner	CMB and Large-Scale Structure (MR I) **Jo Dunkley** R. Bond T. Yang M. Lokken D. Contreras W. Fraser	Stars/Stellar Pops (Mont-Royal II) **Juna Kollmeier** J. Sikora N. Fantin N. Hejazi F. Jahandar M. Munoz		Transients (Mont-Royal I) **Kiyoshi Masui** P. Chawla Z. Pleunis T. Cassanelli S. Kleinman G. Eadie	Short-Period Planets (Mont-Royal II) **Diana Dragomir** C. Ziegler E. Artigau A. Darveau-Bernier P. Gupta A. Hughes
12:30		Euclid Lunch* (MR I)	SKA Lunch (MR II)	CITA Lunch* (MR I)	ACURA/TMT Lunch (II)		Lunch	CFHT Lunch (MR II)
13:45		Galaxy & Star Formation (Mont-Royal I) **Adam Muzzin** N. Drakos C. Lewis A. Man H.A. White D. Rennehan	WD/NS/BH (Mont-Royal II) **Liliana Caballero** B. Côté A. Bédard H. Richer V. Hénault-Brunet A.K. Naidu	Clusters/Groups (Mont-Royal I) **Yashar Hezaveh** A. Richard-Laferrière R. Hill I. Roberts A. Reeves M.L. Gendron-Marsolais	Long-Period Planets (Mont-Royal II) **Ruobing Dong** F. Baron B. Gerard L. Dang S. Lawler N. van der Marel		QSO/AGN/SMBH (Mont-Royal I) **Darren Grant** N. MacDonald C. Peters J. Ruan S. Ellison H. Boyce	EPO (Mont-Royal II) I. Short C. Bredeson J. Bolduc-Duval N. Ouellette M. Reid A. Man M.B. Laychak
15:15		Break		Break			Break	
15:45		CMR Mont-Royal I & II (Moderator: Ellison) Qilak Prize Talk: **Cami** (45 min) LRP Information 1 (45 min): LRP Chairs **Barmby** & **Gaensler**		Posters (Foyer Mont-Royal)			CMR Mont-Royal I & II (Moderator: De Robertis) NSERC Updates: **Elizabeth Boston** (45 min) Poster/Talk Awards: R. Thacker (10 min) CASCA AGM: J. Di Francesco (60 min) CASCA 2020: M. De Robertis (5 min)	
17:00	Opening Night Reception Foyer Mont Royal (CMR 4th floor)				LSST & Canada			
17:15								
17:45								
18:00		**Banquet** Le Local, 740 rue William		Hogg Prize Lecture: **Sera Markoff** McGill University, McIntyre Medical Building, Room 522				
18:30								

CMR = Centre Mont-Royal (2200 Mansfield)

*The Euclid and CITA lunches are by invitation only

Invited talks are bolded

Full Schedule

Monday, June 17

<table>
<tr><td colspan="2">Graduate Student Workshop
Location: Trottier Building, Room 0100
McGill University, 3630 rue University</td><td>CASCA Board & JCSA Meetings
Location: Various @ McGill University</td></tr>
<tr><td>8:00</td><td>Grad Workshop Registration</td><td rowspan="9">All day CASCA Board Meeting
Rutherford Building, Bell Room/Room 103
McGill University, 3600 rue University

All day JCSA Meeting
MSI Conference Room
McGill Space Institute, 3550 rue University</td></tr>
<tr><td>9:00</td><td>Welcome & CASCA Grad Student Council</td></tr>
<tr><td>9:15</td><td>Allyship Workshop</td></tr>
<tr><td>10:30</td><td>Coffee Break</td></tr>
<tr><td>11:30</td><td>Graduate Student Committee AGM</td></tr>
<tr><td>12:00</td><td>Lunch</td></tr>
<tr><td>13:30</td><td>Science Communication (iREx)</td></tr>
<tr><td>14:00</td><td>Coffee Break</td></tr>
<tr><td>14:30</td><td>Industry Networking</td></tr>
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<table>
<tr><td colspan="2">Opening Night Reception
Location: Foyer Mont Royal, Centre Mont-Royal (CMR), 4th Floor
2200 Mansfield Street</td></tr>
<tr><td>17:00</td><td>Opening Reception</td></tr>
</table>

Tuesday, June 18

Plenary Session 1 *Location*: CMR Mont-Royal I & II, 4th Floor *Moderator*: R. Thacker (CASCA President)			
8:30	**Welcome and Territory Acknowledgement** The Medicine Bear Drummers D. Haggard & N. Cowan (CASCA 2019 Chairs) J. Grant (Medicine Bear Drummers & .caISES)		
9:00	**Richer Prize Lecture**: Nicolas Cowan (McGill): McGill Exoplanet Characterization		
9:45	**Petrie Prize Lecture**: Gabriela González (Louisiana State): Gravitational Waves Astronomy		
Coffee Break *Location*: CMR Mont-Royal Foyer			
10:30	Poster, Demo, and Sponsor Interactions		
Science Breakout 1	**Intensity Mapping & 21cm Cosmology** *Location*: Mont-Royal I, *Chair*: J. Sievers	**Science Breakout 2**	**Interstellar Medium & Star Formation** *Location*: Mont-Royal II, *Chair*: A. Cumming
11:00	R. Monsalve (McGill): The Signature of the Cosmic Dawn in the Global Radio Spectrum (**invited**)	11:00	R.E. Pudritz (McMaster): A universal route for massive cluster formation in giant molecular clouds
		11:13	J. Keown (Victoria): KEYSTONE: KFPA Examinations of Young Stellar (O-star) Natal Environments
11:30	H.C. Chiang (McGill): Observing the <100 MHz radio sky	11:26	S. Benincasa (UC Davis): The life and death of stellar nurseries: GMCs and stellar clusters in Latte
11:42	A. Liu (McGill): Illuminating the First Stars and Galaxies with the Hydrogen Epoch of Reionization Array	11:39	E. Peeters (Western): Tracing PAH Size in Prominent Nearby Mid-Infrared Environments
11:54	K. Lee-Waddell (CSIRO): WALLABY Science results with ASKAP	11:52	S Coudé (SOFIA-USRA): Dynamics of the 30 Doradus star-forming region as probed with far-IR polarimetry
12:06	T. Pinsonneault-Marotte (UBC): Calibrating the CHIME antenna array coupling from sky data	12:05	A Ordog (Calgary): Extended Emission Rotation Measures: Observations and Models of Galactic B-Field
12:18	P. Boubel (McGill): Full-sky maps from CHIME	12:18	C. Matzner (Toronto): Acoustic Dynamics of Super-Eddington Outbursts and Supernova Impostors
Lunch Break			
12:30	Euclid Lunch (invitation only)	12:30	SKA Lunch
Science Breakout 3	**Galaxy & Star Formation** *Location*: Mont-Royal I, *Chair*: J. Mirocha	**Science Breakout 4**	**Compact Objects (WD/NS/BH)** *Location*: Mont-Royal II, *Chair*: E. Fonseca
13:45	A. Muzzin (York): Resolving Problems in Galaxy Formation (**invited**)	13:45	L. Caballero (Guelph): Weak makes us strong: neutrinos in the multi-messenger era (**invited**)
14:15	N. Drakos (Waterloo): Dark Matter Halo Properties as a Test of Cosmology	14:15	B. Côté (Konkoly): The Origin of r-process Elements in the Milky Way
14:27	C. Lewis (Queens): Kinematic Modeling of Low-Resolution Disk Galaxies	14:27	A. Bédard (Montreal): The spectral evolution of hot white dwarf stars
14:39	A. Man (Dunlap): Lensed quiescent galaxies at z~2: what quenched their star formation?	14:39	H. Richer (UBC): Search for Young and Massive White Dwarfs
14:51	H.A. White (Toronto/Dunlap): DYnamics of Newly-Assembled Massive Objects (DYNAMO) Galaxy Survey	14:51	V. Hénault-Brunet (NRC Herzberg): Stellar-mass black holes in globular clusters
15:03	D. Rennehan (Victoria): Coeval star formation and the assembly of the most massive galaxies in the universe	15:03	A.K. Naidu (McGill): Subpulse drifting studies of pulsars using the CHIME/Pulsar data
Coffee Break *Location*: CMR Mont-Royal Foyer			
15:15	Poster, Demo, and Sponsor Interactions		
Plenary Session 2 *Location*: CMR Mont-Royal I & II, 4th Floor *Moderator*: S. Ellison (CASCA Vice-President)			
15:45	**Qilak Prize Lecture**: Jan Cami (Western): You're the Inspiration		
16:30	**Long Range Plan Session 1**: P. Barmby & B. Gaensler (LRP Chairs)		
Conference Banquet			
18:00	**Conference Banquet** *Location*: Le Local, 740 rue William		

Wednesday, June 19

Teachers Training Workshop (9:00-17:00) *Location*: CMR Mansfield #5 *Convenor*: J. Bolduc-Duval (Discover the Universe)			
Plenary Session 3 *Location*: CMR Mont-Royal I & II, 4th Floor *Moderator*: P. Barmby (LPR Chair)			
9:00	**Martin Prize Lecture**: B. Gaensler (Dunlap/Toronto): Magnets in the Sky		
9:45	**Long Range Plan Session 2**: Ground-based Astronomy Committee Equity and Inclusivity Committee LRP Implementation Committee		
Coffee Break *Location*: CMR Mont-Royal Foyer			
10:30	Poster, Demo, and Sponsor Interactions		
Science Breakout 5	**CMB & Large-Scale Structure** *Location*: Mont-Royal I, *Chair*: A. Liu	**Science Breakout 6**	**Stars & Stellar Populations** *Location*: Mont-Royal II, *Chair*: J. Ruan
11:00	J. Dunkley (Princeton): The Simons Observatory: cosmology from the microwave sky (**invited**)	11:00	J. Kollmeier (Carnegie): SDSS-V: Pioneering Panoptic Spectroscopy (**invited**)
11:30	R. Bond (CITA): Intermittent Primordial non-Gaussianities in Large Scale Structure Surveys	11:30	J. Sikora (Queens): Insights Into Stellar Magnetism With TESS
11:42	T. Yang (Waterloo): The mass-to-light ratios of filaments in the Cosmic Web	11:42	N. Fantin (Victoria): Reconstructing the Milky Way Formation History from Its White Dwarfs
11:54	M. Lokken (Toronto): Superclustering in the Cosmic Web: ACTxDES Data vs. Peak-Patch Simulations	11:54	N. Hejazi (Georgia State): Chemical Properties of the Galactic Stellar Disk and Halo
12:06	D. Contreras (York): Mapping the stochastic gravitational wave background	12:06	F. Jahandar (Monteal): Unravelling the Chemistry of Our Nearest Stellar Neighbours with SPIRou
12:18	W. Fraser (NRC Herzberg): Canadian Participation in the LSST	12:18	M. Munoz (Queens): Modelling offset-dipoles with ADM
Lunch Break			
12:30	CITA Lunch (invitation only)	12:30	ACURA/TMT Lunch
Science Breakout 7	**Galaxy Clusters & Groups** *Location*: Mont-Royal I, *Chair*: J. Hlavacek-Larrondo	**Science Breakout 8**	**Long Period Planets** *Location*: Mont-Royal II, *Chair*: T. Bell
13:45	Y. Hezaveh (Flatiron/Montreal): Probing the particle nature of dark matter with strong gravitational lensing (**invited**)	13:45	R. Dong (Victoria): Observational Planet Formation (**invited**)
14:15	A. Richard-Laferrière (Montreal): New Insight about the Origin of Mini-Halos in Clusters of Galaxies	14:15	F. Baron (Montreal): Distribution of giant planets on wide orbits from a compilation of direct imaging surveys
14:27	R. Hill (UBC): SPT2349: A massive proto-cluster at redshift 4	14:27	B. Gerard (Victoria): Exoplanet Imaging: Current Limitations and the Path Forward
14:39	I. Roberts (McMaster): Linking galaxy quenching and ICM density in low-redshift clusters	14:39	L. Dang (McGill): Getting Better at Measuring the Galactic Distribution of Planets with Spitzer
14:51	A. Reeves (Waterloo): Quenching in GOGREEN Galaxy Groups at 1<z<1.5	14:51	S. Lawler (NRC Herzberg): Neptune's Mean-Motion Resonances are Full of TNOs
15:03	M.L. Gendron-Marsolais (ESO): A multi-scale low radio frequency view of the Perseus cluster	15:03	N. van der Marel (NRC Herzberg): Vortices in proto-planetary disks: dust asymmetries & clumps in disk rings
Coffee Break *Location*: CMR Mont-Royal Foyer			
15:15	Poster, Demo, and Sponsor Interactions		
Extended Poster Session *Location*: CMR Mont-Royal Foyer			
15:45	**Extended Poster Session** (plus Demo and Sponsor Interactions) -- *Don't forget Poster Bingo!*		
16:45	LSST & Canada Discussion		
Hogg Prize Lecture *Location*: McGill University, McIntyre Medical Building, Room 522			
18:00	**Hogg Prize Lecture**: Sera Markoff (Amsterdam): Imaging (and Imagining) Black Holes *Public Lecture* -- All are welcome!!		

Thursday, June 20

Plenary Session 4 *Location*: CMR Mont-Royal I & II, 4th Floor *Moderators*: R. Hložek (CASCA Prizes Chair) & B. Gaensler (LPR Chair)	
9:00	**Plaskett Prize Lecture**: A. Tetarenko (East Asian Obs): Multi-wavelength fast timing in X-ray binaries
9:45	**Long Range Plan Session 3**: Joint Committee on Space Astronomy Education and Public Outreach Committee Computation and Data Committee
Coffee Break *Location*: CMR Mont-Royal Foyer	
10:30	Poster, Demo, and Sponsor Interactions

Science Breakout 9	**Transients** *Location*: Mont-Royal I, *Chair*: V. Kaspi	**Science Breakout 10**	**Short-Period Planets** *Location*: Mont-Royal II, *Chair*: N. Cowan
11:00	K. Masui (MIT): Mapping the sky with CHIME - a digital radio telescope (**invited**)	11:00	D. Dragomir (MIT/New Mexico): First Results and the Bright Future of the TESS Mission (**invited**)
11:30	P. Chawla (McGill): Constraining the Locations of Fast Radio Bursts in their Host Galaxies	11:30	C. Ziegler (Toronto): One Hit Wonders: Hunting the longest-period TESS planets
11:42	Z. Pleunis (McGill): Fast radio burst morphology with CHIME	11:42	E. Artigau (Montreal): A year after first light: SPIRou status update
11:54	T. Cassanelli (Toronto): VLBI Efforts in support of CHIME/FRB	11:54	A. Darveau-Bernier (Montreal): Transit of HD189733b in the eye of SPIRou - The metastable He absorption
12:06	S. Kleinman (Gemini): Probing the Time Domain with High Spatial Resolution	12:06	P. Gupta (Montreal): First multiple HST/STIS eclipse observations of Wasp 43 b
12:18	G. Eadie (Washington): Improving the Lomb-Scargle Periodogram: A New Method for Time Series Analysis	12:18	A. Hughes (UBC): Constraining the Radio Emission of TRAPPIST-1
Lunch Break			
12:30	Lunch	12:30	CFHT Lunch

Science Breakout 11	**AGN & Supermassive Black Holes** *Location*: Mont-Royal I, *Chair*: D. Haggard	**Science Breakout 12**	**Education and Public Outreach** *Location*: Mont-Royal II, *Chair*: K. Lepo
13:45	D. Grant (Michigan State/Alberta): Neutrino hunting in the Antarctic: recent results from the IceCube Neutrino Observatory (**invited**)	13:45	I. Short (St Mary's): ChromaStar: A star and a life-zone in the classroom
		13:58	C. Bredeson (Athabasca): Development and implementation of effective distance education courses
14:15	N. MacDonald (Max Planck): Non-Horizon Science with The EHT: EHT & ALMA Peer Deeper into Blazars	14:11	J. Bolduc-Duval (Discover the Universe): International Year of Astronomy - 10 years later
14:27	C. Peters (Dunlap): Reducing Catastrophic Outliers in Photometric Redshift	14:24	N. Ouellette (Montreal): SciComm as a Side Gig: EPO for the Busy Astronomer
14:39	J. Ruan (McGill): The Analogous Structure of Accretion Flows in Supermassive and Stellar Mass Black Holes	14:37	M. Reid (Dunlap): Launching or Boosting Astronomy on Tap in Your City
14:51	S. Ellison (Victoria): Galaxy mergers and black hole accretion with the Canada France Imaging Survey	14:50	A. Man (Dunlap): Building capacity in astro research & education in Africa - Initiatives in Kenya & Ghana
15:03	H. Boyce (McGill): Flaring at the Heart of the Milky Way: X-ray and Infrared Variability of Sgr A*	15:03	M.B. Laychak (CFHT): CFHT Outreach: Connecting to our Canadian Community

Coffee Break *Location*: CMR Mont-Royal Foyer	
15:15	Poster, Demo, and Sponsor Interactions
Plenary Session 5 *Location*: CMR Mont-Royal I & II, 4th Floor *Moderator*: M. De Robertis (CASCA 2020)	
15:45	**NSERC Updates**: Elizabeth Boston, Director, Mathematical, Environmental and Physical Sciences
16:30	**CASCA 2019 Award Presentations:** R. Thacker, CASCA President
16:40	**CASCA Annual General Assembly**: J. Di Francesco, CASCA Secretary
17:40	***Announcing CASCA 2020!***

Friday, June 21

All day ACURA Meeting
MSI Conference Room
McGill Space Institute, 3550 rue University

CASCA AGM 2019

Code Of Conduct

The organizers are committed to making this meeting productive and enjoyable for everyone, regardless of age, race, ethnicity, sexual orientation, gender identity, gender expression, marital status, nationality, political affiliation, religion, ability status, physical appearance or educational background. We will not tolerate harassment of participants in any form. Attendance at a CASCA meeting implies consent to abide by this code of conduct.

Explicitly, please follow these guidelines:

- Behave professionally. Harassment and sexist, racist, or exclusionary comments or jokes are not appropriate. Harassment includes sustained disruption of talks or other events, inappropriate physical contact, sexual attention or innuendo, deliberate intimidation, stalking, and photography or recording of an individual without consent. It also includes offensive comments related to gender, sexual orientation, disability, physical appearance, body size, race or religion.
- All communication should be appropriate for a professional audience including people of many different backgrounds. Sexual language and imagery is not appropriate.
- Be kind to others. Do not insult or put down other attendees.
- Participants asked to stop any inappropriate behaviour are expected to comply immediately.
- Attendees violating these rules may be asked to leave the event or conference at the sole discretion of the organizers without a refund of any charge.

Any participant who wishes to report a violation of this policy is asked to speak, in confidence, to CASCA's designated contact(s): a member of the Diversity & Inclusivity Committee, a member of the CASCA AGM 2019 LOC, or a member of the CASCA Board. Please feel free to contact them directly in case of any conduct concerns during the conference.

Consequences may range from verbal warning, to ejection from the meeting without refund, to notifying appropriate authorities. Retaliation for complaints of inappropriate conduct will not be tolerated. If a participant observes inappropriate comments or actions and personal intervention seems appropriate and safe, they should be considerate of all parties before intervening.

Protocol for dealing with violations of this policy

To avoid any confusion or bias in dealing with reports of violations of the code of conduct, the following protocol will be followed:

1. The designated CASCA contact will request a written record of the complaint including time/date plus particulars;
2. The designated CASCA contact will bring the incident to the attention of the LOC and the CASCA Board;
3. The designated CASCA contact will inform the individual(s) indicated to have violated the code of conduct of the allegation and ascertain and record their version of events.

Based on the nature of the violation and the response, the LOC, in concert with representatives of the CASCA Board, will decide upon appropriate actions. Where a violation of the policy is deemed to have occurred, a record will be kept to that effect within CASCA.

This code of conduct is based on the "London Code of Conduct", as originally designed for the conference "Accurate Astrophysics. Correct Cosmology", held in London in July 2015. The London Code was adapted with permission by Andrew Pontzen and Hiranya Peiris from a document by Software Carpentry, which itself derives from original Creative Commons documents by PyCon and Geek Feminism. It is released under a CC-Zero license for reuse.

Code de conduite
CASCA 2019

Les organisateurs s'engagent à ce que cette conférence soit une expérience enrichissante et agréable pour tous, et ce, sans égard à l'âge, race, ethnicité, orientation sexuelle, identité de genre (et son expression), état civil, nationalité, affiliation politique, religion, degré d'habileté, apparence physique ou formation académique. Nous ne tolérerons aucune forme de harcèlement envers un ou des participant(s). Votre présence à cette conférence de la CASCA est votre consentement à respecter et à suivre ce code de conduite.

Vous êtes donc priés de suivre les consignes suivantes :

- Comportez-vous toujours de façon professionnelle. Le harcèlement et les commentaires/plaisanteries de nature sexiste, raciste ou d'exclusion sont inappropriés. Le harcèlement inclut les perturbations soutenues de présentations ou autres événements, contacts physiques inappropriés, sous-entendus ou attention de nature sexuelle, et prises de photos ou enregistrements sans consentement. Il inclut aussi les remarques désobligeantes liées au genre, orientation sexuelle, degré d'habileté, apparence physique, taille, race ou religion.
- Toute communication se doit d'être appropriée pour un auditoire professionnel dont les membres proviennent de milieux différents. Les mots et les images de nature sexuelle ne sont pas appropriés.
- Restez courtois envers tous les autres participants, et évitez toute insulte ou autre humiliation.
- Les participants auxquels l'on demandera de mettre fin à un comportement inapproprié devront se plier à cette directive immédiatement. Faute de quoi, ils pourraient se voir expulsés de la conférence sans aucun remboursement de leurs frais d'inscription. Le recours à l'expulsion est à la seule discrétion des organisateurs.

Tout participant qui désirerait rapporter une infraction au code de conduite est prié de le faire en toute confidence auprès d'une des personnes désignées par le comité organisateur ou de l'un des membres de ce comité, du comité « Diversité et inclusivité » de la CASCA ou du conseil d'administration de la CASCA.

Les conséquences d'une infraction pourront aller d'un avertissement verbal à l'expulsion de la conférence sans remboursement. Les autorités locales pourraient aussi être alertées si nécessaire. Aucune représaille suite à une plainte pour comportement inapproprié ne sera tolérée. Si un(e) participant(e) est témoin d'actions et/ou de commentaires inappropriés et qu'il/elle juge une intervention nécessaire et sécuritaire, il/elle se doit de prendre tous et chacun en considération avant de le faire.

Protocole suite à une plainte

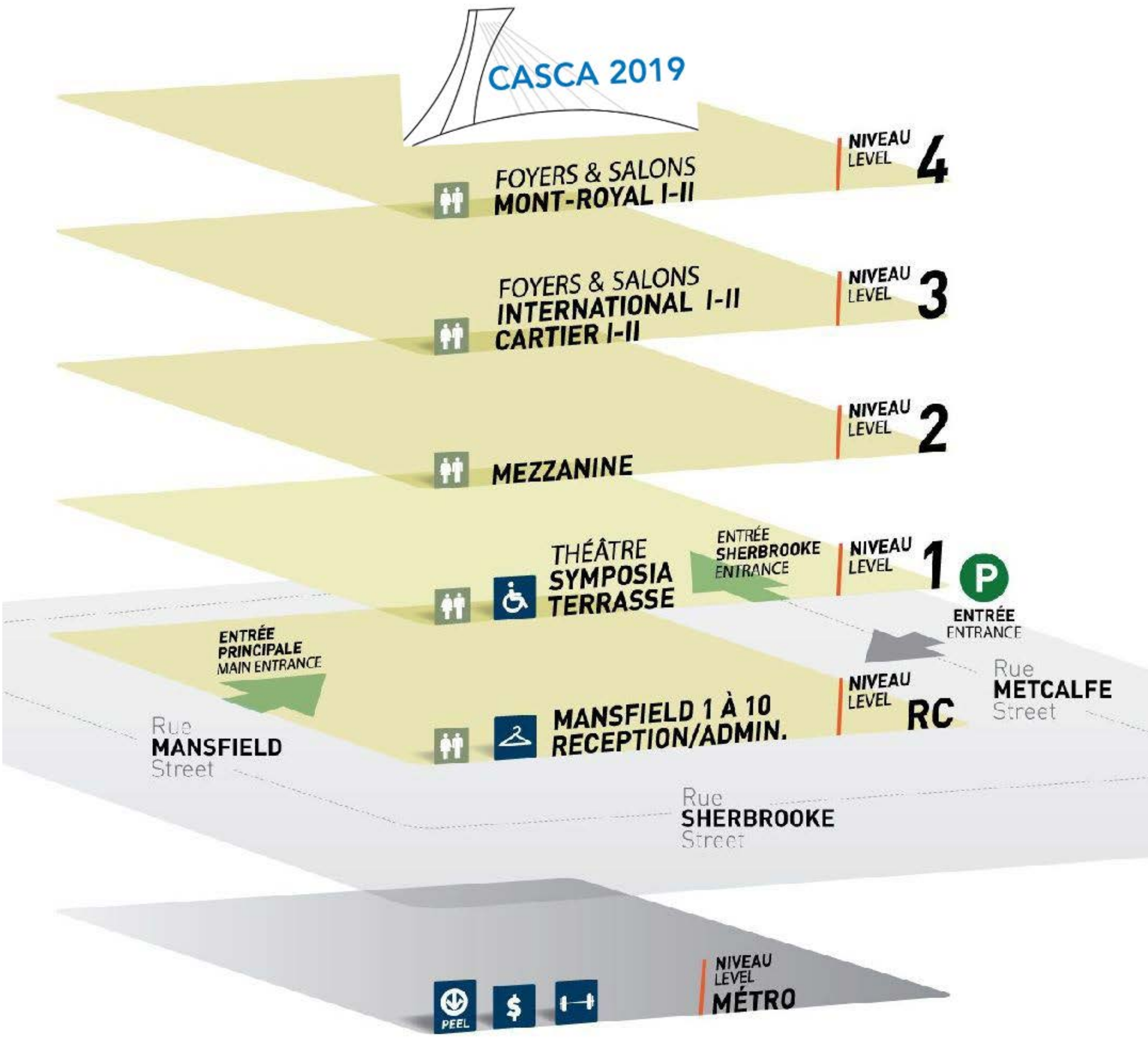
Afin d'éviter toute confusion ou biais dans le traitement d'un constat d'infraction, le protocole ci-dessous sera suivi :

1. La personne désignée de la CASCA demandera un constat d'infraction écrit avec date et tous les détails pertinents à l'appui;
2. La personne désignée de la CASCA portera l'incident à l'attention du comité organisateur et du conseil d'administration de la CASCA;
3. La personne désignée de la CASCA informera ensuite le (ou les) individu(s) présumément impliqué(s) de cette plainte et recueillera leur(s) version(s) des faits.

Selon la nature de l'infraction et sa suite, le comité organisateur, de concert avec les membres du conseil d'administration de la CASCA, décidera des actions à prendre en réponse à la plainte. S'il est établi qu'une infraction a effectivement été commise, elle sera entrée dans un registre interne de la CASCA.

Ce code de conduite est basé sur le « London Code of Conduct » écrit à l'origine pour la conférence «Accurate Astrophysics, Current Cosmology » tenue à Londres en juillet 2015. Le « London Code » a été adapté avec permission par Andrew Pontzen et Hiranya Peiris d'un document de « Software Carpentry». Ce document a lui-même été dérivé des versions originales écrites par « PyCon » et « Geek Feminism» sous license « Creative Commons ». Il est diffusé sous une license « CC-Zero » afin qu'il puisse être ré-utilisé.

Map



CASCA 2019
FOYERS & SALONS
MONT-ROYAL I-II
NIVEAU
LEVEL
4
FOYERS & SALONS
INTERNATIONAL I-II
CARTIER I-II
NIVEAU
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3
MEZZANINE
NIVEAU
LEVEL
2
THÉÂTRE
SYMPOSIA
TERRASSE
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SHERBROOKE
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Street
Rue
MANSFIELD
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SHERBROOKE
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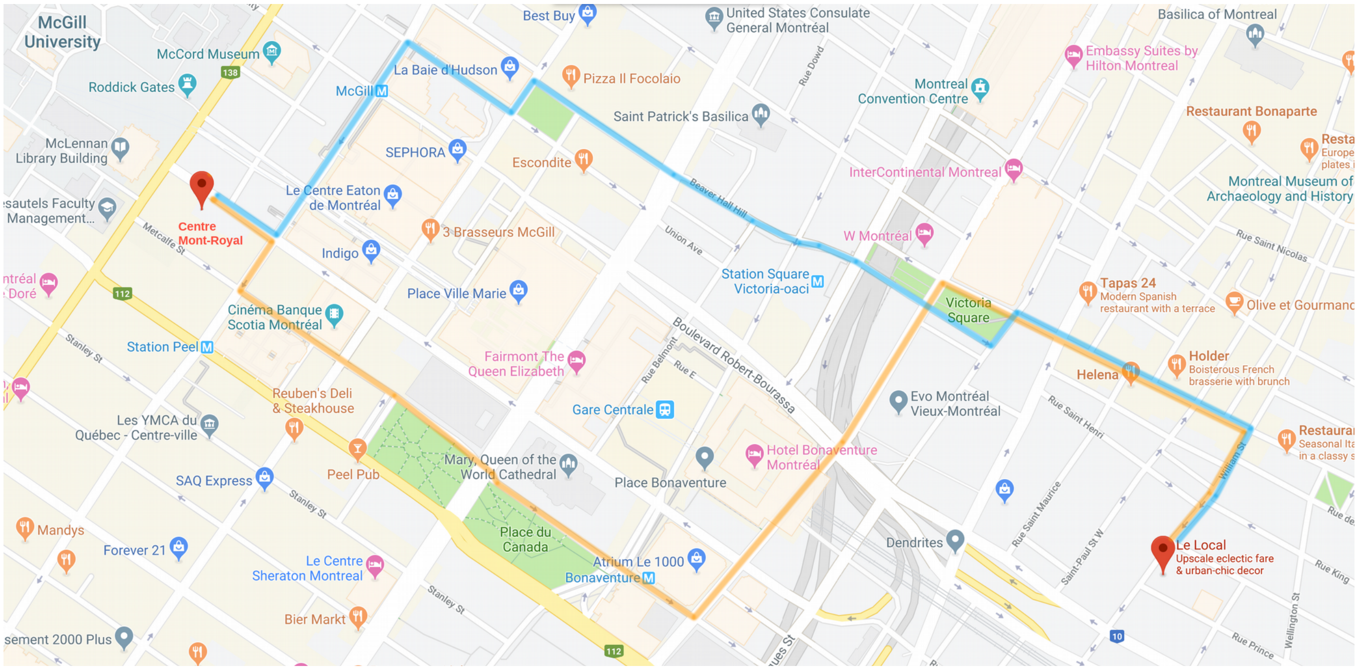
MÉTRO

Directions to CASCA Banquet – Le Local



The Direct Route (2.1 km)

This route has been tested for biking

- Leave Centre Mont-Royal and turn right to head southeast on Rue Mansfield
- Turn left onto Blvd de Maisonneuve Ouest
- Turn right onto Avenue Union
- Turn left onto Rue Sainte-Catherine Ouest and walk along park Square Phillips
- Turn right onto Place Phillips and continue along the park
- Continue straight onto Côte du Beaver Hall
- Continue straight onto Rue du Square-Victoria with park Square Victoria on your left
- Turn left onto Rue Saint-Jacques and continue along Square Victoria
- Turn right onto Rue McGill
- Turn right onto Rue William
- **Continue to Le Local, 740 Rue William**

The Scenic Route (2.3 km)

This route has not been tested for biking

- Leave Centre Mont-Royal and turn right to head southeast on Rue Mansfield
- Turn right onto Boulevard de Maisonneuve Ouest
- Turn right onto Rue Metcalfe with park Square Dorchester on your right
- Continue straight onto Rue de la Cathédrale with Cathédrale Marie-Reine-du-Monde on your left and park Place du Canada on your right
- Turn left onto Rue Saint-Antoine Ouest continuing on through park Square-Victoria
- Turn right onto Rue du Square-Victoria keeping the park on your right
- Continue onto Rue McGill
- Turn right onto Rue William
- **Continue to Le Local, 740 Rue William**

Directions to CASCA Hogg Lecture – Prof. Sera Markoff

To McIntyre Medical Building (~1 km)

This route has not been tested for biking

- Leave Centre Mont-Royal and turn left to head northwest on Rue Mansfield
- Take the first left onto Rue Sherbrooke
- Take the next right onto Rue McTavish (a partially closed/pedestrian road)
- Continue up the stairs on Rue McTavish
- Turn left after the stairs onto Avenue du Docteur-Penfield
- Turn right onto Promenade Sir William Osler
- Turn right where the block to your right reaches street level into McIntyre Medical Building driveway (McIntyre Medical Building has an overhang over the driveway)
- **Continue to Room 522, McIntyre Medical Building, 3655 Promenade Sir William Osler**

Talks

Prize Talks (Plenary)

Mont-Royal I & II

Richer Prize Lecture: McGill Exoplanet Characterization

Nicolas Cowan
McGill University
Tuesday 9:00

Planetary climate is among the most complex physical systems in the Universe. The McGill Exoplanet Characterization team (MECha) is a diverse and interdisciplinary research group that interrogates planetary climate by observing exoplanets. I will describe our ongoing efforts to figure out what these strange worlds are like, from hot Jupiters and lava planets, to transiting temperate terrestrials and Earth twins. The sheer diversity of these planets is forcing us to broaden our views of planet formation, atmospheric physics, and planetary habitability. I will argue that uniform observations for large number of exoplanets is the perfect complement to the detailed remote sensing and in situ investigations possible in the Solar System, and may even lead to a better understanding of the past and future of our own planet.

Petrie Prize Lecture: Gravitational Waves Astronomy

Gabriela González
Louisiana State University
Tuesday 9:45

The first detection of gravitational waves in 2015 by the LIGO detectors, created by the merger of black holes more than a billion years ago, was followed by several other signals from black holes. In 2017, the merger of neutron stars was detected by LIGO and Virgo detectors and by gamma-ray telescopes, and was found by many electromagnetic observations too: a new era of gravitational wave astrophysics has started with very bright prospects for the future. In April 2019, LIGO and Virgo started taking data again, and more merging black holes have been discovered. We will describe the technology involved in the LIGO gravitational wave detectors, details of the latest discoveries and the exciting prospects for more detections in the next years.

Qilak Prize Lecture: You're the Inspiration

Jan Cami
Western University
Tuesday 15:45

Inspiration is a somewhat elusive and ephemeral spiritual phenomenon that lets our mind and spirit take flight, that raises our sense of possibility, and that motivates and empowers us to take action. Not surprisingly then, there is no shortage of inspirational quotes underneath powerful images to grace our office walls, and similarly there are many quotes about the role of inspiration in science, creativity and discovery. Inspiration can come to us in a variety of ways, but many of us can point to at least one person who played an inspirational role on our path to become a scientist. Do these people have special traits? How is it that they inspire others? What can we learn from them that we can apply to ourselves in order to inspire others? Should "inspiring others" be a fundamental part of our professional responsibilities? In the current post-truth era, inspiring the next generation and stimulating their curiosity is more important than ever — not just for the sake of scientific progress, but perhaps even to save many of the living creatures on the planet. For some of us, doing this through outreach activities is a fun and rewarding experience; for others, outreach may feel like an obligation that requires an enormous amount of time and energy. Through some examples and personal experiences, I will show that there is often not much that you have to do to inspire others, and that it typically is a source of mental energy rather than a sink. In other words, you may not know it yet, but you *are* the inspiration!

Martin Prize Lecture: Magnets in the Sky

Bryan Gaensler
University of Toronto
Wednesday 9:00

Everywhere we look, the Universe is threaded with magnetism. These magnetic fields are surprisingly organised and coherent, and are vital to many of the fundamental processes that astronomers take for granted. However, the mechanisms that create and then sustain magnetism in the Universe are not understood, in no small part because magnetic fields are usually not directly observable. I will present innovative new observations of radio polarimetry and Faraday rotation, and will explain how these data sets provide a unique view of magnetic fields in the Milky Way, in distant galaxies, and in the intergalactic medium. I will conclude by showcasing the powerful new generation of radio telescopes that are at last fully opening the window to the magnetic Universe

Plaskett Prize Lecture: Multi-wavelength fast timing in X-ray binaries

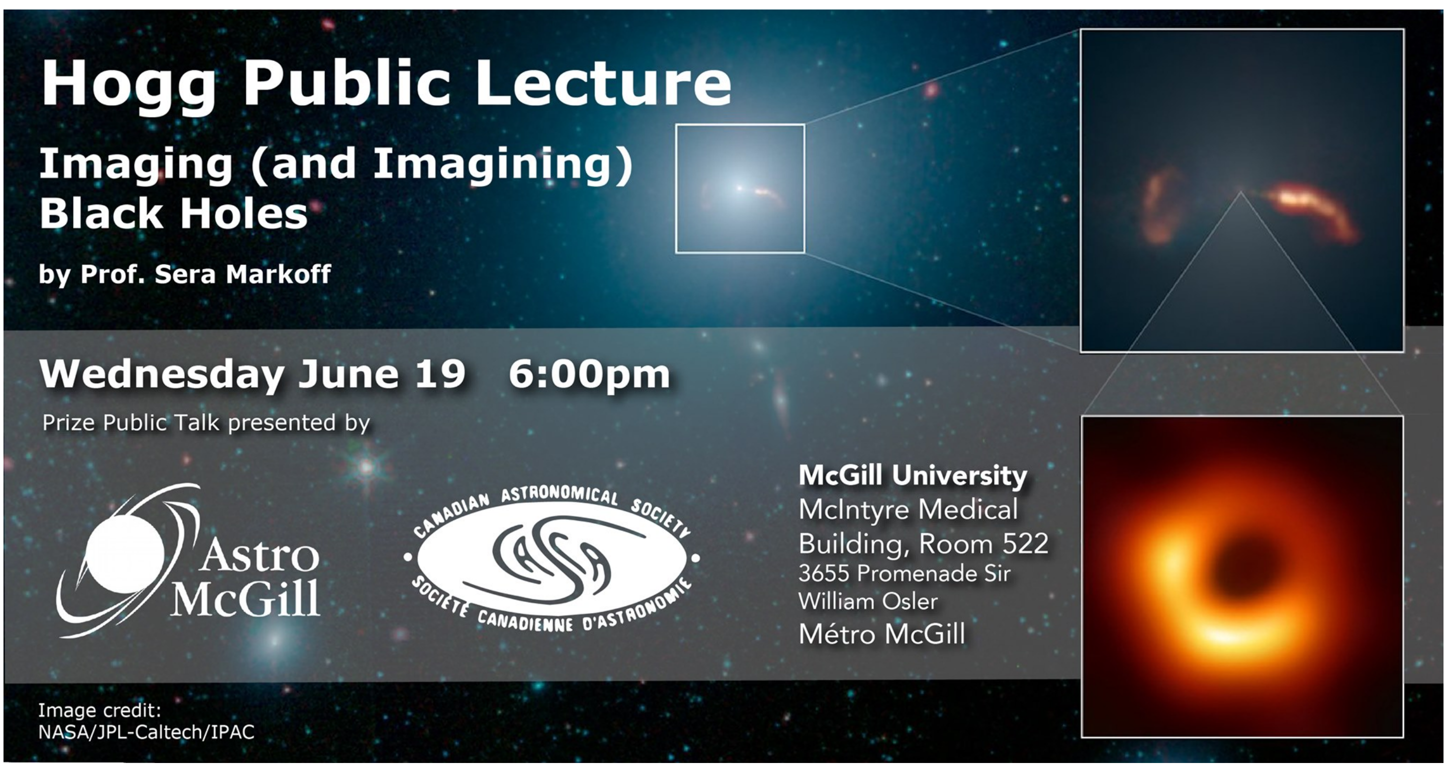
Alexandra Tetarenko
East Asian Observatory
Thursday 9:00

Time domain analysis is a powerful tool with which to study accretion and jet physics near compact objects. Through detecting and characterizing rapid flux variability in X-ray binaries across a wide range of frequency/energy bands (probing emission from different regions of the accretion flow and jet), we can measure properties that are difficult, if not impossible, to measure by traditional spectral and imaging methods (e.g., size scales, geometry, jet speeds, the sequence of events leading to jet launching). While variability studies in the X-ray bands are a staple in the X-ray binary community, there are many challenges that accompany such studies at longer wavelengths. However, with recent advances to observing techniques/instrumentation, the availability of new computational tools, and todays improved coordination capabilities, we are no longer limited by these challenges. In this talk, I will discuss recent advances in multi-wavelength fast timing observations of X-ray binaries, including the OIR, sub-mm, and radio bands, showing how we can directly connect variability properties to internal jet physics. Additionally, I will discuss future prospects for obtaining more of these invaluable data sets, and the key role that next generation instruments (such as the ngVLA and ALMA-2030) will play in driving new discoveries through this science.

Hogg Prize Lecture: Imaging (and Imagining) Black Holes

Sera Markoff
University of Amsterdam
Wednesday 18:00

Black holes are one of the most exotic consequences of Einstein's General Relativity, yet they are also very common, from stellar remnants up to beasts over a billion times more massive than our sun. Contrary to their reputation as cosmic vacuum cleaners, they actually serve as engines for extremely energetic processes, converting a large fraction of the 'fuel' they capture into other forms that can majorly impact their surroundings. For instance, some black holes launch enormous jets of relativistic plasma, bigger than their host galaxies, that accelerate particles to energies millions of times higher than the Large Hadron Collider at CERN! Astronomers, astrophysicists and physicists all want to understand black holes, yet we have been limited by the resolution of our telescopes from actually seeing one directly. This situation has changed dramatically with the Event Horizon Telescope, an Earth-sized millimeter-wavelength array that revealed to the world what a black hole actually looks like just this past April. I will put this exciting result into context by explaining more about how black holes become such efficient, gravity-powered engines, and why they are important players for many different fields of study. Along the way I will also discuss the areas where we still have major questions, and thus the challenges for the coming years.



Intensity Mapping & 21cm Cosmology

Tuesday, 11:00 • Mont-Royal I

The Signature of the Cosmic Dawn in the Global Radio Spectrum (Invited)

Raul Monsalve
McGill University

I will present the measurement of an absorption feature in the all-sky, or global, radio spectrum centered at 78 MHz by the EDGES Low-Band experiment. The measured feature is broadly consistent with the absorption of photons from the microwave background by neutral hydrogen gas in the intergalactic medium (IGM) due to significant star formation about 180 million years after the Big Bang. Despite this consistency, the amplitude and shape of the feature are in tension with physical predictions for the kinetic temperature of the IGM or the intensity of the microwave background at those redshifts. In my talk I will describe the EDGES Low-Band measurement, which was carried out from the desert of Western Australia, and some of the proposed physical implications if the signal is verified to be of cosmological origin. I will also present new measurements with a smaller "Mid-Band" antenna that provide new evidence for an absorption feature centered at 78 MHz.

Observing the <100 MHz radio sky

Hsin Cynthia Chiang
McGill University

Measurements of the radio sky at ~100 MHz and below have the potential to open a new observational window in the universe's history. At the lowest frequencies (tens of MHz), future observations may allow us to one day probe the cosmic "dark ages," an epoch that is unexplored to date. Measurements at these frequencies are extremely challenging because of RFI contamination and ionospheric effects. The state of the art among ground-based measurements dates from the 1960s, when Grote Reber caught brief glimpses of the ~2 MHz sky at low resolution. I will describe a new project that aims to map the low-frequency sky from Marion island using an array of autonomous antenna stations. The final array will comprise roughly 10 antennas operating at 1.2-81 MHz with baselines up to 20 km. A two-element pathfinder was deployed in April 2018, and I will discuss the preliminary observations and upcoming hardware development plans.

Illuminating the First Stars and Galaxies with the Hydrogen Epoch of Reionization Array

Adrian Liu
McGill University

The next few years will potentially yield the first direct detections of Cosmic Dawn and the subsequent reionization epoch via power spectrum measurements of the redshifted 21cm line. I will share progress updates from the Hydrogen Epoch of Reionization Array, which aims to make this first detection. Looking to the future, I will discuss general design principles for optimizing science opportunities with next-generation intensity mapping experiments targeting cosmic dawn and reionization. This may include further statistical measurements, imaging studies, cross-correlations, or ideally all of the above.

WALLABY Science results with ASKAP

Karen Lee-Waddell
CSIRO Astronomy & Space Science

The Australian Square Kilometre Array Pathfinder (ASKAP) uses revolutionary phased array feeds (PAFs) to provide wide-field observations with the sensitivity and resolution required to resolve faint and extended radio emission. I will present the some of the Widefield ASKAP L-band Legacy All-sky Blind surveY (WALLABY) Early Science results being achieve with ASKAP. WALLABY will survey three quarters of the entire sky in neutral hydrogen (HI) to probe the properties of galaxies and their environments. With only a fraction of the array – during the commissioning and Early Science phases of ASKAP – we are already detecting newly resolved HI features, such as tidal streams, intragroup gas and previously unknown HI galaxies. Using ASKAPsoft, the custom-built processing pipeline, we are now producing science-ready image cubes and source catalogues. Our most recent results verify that ASKAP is poised for full operations.

Calibrating the CHIME antenna array coupling from sky data

Tristan Pinsonneault-Marotte
University of British Columbia
Gary Hinshaw, CHIME collaboration

The Canadian Hydrogen Intensity Mapping Experiment (CHIME) has recently begun its radio survey of the northern sky. The experiment aims to produce a three-dimensional map of the large scale structure in the universe by measuring the redshifted 21 cm emission from neutral hydrogen. Detecting the baryon acoustic scale in this map will provide a standard ruler to track the accelerated expansion of space over the redshift range 0.8 to 2.5, and put the cosmological constant model for dark energy to the test. The cosmological signal is buried below astrophysical foregrounds, mainly synchrotron radiation, which are brighter by a factor of $\sim 10^5$. Separating the two signals relies on their differing spectral properties: the foreground signal is characterized by a smooth power law spectrum, whereas the cosmological signal rapidly varies over redshift (frequency). This drives stringent calibration requirements, as frequency-dependent instrumental effects can introduce spectral structure to the foregrounds that can easily dwarf the cosmological signal. CHIME is composed of four cylindrical reflectors, each with 256 dual-polarization antennas distributed along the focal line of the reflector. Cross talk between antennas within a cylinder is seen at multiple time lags, so calibrating the full instrument response will require modelling the coupling between antenna elements. In this talk I will describe the calibration requirements for CHIME and discuss the progress made towards understanding the array beam. These results are potentially relevant to other radio astronomy interferometers.

Full-sky maps from CHIME

Paula Boubel
McGill University

When the Universe was around 10 billion years old, it became dominated by dark energy and began to accelerate in its expansion. This stage in the expansion history of the Universe is crucial for distinguishing dark energy models. The Canadian Hydrogen Intensity Mapping Experiment (CHIME) is a radio telescope designed to measure the expansion during this period by mapping the large-scale distribution of neutral hydrogen gas. CHIME will directly detect the hydrogen 21 cm emission redshifted to frequencies between 400 and 800 MHz. Astrophysical foregrounds are several orders of magnitude brighter than the 21 cm cosmological signal. There is an ongoing effort to understand the instrument to the level of precision required for foreground removal. Measurements of the foregrounds are useful ancillary data products in and of themselves. To date, the best measurement of the full sky in this frequency regime is the 408 MHz map by Haslam et al. from a survey that was conducted in the 70's. As a driftscan interferometer, CHIME is uniquely capable of producing maps of the full radio sky on a daily basis. These detailed maps provide valuable astrophysical data at unexplored frequencies. In this talk I will discuss how we take advantage of the instrument's unique design to employ a non-traditional mapmaking strategy, along with its associated challenges. I will present the first CHIME maps and outline some of their potential contributions to astrophysics.

Interstellar Medium & Star Formation

Tuesday, 11:00 • Mont-Royal II

A universal route for massive cluster formation in giant molecular clouds.

Ralph E. Pudritz
McMaster Universiy
Corey Howard, William E. Harris, Alison Sills

Young massive clusters ($M \geq 10^4 M_\odot$) are proposed modern-day analogues of the globular clusters that were products of star formation in the early universe. The exact conditions and mechanisms under which young massive clusters form remain unknown − a fact further complicated by the extreme radiation fields produced by their numerous young stars. We show that massive clusters are naturally produced in radiation-hydrodynamic (RHD) simulations of isolated $10^7 M_\odot$ turbulent giant molecular clouds with properties typical of the local universe, even under the influence of radiative feedback. Feedback consists of photoionization and radiation pressure produced by the massive stars in the forming clusters. In all cases, we find that these massive clusters grow to globular cluster masses within 5 Myr via a roughly equal combination of filamentary gas accretion and mergers with less massive clusters. Lowering the heavy-element abundance of the molecular cloud by a factor of 10 reduces the opacity of the gas and better represents the high-redshift universe. This results in higher gas accretion leading to a mass increase of the largest cluster by a factor of ~4. We show that when combined with simulations of cluster formation in less massive molecular clouds ($10^{(4-6)} M_\odot$), a clear scaling relation emerges between the maximum cluster mass and the mass of the host cloud. Our results indicate that young massive clusters, and potentially globular clusters, are simple power-law extensions of local cluster formation, and importantly, are insensitive to star formation thresholds. A universal picture emerges without the need for exotic formation scenarios. We also address the application of these results to the formation of multiple stellar populations and supermassive stars in the most massive young clusters.

KEYSTONE: KFPA Examinations of Young Stellar (O-star) Natal Environments

Jared Keown
University of Victoria
James Di Francesco, Erik Rosolowsky, Ayushi Singh, and the Keystone Collaboration

Observations of dust continuum emission from Galactic giant molecular clouds (GMCs) reveal that embedded infrared clusters and massive young stellar objects tend to be located at the intersections of multiple filamentary gas structures. These observations motivate the idea that mass flow along filaments provides the high-density conditions necessary to form stellar clusters and the massive stars (> 8 solar masses) that form within them. This theory has been largely untested, however, due to a lack of large-scale spectroscopic follow-up observations of Galactic GMCs that reveal the flow of gas along or onto filaments and show the locations of dense gas structures prior to cluster formation (termed "clumps"). We present initial results from the KEYSTONE survey, a large project on the 100-m Green Bank Telescope mapping ammonia emission across eleven GMCs. Our ammonia observations not only trace the kinematics of the dense gas in those regions, but also reveal the impact that turbulence and heating have upon forming stellar clusters. We identify over 800 dense gas clumps across the eleven clouds. We find no significant difference between the virial stability of clumps aligned with filaments and those unaligned with filaments, suggesting that filaments might play a lesser role in GMCs than they do in low-mass star-forming environments. In some clouds, however, hubs of dense gas with unusually high mass are located within a single filament or at the intersection of multiple filaments. The gravitational collapse and fragmentation of these dense gas hubs may lead to the formation of massive young stellar objects and stellar clusters.

The life and death of stellar nurseries: GMCs and stellar clusters in Latte

Samantha Benincasa
University of California, Davis
Sarah Loebman, Andrew Wetzel

The connection between GMCs and star formation is complex, involving both the detailed structure of dense gas and the influence of the larger galactic environment. Connecting the evolution of GMCs and stellar clusters to larger structures in galaxies, such as spiral arms, is difficult due to the range of spatial scales. Given the dynamic range involved, it had been difficult to study GMCs in cosmological simulations. We present high resolution simulations from the Latte suite, zoom-ins of Milky Way-type galaxies, which make great strides in this respect. We present one of the first analyses of the properties of GMCs formed in the FIRE-2 cosmological simulations. With unprecedented adaptive spatial resolution down to 1 pc, we are able to resolve internal cloud-wide properties as well as the larger galactic environment. We will show intriguing first results on the distribution of GMCS and the interaction of these entities with stellar clusters, with focus on the role of these clusters in dispersing their birth environments. If time allows, I will end by discussing new results on the role of MHD pressure and cosmic ray feedback in the evolution of the GMCs.

Tracing PAH Size in Prominent Nearby Mid-Infrared Environments

Els Peeters
University of Western Ontario
Knight C., Peeters E., Tielens A.G.G.M., Stock D.J.

We present observations from the First Light Infrared TEst CAMera (FLITECAM) on board the Stratospheric Observatory for Infrared Astronomy (SOFIA), the Infrared Array Camera (IRAC) and the Infrared Spectrograph (IRS) SH mode on board the Spitzer Space Telescope in three well-known Photodissocation Regions (PDRs), the reflection nebulae (RNe) NGC7023 and NGC2023 and to the South-East of the Orion Bar, which are well suited to probe emission from Polycyclic Aromatic Hydrocarbon molecules (PAHs). We investigate the spatial behaviour of the 3.3, 7.7-8.6, and 11.2 um PAH emission bands and their ratios of 11.2/3.3 and Σ(7-9)/11.2 which we use as an approximate measure of the average PAH size and PAH ionization respectively. We find that the relative PAH ionization increases with decreasing distance to the illuminating source in both RNe. We further report that the average PAH size is at a minimum at the PDR front and increases inwards towards the illuminating source in both RNe. In addition, the average PAH sizes derived for NGC2023 are greater than those found for NGC7023 at all points. Both results indicate that the average PAH size depends on the radiation field intensity. These results thus provide additional evidence of a rich carbon-based chemistry driven by the photo-chemical evolution of the omnipresent PAH molecules within the interstellar medium. In contrast, we did not detect a significant variation in the average PAH size found in the region South-East of the Orion Bar and report a peculiar PAH ionization radial profile. These inconclusive results along with the complex morphology of this region beyond the initial edge-on PDR suggest a more in depth investigation into the photo-chemical evolution of this PAH population is required.

The dynamics of the 30 Doradus star-forming region as probed with far-infrared polarimetry

Simon Coudé
SOFIA-USRA

While the exact roles of magnetic fields and turbulence at different stages of star formation still remain poorly understood, the latest generation of polarimetric instruments at far-infrared and submillimeter wavelengths have already shown the ubiquitousness of magnetic fields from the scale of giant molecular clouds to that of protostellar cores. This presentation specifically focuses on far-infrared observations of the polarized dust thermal emission in the massive 30 Doradus star-forming complex (also known as the Tarantula Nebula) within the Large Magellanic Cloud. These publicly available data sets at 53, 89, 154, and 214 μm were obtained with the HAWC+ polarimetric camera aboard the Stratospheric Observatory for Infrared Astronomy (SOFIA). These observations were modelled using an angular dispersion analysis which provides a measurement of the turbulent-to-ordered magnetic energy in the cloud, as well estimating the typical correlation length of the magnetized turbulence cells it contains. Furthermore, these multi-wavelength observations offer a unique opportunity to probe the alignment efficiency of different dust populations in a variety of extreme environments. These provide a valuable test for grain alignment theories, such as Radiative Alignment Torques (RATs), and will prove particularly helpful in characterizing the range of conditions in which they are most efficient.

Extended Emission Rotation Measures: Observations and Toy Models of the Galactic Magnetic Field

Anna Ordog
University of Calgary
Rebecca Booth, Cameron Van Eck, Jo-Anne Brown, Thomas Landecker

Magnetic fields are a crucial component of the interstellar medium (ISM), contributing to Galactic physics on a variety of scales. Continued studies of the Galactic magnetic field (GMF) are necessary in understanding the dynamics of the Milky Way. Faraday rotation observations of extragalactic (EG) compact sources have formed the foundation for many GMF studies. The advantage of compact sources as GMF probes is that their emission can be approximated as originating from a single point in space, with Faraday rotation occurring primarily due to the magnetized plasma of the ISM. Consequently, extracting GMF information requires observations at only a handful of radio frequencies, from which the Faraday effect can be quantified as a Rotation Measure (RM). Apart from EG sources, polarised extended emission (XE) is also seen along lines of sight through the Galactic disk, but intermixing of emission and rotation within the same volume leads to XE potentially having increased complexity in terms of its Faraday rotation. An approach to extracting GMF information from the XE involves observing polarisation over a broad range of closely spaced frequencies. However, there is already an abundance of high quality polarised XE data available in the Canadian Galactic Plane Survey (CGPS) dataset, which was observed at only 4 frequencies. We have calculated RMs for the XE from the CGPS data in the same way as for the EG sources to determine the utility of this method. We found a strong correlation between the two types of sources as a function of Galactic longitude. Additionally, we found that along many lines of sight the EG and XE RMs differ by about a factor of 2, the ratio expected from a uniform structure of the ISM. We present toy models that illustrate this ratio of 2 arising from GMF and ISM configurations with non-uniform structure.

Acoustic Dynamics of Super-Eddington Outbursts and Supernova Impostors

Christopher Matzner
University of Toronto
Stephen Ro

Sound energy is a prime suspect in the driving of stellar outbursts (explosions that do not unbind an entire star), and in these events wave energy is dissipated primarily by the formation of shocks. We identify two simple rules governing one-dimensional sound propagation and weak shock evolution, even within stratified stellar structures, and verify these with numerical simulations. In addition to the stellar context, these rules are applicable to converging waves that form shocks, as in sonoluminescence.

Galaxy & Star Formation

Tuesday, 13:45 • Mont-Royal I

Resolving Problems in Galaxy Formation (Invited)

Adam Muzzin
York University

Over the past two decades studies of galaxy formation and evolution have enjoyed enormous successes. Using multi-wavelength data we have mapped the evolution of the stellar mass density and star formation density of the universe to redshifts as high as z ~ 10. While this gives us a nearly complete census of stars and star formation in the universe, we remain a very long way from understanding the physics of galaxy evolution. One problem we face is that the majority of work done so far has been done with unresolved ground-based studies. Our next step is to resolve galaxies and map out where within them stars actually form: Do galaxies build up inside-out, or outside-in? Do bulges co-evolve with their supermassive black holes? Where within a galaxy does quenching occur? In this talk I will show new results on resolved star formation from ALMA and HST, as well as stellar mass maps of galaxies from HST and new image deconvolution techniques, all of which take first steps toward answering these questions. I will also look forward to the instruments of the next decade that will allow us to resolve high-redshift galaxies in extraordinary detail. In particular I will focus on GIRMOS, our fully Canadian-funded and Canadian-built adaptive optics driven, multi-object, near-infrared, IFU spectrograph for Gemini. GIRMOS will be by far the most powerful instrument of its kind and allow us to map star formation with exquisite angular resolution for hundreds of galaxies over ~ 85% of cosmic time, revolutionizing our understanding of galaxy assembly.

Dark Matter Halo Properties as a Test of Cosmology

Nicole Drakos
University of Waterloo
James E. Taylor, Anael Berrouet, Aaron S. G. Robotham, Chris Power

The evolution of dark matter halos has been studied primarily through cosmological simulations, where halos form hierarchically through repeated mergers. Though average trends in halo evolution are well understood, it is not clear how the properties of individual halos evolve in mergers. I will present a large suite of isolated equal-mass merger simulations used to study halo evolution. Overall, we find the evolution of halo properties is linked to the amount of angular momentum and energy available in the merger; specifically, final halo properties can be predicted from two parameters (1) the spin parameter and (2) the relative change in halo internal energy. These predictions are useful for the development of semi-analytic models of halo evolution. Finally, I will introduce a potential cosmological test based on halo properties.

Kinematic Modeling of Low-Resolution Disk Galaxies

Colin Lewis
Queen's University

Reconciling the velocity function of dark matter halos in collisionless simulations with those derived observationally requires understanding how galaxies are embedded in their dark matter halos. Widefield HI surveys with SKA pathfinders such as Wallaby on ASKAP will address this issue since they will resolve the kinematics of representative samples of galaxies beyond their optical disks. These statistical samples afford constructing a velocity function out of resolved galaxies, including those with distorted kinematics that recent hydrodynamical simulations suggest make up a significant fraction of nearby systems. In order to do so, however, the kinematics of the thousands of poorly resolved galaxies that will comprise the majority of Wallaby detections will need to be modelled using novel techniques. Several new codes have been developed, but few have been tested in the marginally resolved regime. Starting from empirical scaling relations for disk galaxies in the local volume, we generate a large suite of resolved, Wallaby-like synthetic galaxy datacubes and use them to test how well their kinematics can be recovered using the Fully Automated TiRiFiC (FAT) 3D modelling code. We then simulate a mock Wallaby volume of resolved galaxy detections, use our model fitting results to determine the reliability with which the kinematics of each can be recovered, and predict the resolved galaxy velocity function that Wallaby will measure. Our ability to model galaxies with fewer than five beams across their major axes significantly increases the number of resolved detections that could contribute to the sample. We discuss how the predicted Wallaby velocity function is impacted as the sample size grows to contain these more poorly resolved galaxies.

Lensed quiescent galaxies at z~2: what quenched their star formation?

Allison Man
Dunlap Institute for Astronomy and Astrophysics

A key outstanding issue in galaxy evolution studies is how galaxies quench their star formation. I will present new results from our VLT/X-Shooter, ALMA and VLA campaign of a pilot sample of lensed quiescent massive galaxies at z>1.5. Lensing magnification enables us to spatially resolve the stellar structure and kinematics of these compact galaxies, that are otherwise barely resolvable even with HST. Our deep X-Shooter spectra provided multiple absorption lines enabling strong constraints on their stellar populations, namely their star formation rates, ages, dispersions, and in some cases metallicities. Our complementary ALMA+VLA programme probes their molecular gas content through CO emission. All these observations provide unparalleled constraints on their quenching mechanisms. Our results indicate that quiescent galaxies at z~2 (1) have short star formation timescales of a few hundred Myrs; (2) have a variety of stellar morphology from exponential disks to bulges; (3) are devoid of molecular gas; and (4) host low-luminosity active galactic nuclei which may be responsible for suppressing star formation. I will discuss the physical insights on the quenching process brought about by these findings.

DYnamics of Newly-Assembled Massive Objects (DYNAMO) Galaxy Survey

Heidi Anne White
University of Toronto - Dunlap Institute
Roberto Abraham

I will present results using DYNAMO, an extremely rare sample of nearby galaxies whose kinematic and star formation properties closely resemble that observed in z~1-2 main-sequence galaxies. Systems in DYNAMO are well-matched to high-z star-forming disks in gas fraction (f_gas~20-80%), kinematics (rotating disks with velocity dispersions ranging 20-100 km/s), structure (exponential disks), and morphology (clumpy star formation). However, DYNAMO galaxies are located at z=0.1. We therefore use DYNAMO galaxies as convenient laboratories for studying the processes governing the dominate mode of star formation in the Universe and carry out targeted, complementary studies to large surveys at high redshift. In my talk, I will report on results from our DYNAMO programs with HST, Keck, and NOEMA that are aimed at testing feedback regulated models of star formation. I will describe how we have used DYNAMO galaxies to study the impact of resolution effects in clumpy galaxies and the violent disk instability model of clumpy galaxy evolution. In particular, we have discovered a roughly linear relationship between disk kinematics (sigma_gas/V_rot) and molecular gas fraction, providing the first direct observational evidence of the role performed by the internal velocity dispersion of the gas in the formation of massive star forming clumps within galaxies. I will also describe the results of recent work on the properties (e.g. stellar masses and colours) of clumps in DYNAMO galaxies and discuss the viability of these clumps in the context of stellar feedback models.

Rapid early coeval star formation and the assembly of the most massive galaxies in the universe

Douglas Rennehan
University of Victoria
Arif Babul, Christopher C. Hayward, Connor Bottrell, Maan Hani, Scott C. Chapman

The current consensus on the assembly of brightest cluster galaxies is that they assemble their stellar mass late in the evolution of the universe. However, advances in observational techniques have led to the discovery of high-redshift protoclusters, the birthplace of brightest cluster galaxies, including a handful of cases of highly over-dense systems out to z ◎ 6. We show, using a combination of observationally constrained hydrodynamical and dark-matter-only simulations, that the stellar assembly time of a sub-set of brightest cluster galaxies occurs at high-redshifts (z > 3) rather than at low-redshifts (z < 1), as is commonly accepted. We find that the highly-overdense protoclusters form and assemble 90% their stars into a brightest cluster galaxy within ~ 1 Gyr of evolution — producing massive blue elliptical galaxies at high redshifts (z > 3). We present simulated James Webb Space Telescope observations to show that we will be able to detect and confirm our prediction of these high-redshift blue elliptical galaxies in the near future.

Compact Objects (WD/NS/BH)

Tuesday, 13:45 • Mont-Royal II

Weak makes us strong: neutrinos in the multi-messenger era (Invited)

Liliana Caballero
University of Guelph

We are entering an era of unprecedented capabilities for astronomical observations from compact objects. The analysis of signals in multiple bands, i.e., gravitational waves, gamma and X-ray emissions, will provide detailed insight about the physics of diverse astrophysical phenomena such as the synthesis of heavy elements and the mechanism of stellar explosions. Neutrinos provide extra pieces to those long standing puzzles by playing a fundamental role in the evolution of supernovae, neutron star mergers and accretion disks around black holes. In this talk, I shall discuss the connection between neutrinos and compact objects, as well as present results on gravitational wave signals and neutrino observations.

The Origin of r-process Elements in the Milky Way

Benoit Côté
Konkoly Observatory (Hungary) / JINA-CEE (USA)
C. Fryer, K. Belczynski, O. Korobkin, M. Chruslinska, N. Vassh, M. Mumpower, J. Lippuner, T. Sprouse, R. Surman, R. Wollaeger, M. Eichler, A. Arcones, C. Hansen, P. Simonetti, A. Frebel, M. Pignatari, M. Reichert, F. Matteucci

Galactic chemical evolution simulations are powerful tools to probe the origin of the elements in the Universe. However, for the evolution of r-process elements, such as gold and europium, different modeling assumptions regarding the properties of r-process sites (e.g., rate and ejecta of neutron star mergers and rare classes of supernovae) can lead to similar chemical evolution predictions. Therefore, such predictions should not be seen as the final answer, but rather as a diagnostic tool. In order to build a coherent picture of where, when, and how r-process elements have been synthesized in our Galaxy, the conclusions extracted from chemical evolution studies must be compared and combined with the messages sent by other fields of research. In this talk, I will present our effort to connect nucleosynthesis and chemical evolution studies with the gravitational wave detections of LIGO/Virgo, to quantify whether neutron star mergers can be the dominant source of r-process elements in the Universe. I will also present the challenges of reproducing the chemical evolution trends of europium, gadolinium, and dysprosium in the Galactic disc with neutron star mergers only, given the constraints provided by short-gamma ray bursts, population synthesis models, and the host galaxy of GW170817. This potentially points to an extra source of r-process elements in the early Universe.

The spectral evolution of hot white dwarf stars

Antoine Bédard
Université de Montréal
Pierre Bergeron, Gilles Fontaine, Pierre Brassard

The evolution of white dwarf stars, these compact stellar remnants that cool and fade over billions of years, appears quite simple at first glance. However, some 30 years ago, it was surprisingly discovered that the surface composition of a white dwarf can change radically as a function of time. Some aspects of this phenomenon, which is referred to as spectral evolution, remain poorly understood. In this presentation, I will discuss the spectral evolution of hot (and thus young) white dwarfs, with effective temperatures higher than 30,000 K. First, I will briefly introduce new state-of-the-art model atmospheres and evolutionary sequences appropriate to the study of these stars. Then, I will present the results of a spectroscopic analysis, performed using these new models, of close to 2000 objects identified in the Sloan Digital Sky Survey. Finally, I will show that such an analysis allows us to better characterize the variations in surface composition along a large part of the white dwarf cooling sequence.

Search for Young and Massive White Dwarfs

Harvey Richer
University of British Columbia
Ronan Kerr, Jeremy Heyl, Ilaria Caiazzo, Jeffrey Cummings, Pierre Bergeron, Patrick Dufour

Ultramassive white dwarfs set the upper-mass limit to white dwarf production and the lower limit to supernova production, which controls much of the energetics and chemical evolution of galaxies. The highest mass white dwarf currently known is 1.26 Msun, still well below the Chandrasekhar Limit of 1.38 Msun. In an attempt to find more massive white dwarfs and provide tension with the Chandrasekhar Limit, we used the Gaia database to search for young and massive white dwarfs in open star clusters. We explored all open clusters with turnoff masses between 4.5 Msun and 15 Msun (ages between 158 and 10 Myrs) and distances less than 800 pc. We report here on the discovery and subsequent spectroscopic observations with Gemini of a remarkable white dwarf in a 150 Myr-old cluster.

Stellar-mass black holes in globular clusters

Vincent Hénault-Brunet
NRC Herzberg

The growing number of (accreting) candidate stellar-mass black holes (BHs) observed in globular clusters (GCs) may represent the tip of the iceberg of a much larger population of BHs in these systems. To fully understand the evolution of BHs in clusters and the importance of dynamical formation of BH-BH binaries for gravitational wave detections, we must constrain the actual size of these BH populations at the present day. I will introduce dynamical models that are a powerful tool to indirectly quantify the population of BHs in GCs by comparison with observations of the kinematics, distribution, and mass function of visible stars within clusters, and how these are affected by the presence of BHs. I will finally show results of model fits for selected GCs which show promising dynamical signatures consistent with them hosting of a significant population of retained BHs.

Subpulse drifting studies of pulsars using the CHIME/Pulsar data.

Arun Kumar Naidu
McGill Space Institute
CHIME/Pulsar collaboration

While pulsars usually have a stable integrated profile, their single pulses, consisting of multiple subpulses, often exhibit varying intensities and shapes on a pulse to pulse basis. In some pulsars, these subpulses show a remarkable arrangement, where subpulses seem to be "marching" or drifting within the pulse window. This systematic progressive change in phase with the pulse number is called subpulse drifting. Subpulse drifting is closely related to the physical processes responsible for radio emission in pulsars. Moreover, some pulsar exhibit sudden changes in drift rates which are believed to be the manifestations of changes in the magnetospheric state of the neutron star. Systematic Systematic monitoring observations of 112 pulsars for single pulse studies have been carried out using the CHIME/Pulsar backend over the span of four months, resulting in a total of ~600 hours of data. Here, I will present results from our detailed fluctuation spectral analysis of these pulsars and their implications for the magnetospheric physics of the neutron stars.

CMB & Large-scale Structure

Wednesday, 11:00 • Mont-Royal I

The Simons Observatory: cosmology from the microwave sky (Invited)

Jo Dunkley
Princeton University

The Simons Observatory (SO) is a new CMB experiment being built in the Atacama Desert in Chile, due to begin observations in the early 2020s. SO will measure the temperature and polarization anisotropy of the CMB using 60,000 detectors measuring the sky in six frequency bands, and will see both primary and secondary signals. The observatory will have three 0.5-m telescopes and one 6-m telescope. I will describe SO's goals: to characterize the primordial perturbations and look for primordial gravitational waves, to measure the mass of neutrino particles and the number of relativistic species, to test for deviations from a cosmological constant, to improve our understanding of galaxy evolution, and to constrain the duration of cosmic reionization. Much of this science will benefit from combining secondary CMB effects with data from optical surveys, in particular with LSST and DESI.

Beyond Planck 2019: Detecting Intermittent Primordial non-Gaussianities in 2D CMB and 3D Large Scale Structure Surveys

J. Richard Bond
Canadian Institute for Theoretical Astrophysics
J. Braden, J. Chakrani, Z. Huang, G. Stein

I will describe our Planck 2019 Legacy work on how remarkably Gaussian the CMB and early Universe is, through general "isotropy and statistics" tests on CMB temperature and E-polarization maps, and derived early Universe inflation-epoch maps of isotropic strain. Constraints on specific primordial non-Gaussian patterns correlated with the underlying dominant Gaussian through a single perturbation parameter are significantly stronger. However novel primordial non-Gaussianities characterized by spatial intermittency are well-motivated theoretically, related to bursts of particle creation, are not strongly 2D CMB-constrained so far, though the Planckian low-multipole anomalies are intriguing. 3D Large Scale Structure Surveys that add the redshift dimension should improve detectability, and LSS examples using a halo-like model, but in strain-space, for the intermittency computed in early Universe simulations will illustrate the possibilities and the difficulties.

The mass-to-light ratios of filaments in the Cosmic Web

Tianyi Yang
University of Waterloo
Mike Hudson, Niayesh Afshordi

The Cold Dark Matter cosmology predicts that dark matter halos are expected to be connected by filaments in the “Cosmic Web”. Recently, our team detected these dark-matter dominated filaments via weak lensing (Epps & Hudson 17), but it was unclear how dark the filaments are. In this study, by stacking the light from galaxies between ~500,000 LRG (luminous red galaxy) pairs selected from Sloan Digital Sky Survey Data Release 14 (SDSS DR14)/Baryon Oscillation Spectroscopic Survey (BOSS), we investigate the average luminosity of filaments. In order to enhance the signal, we construct two equal-sized catalogues of physical LRG pairs and non-physical LRG pairs that are only paired in 2D projected plane and stack them together, and the subtraction between two maps indicates the excess light between the two LRGs. Combining the results obtained from this study with the filament mass determined from the weak gravitational lensing, we estimate the total mass-to-light ratio of the filaments and make a comparison between this value and the M/L ratio determined from galaxy halos or clusters.

A Comparison of Superclustering in the Cosmic Web: ACTxDES Data vs. Peak-Patch Simulations

Martine Lokken
University of Toronto
J. Richard Bond, George Stein, Alexander van Engelen

Cosmological theory and observations have determined that on the largest scales, matter in the universe is distributed along a web-like structure. Dense galaxy clusters are bridged by filaments, which form the edges to large underdense void regions. Comparing the details of filaments, the largest structures in the universe, between simulations and data may provide new insight into cosmic structure formation models. The thermal Sunyaev-Zel’dovich (tSZ) effect is typically used to identify the hot dense gas in clusters, but also provides additional signal from the less dense inter-cluster gas. In this project, we make use of recent high-resolution tSZ maps from the combined data of the Atacama Cosmology Telescope and Planck satellite. We stack images of clusters at similar redshifts, orienting each image by its most likely axis of superclustering and aligning the stacks along this axis. The orientation of filaments is inferred from the surrounding galaxy field of each cluster, constructed with data from the Dark Energy Survey and Baryon Oscillation Spectroscopic Survey. We perform identical methods on mock tSZ maps produced by the Peak-Patch simulations, using simulated halo catalogs to mimic the galaxy survey data. We compare the multipole expansion of the resulting stacks to test theory against observations at varying redshifts.

Mapping the stochastic gravitational wave background

Dagoberto Contreras
York University

With the recent detection of gravitational waves from binary black hole/neutron star mergers an immediate follow up question arises. What about the events we cannot detect? That is, what about the events occurring below the noise level of the detectors? What information is contained in the background? This stochastic background of events can be detected via a time-delayed cross-correlation of the strain signal between any two detectors. This idea has been used to look for anisotropies of the background. We demonstrate a simple method (optimal in the Gaussian limit) to search for such a signal in harmonic space, and apply it to generate Stokes I, Q, U, V maps of the stochastic gravitational wave background signal. The method can be used with an of the assumed frequency dependence of the signal, or in a large number of frequency bins to reconstruct the frequency dependence. The technique is applied to current LIGO and VIRGO data and the subsequent maps are used in cross-correlation with other tracers of matter (Lensing, tSZ, etc.). We discuss the differences between detecting such a signal in auto- and cross-correlation.

Canadian Participation in the LSST

Wesley Fraser
NRC-Herzberg
James Di Francesco, Gwendolyn Eadie, Melissa L. Graham, Renee Hlozek, JJ Kavelaars, John Ruan

The Large Synoptic Survey Telescope will revolutionize optical wide-field astronomy while opening the window to short time-domain astronomy. Many astronomy communities, like the Canadian community, largely do not have membership in the LSST, but could benefit from its data products. We have conducted a survey of the Canadian community to gauge their interests with the LSST, and what data products are most desirable. We will summarize the results of this survey. In particular, we have found that the astronomy research of Canadians would greatly benefit from having access to the LSST. Canadian astronomers fall broadly into two categories: those interested in time domain, and the LSST's alerts; and those interested in more classical wide-field astronomy of the stationary sky. We have identified 4 data products in particular which the majority of responders desired. These data products represent a relatively low data volume compared to the full LSST pixel-to-catalog products, and present the opportunity to host a so-called LSST-light data centre. We will discuss this survey, and how it could act as a national facility, which would largely satisfy the LSST-related data needs of the vast majority of Canadian astronomers, and would provide LSST data enhanced by Canadians, for Canadians.

Stars & Stellar Populations

Wednesday, 11:00 • Mont-Royal II

SDSS-V: Pioneering Panoptic Spectroscopy (Invited)

Juna A. Kollmeier
Carnegie Institution for Science

I will describe the current plans for the Fifth Generation of SDSS. SDSS-V is an unprecedented all-sky spectroscopic survey of over six million objects. It is designed to decode the history of the Milky Way galaxy, trace the emergence of the chemical elements, reveal the inner workings of stars, and investigate the origin of planets. It will provide the most comprehensive all-sky spectroscopy to multiply the science from the Gaia, TESS and eROSITA missions. SDSS will also create a contiguous spectroscopic map of the interstellar gas in the Milky Way and nearby galaxies that is 1,000 times larger than the state of the art, uncovering the self-regulation mechanisms of galactic ecosystems. It will pioneer systematic, spectroscopic monitoring across the whole sky, revealing changes on timescales from 20 minutes to 20 years. I will highlight key areas of current scientific and technical development as well as opportunities to participate in the survey design in multiple sectors.

Insights Into Stellar Magnetism With TESS: Are magnetic A-type stars far more common than previously believed?

James Sikora
Queen's University
Gregg Wade, Alexandre David-Uraz, Viktor Khalack, Oleksandr Kobzar

Along with detecting thousands of new exoplanets, the recently launched Transiting Exoplanet Survey Satellite (TESS) is yielding new and exciting insights in the field of stellar magnetism. Only a small fraction of main sequence A-type stars are known to be magnetic; however, surprisingly the all-sky high-precision and high-cadence photometric measurements provided by TESS have already revealed a large number of A-type stars that exhibit rotationally modulated light curves — a telltale sign of magnetic activity. Such findings, if confirmed, would challenge our current understanding of how these objects are able to sustain magnetic fields whose influences are apparent at the stellar surface. We will present our recent search for candidate rotationally variable A-type stars based on the early TESS data releases. The identification of these objects is particularly important because, unlike the stars observed within the similarly designed Kepler mission, many of the TESS targets are bright enough to allow for follow-up high-precision magnetic and spectroscopic measurements to be obtained.

Reconstructing the Milky Way Formation History from Its White Dwarfs

Nicholas Fantin
University of Victoria
Patrick Côté, Alan McConnachie

As the remnants of stars with initial masses less than ~8-10 solar masses, white dwarfs contain valuable information regarding the formation history of stellar populations as a whole. In this talk, I will present a newly developed white dwarf population synthesis code which returns mock observations of a white dwarf population given a prescription for the star formation history and geometry of the Milky Way, while simultaneously taking survey parameters into account. We use photometric data from the Canada France Imaging Survey, Pan-STARRS DR1, as well as astrometry from Gaia DR2 to select ~30,000 white dwarf candidates in order to simultaneously fit the star formation history for the thin disc, thick disc, and halo of the Milky Way using the Approximate Bayesian Computation MCMC code astroABC. The resulting star formation history and mass assembly will be presented, showing a burst of star formation from ~11.8-9.8 Gyr in the thick disc, followed by a period of relative inactivity, before the thin disc begins forming stars at a roughly constant rate for 7.4 Gyr.

I will finish with a discussion on future uses for our white dwarf population synthesis code in the era of WFIRST, LSST, Euclid, and Castor.

Chemical Properties of the Galactic stellar Disk and Halo: Low- and Medium-Resolution Spectroscopic Sample of M dwarfs and M subdwarfs

Neda Hejazi
Georgia State University
Sebastien Lepine, Derek Homeier, R. Michael Rich, Michael M. Shara

Due to their ubiquity and very long main sequence lifetimes, M dwarfs provide an excellent tool to study the formation and chemical enrichment history of our Galaxy. Owing to their intrinsic faintness, the acquisition of high-resolution, high signal-to-noise spectra of low-mass stars has been limited to small numbers of very nearby stars, mostly from the Galactic disk population. On the other hand, large numbers of low- and medium-resolution spectra of M dwarfs from both the local Galactic disk and halo are available from various surveys. In order to fully exploit these data, we have developed a pipeline to automatically determine the effective temperature, metallicity, α-element enhancement and surface gravity of M dwarfs/subdwarfs using the latest version of BT-Settl model atmospheres. We have applied this pipeline to a sample of around 1500 high-proper motion ($\mu > 0.4''$/yr) M dwarfs/subdwarfs, collected from low/medium-resolution observations at the MDM observatory. The Hertzsprung-Russell diagram assembled using Gaia DR2 parallaxes and magnitudes, and the reduced proper motion diagram show that stars with different metallicity ranges fall into clearly distinct loci, which can be used to distinguish different populations in larger surveys. More importantly, we find that the [α/Fe] vs. [M/H] diagram, which has been used for more massive stars to identify the components of the Galaxy , also reveals interesting substructures in the Galactic disk and halo.

Unravelling the Chemistry of Our Nearest Stellar Neighbours with SPIRou

Farbod Jahandar
Université de Montréal – iREx
René Doyon, Étienne Artigau

Constraining the chemical abundance of different elements in M dwarfs have been a challenging task as their optical spectra are dominated by different molecule bands (i.e. TiO) with lack of a clear continuum and few atomic lines. Therefore, metallicity of M dwarfs has usually inferred empirically and indirectly through infrared (IR) photometry and spectroscopy of the M dwarf companions. Currently, thanks to the high-resolution spectrograph of SPIRou at CFHT, independent high-resolution IR spectroscopy of M dwarfs have been enabled. In this work, we present a high-resolution chemical analysis of Barnard's star spectrum. The chemical abundances of 16 different elements are determined through the examination of over 300 absorption lines using Chi-squared minimization in multidimensional parameter space. Such analysis for an M dwarf is the first of its kind to date. These tools will be applied on dozens of our nearest neighbours (all within 7 pc) from the SPIRou Legacy Survey. This will be a critical component for a better understanding of the chemical evolution of M dwarfs and also can heavily contribute to chemical and dynamical improvements of the current synthetic stellar models.

Modelling offset-dipoles with ADM

Melissa Munoz
Queen's University
Gregg Wade

Surface magnetic fields can significantly alter the evolution and fate of a star. For massive stars, the presence of a magnetic field channels their strong ouflowing winds into the formation of a magnetosphere via magnetic confinement. This significantly reduces their mass-loss rates and rotation rates. A small subset of Galactic O-type stars are known to possess strong, organized and predominantly dipolar magnetic fields. They are oblique magnetic rotators and, as a result, are expected to exhibit periodic rotational modulations across several observational quantities, namely in their photometric brightness, line-of-sight magnetic field strength, and line emission strength. The dynamical magnetospheres of magnetic O-type stars are complex, co-rotating structures that are formally modelled using computationally expensive MHD simulations. However, recently, an Analytical Dynamical Magnetosphere (ADM) model has been developed (Owocki et al.2016). The ADM model assumes a dipolar field topology and is capable of quickly computing the temperature, velocity and density structure of a stellar magnetosphere. In earlier papers (e.g. Munoz 2019), we have used ADM to reproduce the photometric and polarimetric variability of magnetic massive stars as a means to infer or constrain their magnetic and wind properties. In this presentation, we expand to ADM model to an offset-dipole field topology. This break in axial symmetry causes unique magnetic signatures to appear in their observable quantities. Such asymmetric features have previously been seen in the photometry and spectroscopy of magnetic massive stars and can now be more accurately reproduced.

Galaxy Clusters & Groups

Wednesday, 13:45 • Mont-Royal I

Probing the particle nature of dark matter with strong gravitational lensing (Invited)

Yashar Hezaveh
Flatiron Institute – University of Montreal
Laurence Perreault Levasseur, Warren Morningstar, Neal Dalal, Gil Holder, and the SPT-DMS collaboration

The nature of dark matter is one of the most important outstanding questions in modern cosmology and astrophysics. Uncovering the properties of the dark matter particle could result in significant leaps in our understanding of fundamental physics and impact numerous astrophysical models. It is well understood that the microphysics of the dark matter particle impacts its clustering properties on different scales. The most widely accepted dark matter model, cold dark matter, has had tremendous success explaining the large-scale structure of the universe. However, it has faced many challenges for its predictions of the distribution of matter on small, sub-galactic scales, with some observations seemingly favoring a warm dark matter alternative. A definitive answer to this question can only be achieved by mapping the distribution of dark matter on small scales with a purely gravitational probe. Strong gravitational lensing is the only probe capable of doing this at cosmological distances. In this talk, I will discuss how the discovery of a new population of strong gravitational lenses, a new observatory, ALMA, and new advances in analysis methods are allowing us to map the distribution of dark matter on small scales with high precision. In the coming years, thousands of new lenses from large surveys (e.g., LSST), existing and new facilities (e.g., ALMA, JWST, TMT), and new analysis methods (machine learning) will transform this field, allowing us to understand the small-scale behavior of dark matter with unprecedented accuracy and precision, opening a new window for testing dark matter models in a previously inaccessible regime.

New Insight about the Origin of Mini-Halos in Clusters of Galaxies

Annabelle Richard-Laferrière
Université de Montréal
J. Hlavacek-Larrondo, M. Latulippe, G. B. Taylor, J. S. Sanders, M. T. Hogan, A. C. Edge, M. Gendron-Marsolais, A. C. Fabian, R. S. Nemmen, C. L. Rhea and G. Demontigny

Clusters of galaxies host the most diverse and interesting phenomena in the Universe. Radio mini-halos are one of them, diffuse radio sources that give an observational signature to the very dynamic and active central regions of cool core clusters. Radio mini-halos arise from relativistic particles in a magnetic field. However, this radio emission is located too far from the relativistic particles source, the central Active Galactic Nucleus (AGN), implying that the particles must be reaccelerated or created in situ. Unfortunately, the explanation is not complete understood; therefore, their origin remains unknown. Moreover, only a few mini-halos have been discovered so far. I will report on the discovery of two new mini-halos based on new VLA observations (PKS 0745-19 (z=0.1028) and MACS J1447.4+0827 (z=0.3755)), as well as a compilation from the literature of the 27 known mini-halos. This compilation allows us to compare properties of mini-halos to those of their host cluster of galaxies and find new, previously unknown, correlations between the radio power of the mini-halo and of the dominant galaxy of the cluster (Brightest Cluster Galaxy), as well as between the radio power of the mini-halo and the X-ray cavity power created by the central AGN. We also compare the mini-halo radio power and the cluster mass. The implication of the discovered relations will be discussed.

SPT2349: A massive proto-cluster at redshift 4

Ryley Hill
University of British Columbia

The South Pole Telescope has discovered a handful of distant proto-clusters in a 2500 deg^2 survey at 1.4mm. SPT2349 is likely the most extraordinary of these objects, with a mass of at least 10^13 M_sol and a total star-formation rate of over 20,000 M_sol/year. Spectroscopic follow-up has placed this proto-cluster at z=4.3, only 1.5 Gyr after the Big Bang; it will likely reach a mass of 10^15 M_sol at z=0, making it one of the most massive structures in the observable Universe. However, understanding how such a massive structure evolved so quickly is a challenge. I will present a suite of new ALMA observations targeting SPT2349, including an expanded mosaic of the outer regions of the structure and super-deep molecular gas imaging, reaching the limit of the luminosity function. I will discuss what these new observations tell us about how the most extreme large-scale structures formed in the early Universe.

Linking galaxy quenching and ICM density in low-redshift clusters

Ian Roberts
McMaster University
Laura Parker, Toby Brown, Gandhali Joshi, Julie Hlavacek-Larrondo, James Wadsley

We study the influence of the dense intra-cluster medium (ICM) on star formation quenching in satellite galaxies of Sloan Digital Sky Survey galaxy clusters with high-quality Chandra X-ray data. We find that the fraction of quenched, low-mass galaxies increases modestly at ICM densities below a threshold before increasing sharply beyond this threshold toward the cluster center. The quenching of these galaxies at high ICM density is well matched by a simple, analytic model of ram pressure stripping. These results are consistent with a framework where low-mass cluster galaxies experience an initial, slow-quenching mode driven by steady gas depletion, followed by rapid quenching associated with ram pressure stripping near the cluster center. Finally, we will present preliminary results from a detailed study of the connection between environmental quenching and ICM density in the Coma cluster, using MANGA integral field spectroscopy and very deep XMM-Newton X-ray data.

Quenching in GOGREEN Galaxy Groups at 1<z<1.5

Andrew Reeves
University of Waterloo
Michael Balogh, GOGREEN collaboration

It is not well understood how the stellar mass of galaxies grows relative to their host dark matter halos. I will present new results from the GOGREEN survey on the properties of galaxy populations within low mass groups at 1<z<1.5. Specifically, I will show measurements of the red and blue sequence stellar mass functions of galaxies groups in the COSMOS and SXDF survey regions. Surprisingly, we find that evidence for environmentally differential evolution is mild, at best. This is in contrast with results from surveys at z<1 which indicated that the quenching of star formation is significantly enhanced in groups. This suggests that the gas stripping processes that operate on satellite galaxies at z<1 are greatly suppressed in small dark matter haloes at higher redshift. These results will be compared with preliminary results on higher mass clusters from the GOGREEN survey, and lower redshift systems, which will ultimately allow a determination of the redshift and halo mass where different mechanisms for star formation quenching kick in.

A multi-scale low radio frequency view of the Perseus cluster

Marie-Lou Gendron-Marsolais
European Southern Observatory
J. Hlavacek-Larrondo, R. J. van Weeren, T. Clarke, A. C. Fabian, H. T. Intema, G. B. Taylor, K. M. Blundell and J. S. Sanders

Jets created from accretion onto supermassive black holes release relativistic particles on large distances. These strongly affect the intracluster medium when located in the center of a brightest cluster galaxy. On the other hand, the hierarchical merging of subclusters and groups, from which cluster originate, also generates perturbations into the intracluster medium through shocks and turbulence, constituting a potential source of reacceleration for these particles. In this talk, I will present deep multi-scale low radio frequency (230-470 MHz) observations of the Perseus cluster from the Karl G. Jansky Very Large Array, probing the non-thermal emission from the old particle population of the AGN outflows. Our observations of this nearby relaxed cool core cluster have revealed a multitude of new structures associated with the radio lobes and the mini-halo. The irregular morphology of the mini-halo, extending on hundreds of kpc in size, seems to have been influenced both by the AGN activity and by the sloshing motion of the cluster's gas. In addition, it has a filamentary structure similar to that seen in radio relics found in merging clusters. Furthermore, I will analyze the interplay between these radio structures and the optical filaments of NGC 1275, the Perseus cluster's brightest galaxy, based on observations with the optical imaging Fourier transform spectrometer SITELLE (CFHT). Finally, the Perseus cluster hosts several interesting head-tail radio galaxies (NGC 1265, NGC 1272, IC310 and CR 15) on which I will also present an analysis of the morphology and spectral index distribution.

Long-Period Planets

Wednesday, 13:45 • Mont-Royal II

Observational Planet Formation (Invited)

Ruobing Dong
University of Victoria

Planets form in gaseous protoplanetary disks surrounding newborn stars. As such, the most direct way to learn how they form from observations, is to directly watch them forming in disks. In the past, this was difficult due to a lack of observational capabilities, and planet formation was a subject of theoretical research. Now, thanks to a fleet of new instruments with unprecedented resolving power that have come online in the past decade, we have just started to unveil features in resolved images of protoplanetary disks, such as gaps and spiral arms, that are most likely associated with embedded (unseen) planets. By comparing observations with theoretical models of planet-disk interactions, the properties of these still forming planets may be constrained. Such planets help us test planet formation models. This marks the onset of a new field: observational planet formation. I will introduce the current status of this field, highlight some of the latest developments, and discuss where this field is heading.

Constraining the distribution of giant planet on wide orbits from a compilation of direct imaging surveys

Frédérique Baron
Université de Montréal
David Lafrenière, Étienne Artigau, Jonathan Gagné, Julien Rameau, Philippe Delorme, Marie-Eve Naud

The direct imaging method has lead to the discovery of very interesting giant exoplanets in the last 15 years. While a large number of stars were probed in hope to find companion, only about 20 giant exoplanets were discovered. We compiled and used the results from several direct imaging surveys in the literature with a Bayesian and Markov chain Monte Carlo approach to explore the occurrence rate and distribution of 1–20 Mjup companions at separation of 5–5000 au. Our overall sample of 344 unique target host stars includes only confirmed members of nearby young associations. Overall, the occurrence of companions is anticorrelated with the semi-major axis and the companion mass but is correlated with the stellar host mass. The mass distribution we find is in good agreement with other distributions found by direct imaging surveys but is shallower than the distributions inferred by radial velocity studies of gas giants in the 1–3 au range.

Exoplanet Imaging: Current Limitations and the Path Forward

Benjamin Gerard
University of Victoria
Christian Marois, Raphael Galicher, Thayne Currie, Jean-Pierre Veran

Direct detection and detailed characterization of exoplanets using extreme adaptive optics (ExAO) is a key science goal of both current and future extremely large telescopes. However, both chromatic and temporal wavefront errors currently limit the sensitivity of this endeavour. In this talk I will first demonstrate the limitations set by chromatic wavefront errors using on-sky data taken with the Subaru Coronagraphic ExAO system. I will then present simulations and laboratory validation of the Fast Atmospheric Self-coherent camera Technique (FAST), a new approach that our Victoria ExAO group has developed to remove the current limitations set by temporal wavefront errors. I will lastly discuss ongoing plans for FAST testing at the NRC NEW EARTH laboratory, and future implementation, including an upgrade of the Gemini Planet Imager. The sensitivity improvement from techniques such as FAST will play an essential role in the future ground-based detection and characterization of lower mass and/or colder exoplanets.

Getting Better at Measuring the Galactic Distribution of Planets with Spitzer

Lisa Dang
McGill University
Sebastiano Calchi Novati, Sean Carey

Gravitational microlensing is a powerful tool that allows us to discover planets through the gravitational effect they have on light from more distant sources. Unlike most other planet detection methods, gravitational lensing does not rely on the detection of photons from the planet or its host star. Therefore, this method allows us to probe planets well outside of the Solar neighbourhood. In addition, gravitational microlensing is most sensitive to detecting planets beyond the snow line and Solar System analogs, a category of planets that is also difficult to detect with other methods. Since 2015, the Spitzer team is leading a microlensing observational campaign towards the Galactic Bulge following up microlensing events alerted by ground-based surveys. Simultaneous observations of microlensing events from two distant observatories allow for the measurement of microlensing parallax which allows us to measure both the lenses' mass and distances. The main scientific drive of this campaign is to build a galactic distribution on planets towards the bulge of the Milky Way. As microlensing events are mostly unpredictable, surveys toward the bulge are favorable, however, photometry extraction in crowded fields is challenging. In this talk, I will present results from this Spitzer Microlensing campaign and our efforts in obtaining exquisite level of photometric precision with Spitzer.

Neptune's Mean-Motion Resonances are Full of TNOs

Samantha Lawler
NRC-Herzberg
the OSSOS Team

The Outer Solar System Origins Survey (OSSOS) was a large program carried out over 5 years on the Canada-France-Hawaii Telescope, which detected and tracked over 800 trans-Neptunian objects (TNOs) while carefully measuring all survey biases. Over 300 of these TNOs are measured to be in orbital mean-motion resonances with Neptune. Because all of the biases are tracked in OSSOS, we can use the OSSOS Survey Simulator to construct unbiased orbital models of each TNO subpopulation, providing the most accurate measurements to date of the Kuiper Belt orbital distribution. Resonant TNOs have particular observing biases that must be accounted for, due to their spirograph-like orbits relative to Neptune. The population ratios and orbital distributions of the resonant TNOs provide constraints on Neptune's migration, as well as the makeup of the proto-Kuiper Belt. The fact that so many TNOs inhabit high-order resonances also provides interesting constraints on resonant sticking timescales, transient TNO populations, and possible additional planets in the Solar System. These detailed orbital measurements of the Kuiper Belt can be used to construct realistic debris disk models and inform theories of exoplanet migration.

Signatures of vortices in protoplanetary disks: dust asymmetries and clumps along disk rings

Nienke van der Marel
NRC Herzberg
Maryum Sayeed, Ruobing Dong, Paola Pinilla, Til Birnstiel, Marco Tazzari

ALMA has revealed a large diversity of dust structures in protoplanetary disks, in particular rings and gaps. However, several systems also contain asymmetric dust rings or 'clumps', which are thought to be caused by dust-trapping long-lived vortices, which could act as the start of the formation of a planetary embryo. As the majority of disks observed at high angular resolution is axisymmetric, it is possible that the small fraction of disks with azimuthal asymmetries is caused by the limited lifetime of the dust trap in the vortex compared to the lifetime of the disk. Interestingly, asymmetric disks all show spiral arms in scattered light images, suggesting that these two phenomena have a common origin. We have developed a new analysis method through MCMC modeling of ALMA continuum visibility data to quantify asymmetric disk structures and have applied these to new ALMA datasets of asymmetric disks: RY Lup and Oph IRS 48. I will present the results of this analysis and discuss the implications for the origin, lifetime and dust growth potential of vortices, and relate them to the planet formation process.

Transients

Thursday, 11:00 • Mont-Royal I

Mapping the sky with CHIME - a digital radio telescope (Invited)

Kiyoshi Masui
Massachusetts Institute of Technology
The CHIME and CHIME/FRB Collaborations

Recent years have seen a surge in the construction of a novel class of radio telescope: compact transit interferometers, which have no moving parts and "steer" solely via digital signal processing. Making use of mass-produced analogue and digital hardware, such instruments are capable of mapping the sky with unprecedented combination of sensitivity, field-of-view, and bandwidth. At the forefront of this surge is the Canadian Hydrogen Intensity Mapping Experiment (CHIME), which is making the largest-ever three-dimensional map of the large-scale structure of the Universe through the 21 cm line from neutral hydrogen. This map will enable precise measurements of the expansion of the Universe to understand its anomalous acceleration and the dark energy hypothesized to be driving it. CHIME is simultaneously discovering large numbers of fast radio bursts opening a new era in the study of this enigmatic phenomena. The remarkable scalability of transit interferometers will ultimately enable construction of instruments with several orders of magnitude greater mapping speed, opening a broad discovery space for new phenomena and fundamental physics.

Constraining the Locations of Fast Radio Bursts in their Host Galaxies

Pragya Chawla
McGill University
The CHIME/FRB Collaboration

Fast Radio Bursts (FRBs) are bright, extragalactic, millisecond-duration events of unknown origin, detectable at radio frequencies. Ever since the Canadian Hydrogen Intensity Mapping Experiment (CHIME) telescope, based in Penticton, BC, has come online, the number of FRB detections has greatly increased. The first thirteen FRBs discovered with CHIME had a slew of interesting properties with seven of them showing significant scattering (pulse-broadening introduced due to propagation in the inhomogeneous intervening medium) across the CHIME bandwidth of 400-800 MHz. Here we show how the observed scattering properties of the

CHIME/FRB sample can be useful in determining preferred locations of FRBs within their host galaxies. I will discuss simulations of FRBs in Milky-Way like host galaxies that we performed, the results of which suggest that FRBs are located in extreme environments with stronger scattering properties than the quiescent ISM of the Milky Way, such as HII regions or the vicinity of super-massive black holes.

Fast radio burst morphology with CHIME

Ziggy Pleunis
McGill University
The CHIME/FRB Collaboration

Fast radio bursts (FRBs) are millisecond-duration extragalactic radio transients of elusive origin. The bursts exhibit a variety of time-frequency structures, shaped by an unknown emission mechanism and transformed by propagation through an ionized and inhomogeneous medium. At least two sources of FRBs repeat and show bursts with downward-drifting sub-pulses that have so far not been seen in non-repeating FRBs. The Canadian Hydrogen Intensity Mapping Experiment (CHIME) is a 4-cylinder 80m x 100m transit radio interferometer, located at the Dominion Radio Astrophysical Observatory near Penticton, B.C. The CHIME/FRB experiment has started detecting a large number of (repeating) FRBs in the 400-800 MHz octave and will gather an unprecedented catalog of bursts, all detected with the same instrument and similar selection function. Here, we show how we use the morphology of FRBs to classify the CHIME sample, to try and distinguish between repeating and non-repeating sources and as a probe of FRB emission and propagation.

VLBI Efforts in support of CHIME/FRB

Tomas Cassanelli
University of Toronto
K. Vanderlinde, M. Rahman

Fast Radio Bursts (FRBs) are bright, unresolved, and possibly repeating millisecond flashes, which are primarily found at high galactic latitudes. From past observations it is known that they have an extragalactic origin, and hence can potentially be probes for cosmology. FRBs are especially complicated to observe due to their short duration, and consequently, they cannot be located within an arcsecond accuracy using single-dish telescopes. The CHIME/FRB collaboration has found more than 300+ FRBs, including repeating sources, and has mapped the FRB distribution and estimated the positions of these sources in the sky. Unfortunately, CHIME is only able to find sources at an arcsecond precision, hence we are unable to determine single-burst FRB galactic hosts. Localization is a fundamental constraint for FRBs: by knowing their galactic hosts we can open a window on the astrophysical mechanism that generated these enigmatic phenomena. The VLBI-FRB project will perform Very Long Baseline Interferometry (VLBI) across Canada to localize single-bursts FRBs, with efforts focused on an initial outrigger station at the Algonquin Radio Observatory (ARO). In this talk, I will explore the potential use of a decommissioned 10-m single-dish telescope at ARO for the purpose of FRB localization. By equipping the ARO dish with a CHIME feed, the beam of the ARO telescope will overlap a portion of the CHIME field of view equivalent to 32 of CHIME's beams, and will allow us to perform VLBI between the two telescopes. I will present our current progress on building the system pipeline and establishing communication between the CHIME and ARO sites, which is crucial in carrying out these high-precision observations. I will then focus on our efforts to cross-correlate data between the two telescopes, the tool to transform baseline to angular localization. This will present us with the highest spatial resolution observations of FRBs to date.

Probing the Time Domain with High Spatial Resolution

Scot Kleinman
Gemini Observatory

Early next decade, the Large Synoptic Survey Telescope (LSST), operating on Cerro Pachón in the Chilean Andes, will revolutionize the young field of Time Domain Astronomy through its wide-field, multi-band optical imaging survey. At the same time, the James Webb Space Telescope (JWST), orbiting at the Sun-Earth L2 Lagrange point, will provide stunningly high-resolution views of selected targets from the red end of the optical spectrum to the mid-infrared. However, the spatial resolution of the LSST observations will be limited by atmospheric seeing, while JWST will be limited in its time-domain capabilities. This talk highlights scientific opportunities in the interstitial space between these two landmark missions, i.e., science enabled by systems capable of astronomical observations with both high cadence in the time domain and high resolution in the spatial domain. The opportunities range from constraining the late phases of stellar evolution in nearby resolved populations to constraining dark matter distributions and cosmology using lensed transient sources. I conclude by describing a system that can deliver the required capabilities.

Improving the Lomb-Scargle Periodogram: A New Method for Time Series Analysis in Astronomy

Gwendolyn Eadie
University of Washington
Aaron Springford, David Thomson

Time series data are becoming more prevalent in astronomy and astrophysics. Thousands of lightcurves are available from the Kepler spacecraft, and millions more are arriving and will arrive thanks to spacecraft and surveys like the Transiting Exoplanet Survey Satellite (TESS), the Zwicky Transient Facility (ZTF), and the Large Synoptic Survey Telescope (LSST). Periodic signals in lightcurve data — which are of interest to astronomers — are usually searched for in the frequency domain by estimating the spectral power density (or power spectrum) of the time series. Because these time series data are often unevenly-sampled in time, a popular way to identify periodic signals is through the Lomb-Scargle (LS) periodogram (Lomb 1976, Scargle 1982). Unfortunately, the LS periodogram is (1) statistically inconsistent, (2) biased, and (3) suffers from an issue called spectral leakage. The LS periodogram is designed to identify the single strongest periodic signal in time series with white noise – it can perform poorly when there are multiple signals and/or non-white noise (Scargle, 1982). In this talk, I will demonstrate the shortcomings of the LS periodogram, and introduce a better method that should allow astronomers to answer a variety questions using the abundance of time series available now and in the near future.

Short-Period Planets

Thursday, 11:00 • Mont-Royal II

First Results and the Bright Future of the TESS Mission (Invited)

Diana Dragomir
MIT/UNM

Nearly halfway through its primary mission, TESS has already brought about the discovery of tens of exciting new exoplanet systems. I will give an overview of TESS results so far, and I will describe the vibrant community process that leads from the discovery to the confirmation of TESS planets. The most conspicuous legacy of TESS will be the discovery of individual systems suitable for detailed atmospheric characterization. But I will argue that the survey can also revolutionize the exoplanet field by dramatically increasing the number of small exoplanets accessible to a wide swath of follow-up observations, including mass and obliquity measurements, thanks to their bright host stars. This ensemble of well-characterized exoplanets will open previously inaccessible avenues for statistical studies. In the coming months and years, the community will leverage this enhanced ensemble to uncover new trends and gain deeper insights into the composition, system architecture, and ultimately the formation of small exoplanets. Finally, I will discuss TESS' growing impact on solar system, stellar, galactic and extragalactic science as well.

One Hit Wonders: Hunting the longest-period TESS planets

Carl Ziegler
University of Toronto
Suresh Sivanandam, Adam Butko, Emily Deibert, Masen Lamb

TESS is searching nearly the entire sky for transiting planets around nearby, bright stars. Most of the sky will only be observed by TESS for 27 days, however, meaning most of the planets detected will have short orbital periods. Around a thousand longer period planets will have a single transit observed by TESS. The ephemerides of these planets will remain largely unconstrained without subsequent transit observations, and it is likely the majority of these planets will be unrecovered in the foreseeable future. The One Hit Wonders survey will hunt subsequent transits from these planets using a robotic half-meter telescope. These observations will help confirm the longest period planets that TESS will detect. These planets will generally orbit bright stars, populating a currently sparse regime in the orbital-period versus host-star magnitude parameter space for transiting planets, making them excellent targets for atmospheric spectroscopy. At present, the characterization of exoplanet atmospheres has largely been performed on short-period planets, in part due to the paucity of suitable targets. Subsequently little is known about the atmospheric composition of exoplanets far from their host stars, with several magnitude less stellar insolation. These planets are sufficiently cool for many heavy molecules such as water, with its dense forest of absorption lines, to condense out, making it possible to detect gases such as methane.

A year after first light: SPIRou status update

Etienne Artigau
Université de Montréal
René Doyon

SPIRou is a precision near-infrared spectropolarimeter currently in use at the CFHT. The instrument has seen first light as CFHT in April 2018 and has been offered to the community since 2019A. The combination of a wide wavelength coverage (0.98-2.5µm), polarimetry and long-term stability (goal of 1 m/s) is unique worldwide. SPIRou has been designed to perform high-accuracy velocimetry of late-type stars to uncover planetary system around our nearest stellar neighbors as well has study the magnetic fields of deeply embedded proto-stars. A 300-night large program has been approved for the upcoming 4 years along these lines. In addition to these science avenues, SPIRou has received a large number of PI proposals for 2019A and 2019B on diverse programs such as the determination of fundamental properties L and M dwarfs, eclipse and transit exoplanet spectroscopy, young stars, interstellar medium, etc. I will provide a status update on the project and present some early science results.

The transit of HD189733b in the eye of SPIRou - The metastable helium absorption.

Antoine Darveau-Bernier
Université de Montréal
Anne Boucher, David Lafrenière, René Doyon, Étienne Artigau, Neil Cook, Romain Allart

Evidence of atmospheric evaporation via hydrodynamical escape has been detected on many highly-irradiated exoplanets. It translates into a strong transit depth in Ly-alpha wings in the UV spectrum. More recently, the metastable triplet state of helium, in the near-infrared at 1083.0 nm, was found to be an excellent new tracer for the upper atmosphere. It is a much better alternative since it's less subject to extinction by the interstellar medium and doesn't require space-based facilities, unlike UV observations. This triplet resides in SPIRou's spectral coverage and can be resolved thanks to SPIRou's high resolution (R~75,000). Here, we present the detection of the metastable Helium triplet during the first observation of an exoplanet transit by SPIRou and discuss the effect of stellar contamination. This result is in agreement with a previous measurements from CARMENES.

First multiple HST/STIS eclipse observations of Wasp 43 b

Prashansa Gupta
Université de Montréal
Björn Benneke

A considerable amount of progress has already been made in our understanding of exoplanet atmospheres by measuring transmission, thermal emission and phase curves for a variety of hot Jupiters. However, several open questions remain in the understanding of their albedos, the most fundamental being the hot Jupiter Albedo problem. While Solar System gas giants show Bond albedos lower than geometric albedos, the measurements from optical and infrared instruments (Kepler, CoRoT, MOST and Spitzer) for hot Jupiters such as HD 189733 and HD 209458 show the opposite. This phenomenon could be explained by higher geometric albedos at UV/optical wavelengths outside the Kepler bandpass, but very few measurements exist to corroborate this. We present the first multiple HST/STIS reflection spectra for a well-characterized hot Jupiter WASP-43 b in the 290-570 nm waveband, and provide limits on the geometric albedo. When combined with the existing Spitzer or improved JWST's eclipse observations at wavelengths > 600 nm, these observations will answer key questions about its atmospheric composition, structure, global energy budget and circulation.

Constraining the Radio Emission of TRAPPIST-1

Anna Hughes
University of British Columbia
Rachel Osten, Aaron Boley, Jacob White

TRAPPIST-1 is a late-type M dwarf with a system of 7 Earth-like planets, at least three of which are in the habitable zone. The habitable zone is typically defined as the region around a star capable of supporting liquid water, however, high energy radiation produced by magnetic processes could threaten surface life. Gyrosynchrotron emission, detectable at frequencies between 2 and 100 GHz, is one of the only processes that can be used to infer the presence of high energy particles incident on the surrounding planets. We present radio observations of TRAPPIST-1 using the Atacama Large Millimetre Array (ALMA) telescope in band 3 (97.5 GHz) and using the Very Large Array (VLA) in the Q band (44 GHz). We use these results to constrain the radio flux density at these frequencies, and place limits on the magnetic properties and outgoing high energy particle radiation from the star. M dwarf stars like TRAPPIST-1 are frequent hosts of terrestrial planets, so characterising their stellar emission is a crucial part of assessing the habitability of surrounding planets. Outgoing high energy particle radiation from the star - traceable by the radio flux density - can erode planetary atmospheres. While our results do not imply that the TRAPPIST-1 stellar environment must be suitable for life, we find no evidence that it is overtly unsuitable.

AGN & Supermassive Black Holes

Thursday, 13:45 • Mont-Royal I

Neutrino hunting in the Antarctic: recent results from the IceCube Neutrino Observatory (Invited)

Darren Grant
Michigan State University/University of Alberta

In some of the planet's most extreme environments scientists are constructing enormous detectors to study the very rare interactions produced by neutrinos. In particular, at South Pole Station Antarctica more than a cubic kilometer of the deep glacial ice has been instrumented to construct the world's largest neutrino detector to date: the IceCube Neutrino Observatory. Designed to detect the highest energy neutrinos expected to be produced in extreme astrophysical processes, IceCube has established a vibrant scientific program that has begun to revolutionize the fields of particle and astro-physics. In this talk I will present some of the most recent results from this new window to the Universe, and will discuss the plans underway to significantly enhance its long-term future reach.

Non-Horizon Science with The Event Horizon Telescope: Using The EHT & ALMA to Peer Deeper into Blazars

Nicholas MacDonald
Max Planck Institute for Radio Astronomy
Thomas Krichbaum, Carolina Casadio, Rusen Lu, Eduardo Ros, Alan Marscher, Svetlana Jorstad, Jae-Young Kim

Blazar jets are highly collimated beams of relativistic plasma that emanate from supermassive black holes residing in the centers of active galaxies. Despite decades of dedicated Very Long Baseline Interferometric (VLBI) observation, the nature of the plasma content and the magnetic field morphology within these relativistic outflows remains largely unknown. With the addition of a phased Atacama Large Millimeter Array (ALMA) to the Global mm-VLBI Array (GMVA) at a wavelength of 3 mm, and The Event Horizon Telescope (EHT) at a wavelength of 1 mm, the polarized emission emanating from blazar jets can now be imaged on micro arc second scales with high sensitivity. This new observational capability provides us with a powerful probe into the underlying nature of blazar jets. In this talk, I will present the science case of two accepted ALMA VLBI proposals (one in combination with the GMVA and the other in combination with the EHT) which highlight the ability of deep mm-wave polarimetric imaging to distinguish between theoretical models that have been developed to explain flaring states in some of the brightest blazars on the sky.

Reducing Catastrophic Outliers in Photometric Redshift

Christina Peters
Dunlap Institute for Astronomy and Astrophysics

The Large Synoptic Survey Telescope (LSST) will have no dedicated spectroscopic follow up, which is necessary for determining redshift. Without spectroscopy, photometry can be used to estimate the redshift, producing a photometric redshift. The accuracy of quasar photometric redshifts can be improved by integrating astrometry, positional information, as an additional feature in empirical photometric redshift algorithms. The position of an object shifts on the sky by different amounts depending on the effective wavelength of the filter because of differential chromatic refraction. For strong emission line objects, spectral features cause a shift which is redshift dependent. This astrometric information has been shown to break degeneracies in the redshift-color relation for quasars, decreasing the number of catastrophic outliers in photometric redshift for quasars in the Sloan Digital Sky Survey by 15%, relative to the standard approach. Depending on the observing strategy, the improvement for LSST could be significantly higher, resulting in a significantly reduced bias when using quasars with photometric redshifts as tracers of black hole accretion or to study galaxy evolution.

The Analogous Structure of Accretion Flows in Supermassive and Stellar Mass Black Holes

John Ruan
McGill University
Scott F. Anderson, Michael Eracleous, Paul J. Green, Daryl Haggard, Chelsea MacLeod, Jessie C. Runnoe, Malgosia A. Sobolewska

Several lines of evidence now suggest possible similarities between black hole accretion flows in active galactic nuclei (AGN) and Galactic X-ray binaries, despite their factor of ~10^8 difference in black hole mass. However, it is still uncertain whether the structure and geometry of the disk-corona system in X-ray binaries directly scale up in mass to AGN, and whether this analogy still holds in different spectral states. I will present a novel approach to testing the X-ray binary/AGN analogy, based on direct comparisons of faded 'changing-look quasars' to X-ray binary outbursts. Using Chandra X-ray and ground-based rest-UV observations of faded changing-look quasars, we probe the evolving geometry of their accretion flows as a function of Eddington ratio, based on the observed spectral changes. We find that the observed spectral evolution in fading quasars displays a remarkable similarity to accretion state transitions in X-ray binary outbursts. These results show that the structures of black hole accretion flows directly scales across a factor of 10^8 in black hole mass and across different accretion states.

Witnessing the connection between galaxy mergers and black hole accretion with the Canada France Imaging Survey

Sara Ellison
University of Victoria

Galaxy mergers have long been proposed to trigger accretion onto a galaxy's central supermassive black hole. However, observational evidence for this phenomenon has been controversial. Here, I present new results from the Canada France Imaging Survey (CFIS) that finds definitive evidence for fuelling active galactic nuclei (AGN) in the nearby universe, by combining deep imaging with SDSS spectroscopy.

Flaring at the Heart of the Milky Way: X-ray and Infrared Variability of Sgr A*

Hope Boyce
McGill University
D.Haggard, G. Witzel, S. P. Willner, J. Neilsen, J. L. Hora, S. Markoff, G. Ponti, F. Baganoff, E. Becklin, G. Fazio, P. Lowrance, M. R. Morris, H. A. Smith

Emission from the supermassive black hole at the center of our galaxy, Sagittarius A* (Sgr A*), is variable at both X-ray and infrared (IR) wavelengths. The physical mechanism behind the variability is still unknown, but careful characterization of the emission using simultaneous multi-wavelength observations can constrain models of the accretion flow and the emission mechanism. Recently, simultaneous observations have observed X-ray flares are always accompanied by a rise in the IR activity, while the opposite is not always true (not all peaks in the IR have a corresponding X-ray flare). Using 100+ hours of overlapping data from a coordinated campaign between the Spitzer Space Telescope and the Chandra X-ray Observatory, I will present results of the longest simultaneous IR and X-ray observations of Sgr A* taken to date.

Education & Public Outreach

Thursday, 13:45• Mont-Royal II

ChromaStar: A star and a life-zone in the classroom

Ian Short
Saint Mary's University
Jason H. T. Bayer, Lindsey M. Burns

ChromaStar gives students and instructors a responsive proper model star along with a consistent exoplanet life-zone, and a suite of virtual instruments and other outputs, that can be instantly accessed with any web browser on any commonplace device, as is. This allows for classroom demonstrations and lab assignments based on parameter perturbation experiments and synthetic observations and measurements, starting at a basic level. For more advanced students, the underlying stellar atmosphere and spectrum modelling code, and post-processing, can be accessed through the browser's developer tools. See www.ap.smu.ca/OpenStars/.

Development and implementation of effective distance education courses in astronomy

Christy Bredeson
Athabasca University
Martin Connors

Universities across Canada have begun a shift to supplement astronomy course offerings through distance education courses, whereby students work from home in supported, self-learning environments. Distance Education astronomy courses require some design considerations unique to this learning format and it takes skill to present a cohesive, engaging course. This talk will address the development and implementation of distance education astronomy courses, drawing from the experience of Athabasca University that has been educating students in astronomy from a distance for the past 30 years. Athabasca University is strictly a distance education university, offering two first year distance education astronomy courses and two upper level planetary science courses, with an enrollment of about 200 students per year. Included in the talk will be discussions of particular challenges in teaching astronomy to students from a distance, with consideration of appropriate course materials and labs.

International Year of Astronomy - 10 years later

Julie Bolduc-Duval
Discover the Universe

What legacy has been left following the successful celebrations of International Year of Astronomy (IYA) in 2009? How far has Canadian astronomy outreach and education come? I will explore the beginnings of Discover the Universe (À la découverte de l'univers) as a national initiative "Beyond IYA" and the progress we've made in the last decade. I will also discuss other legacy initiatives, such as the Qilak Award, and the growing interest in Indigenous astronomy.

SciComm as a Side Gig: EPO for the Busy Astronomer

Nathalie Ouellette
Université de Montréal

The importance of Education and Public Outreach (EPO) activities is being recognised more and more on a Canadian and international level in astronomy and other sciences. Astronomers now realise that our research cannot happen in a vacuum and must absolutely connect with the general public. This is important for a number of reasons: inspiring the next generation of scientists, bolstering public support and funding of our field, improving our skills as communicators, etc. That being said, very few full-time EPO positions exist in Canada, and not everyone who is interested in EPO wants to commit to it as a career. A very common concern highlighted by researchers who are encouraged to participate more actively in EPO efforts is that they are interested, but either do not know where to start or simply can't find the time for these activities. Luckily, there are a number of wonderful science communication opportunities for researchers at all levels of their careers that can take minimal amounts of time out of the modern astronomer's very busy schedule. These cover all kinds of audiences, reach, time commitments, and delivery mechanisms. In this talk, I will showcase a variety of science communication activities that astronomers can participate in to become more involved in EPO as a researcher or even to gain experience in the hopes to becoming a full-time science communicator in the future. These include science writing/journalism, media relations, using different social media channels, mentoring young students through matching programs, Skypeing into classrooms all over the world, volunteering or working part-time with different organisations and more!

Launching or Boosting Astronomy on Tap in Your City

Michael Reid
Dunlap Institute
Zoe Jaremus

Astronomy on Tap (astronomyontap.org) is an is an internationally successful model for informal public outreach. At the Dunlap Institute, we operate a very popular Astronomy on Tap event series, reaching audiences of 500 people, five times a year. The series has been so well received that it has generated an all-ages spinoff, called SpaceTime. In this talk, I'll share the methods we've used to grow our audience from humble beginnings. I will discuss specific strategies you can use to launch a successful Astronomy on Tap series in your city or town, including selecting and training speakers, choosing a venue, advertising, budgeting, and gathering metrics. The goal is for you to come away with concrete strategies to help you start—or boost—your own Astronomy on Tap event. Others who operate Astronomy on Tap events will be welcome to contribute their expertise.

Building capacity in astronomy research and education in Africa - Initiatives in Kenya and Ghana

Allison Man
Dunlap Institute for Astronomy and Astrophysics

The Square Kilometer Array has brought about a lot of interest in astronomy within the scientific community and students in Africa. However, African students face many barriers in pursuing a career in astronomy, including the lack of opportunities for higher education and the perceived lack of job prospects. I will summarize a series of efforts to build capacity in astronomy research and education conducted in Ghana and Kenya. The activities held in 2017-2019 included: (1) a summer school to train ~60 school teachers in West Africa on inquiry-based learning for astronomy; (2) an astronomy research training workshop for ~40 university students to exploit archival data for science; (3) an initiative to build a case for an optical observatory in Kenya, involving astronomers, engineers, and outreach experts. I will provide examples of how skills in astronomy research and technologies can be used to develop Africa. I will share my thoughts on how Canada can contribute to advancing astronomy in Africa.

CFHT Outreach: Connecting to our Canadian Community

Mary Beth Laychak
Canada-France-Hawaii Telescope

The Canada-France-Hawaii Telescope outreach program leverages our Canadian connections to provide a variety of learning experiences. From our work with the Friends of the DAO to this year's teach workshop in Montreal, we make an effort to reach as much of Canada as possible from a distance. We will discuss our Canadian outreach strategy and how positive connections with the Canadian community make the implementation of that strategy possible.

Posters

Galaxy & Star Formation

1) Milky Way Analogues and Their Environments
Laura Chajet
York University

2) A Probabilistic Measurement of the Gaia DR2 Zero Point Parallax and its Impact on the Hubble Constant
Victor Chan
University of Toronto

3) Satellite Galaxies around Massive Centrals from 20 sq deg of very deep CFHT and Subaru Imaging
Lingjian Chen
Saint Mary's University

4) The relationship between molecular gas and star formation at ~kpc scales in galaxies from the CA-MA-EDGE survey
Ryan Chown
McMaster University

5) The star formation histories of dwarf galaxies in Local Group simulations
Ruth Digby
University of Victoria

6) Differences in galaxy simulation results arising from different codes
Dennis Gallant
McMaster University

7) Are the Models Used in Current Galaxy Simulations Reliable?
Hector Robinson
McMaster University

8) Exploring Dwarfs around the Local Group with the Solo Survey
Clare Higgs
University of Victoria

9) Predicting Peculiar Velocities
Amber Hollinger
University of Waterloo

10) The volume-corrected rotation curve shapes of nearby disk galaxies
Lindsay Holmes
Royal Military College of Canada

11) Exploring the substructure of the Milky Way stellar halo
Jaclyn Jensen
University of Victoria

12) Using Atomic Gas to Constrain Ultra-Diffuse Galaxy Formation Mechanisms
Ananthan Karunakaran
Queen's University

13) The Cosmic Web: Impacts on Galaxy Quenching in Clusters
Sachin Kotecha
McMaster University

14) Interplay between models of stellar feedback and dust in high redshift galaxy inference
Jordan Mirocha
McGill University

15) Simulating Galaxy Studies with CASTOR
Emily Pass
University of Waterloo

16) Sizes of globular clusters systems and their host dark matter halos
Bailey Robison
University of Waterloo

17) Confronting Stellar Population Models with Integrated Spectroscopy of Galactic Globular Clusters from 3600 A to 1 micron
Joel C. Roediger
NRC Herzberg Astronomy & Astrophysics Research Centre

18) GALFIT parametric fits of resolved stellar mass maps of disk galaxies in the Hubble Frontier Field
Vivian Tan
York University

19) A Collection of New Dwarf Galaxies in the Centaurus A Group
Matthew Taylor
Gemini Observatory

20) Chemical mapping of the stellar halo of the Milky Way
Guillaume Thomas
NRC Herzberg Astronomy & Astrophysics

21) Environmental Dependence of Resolved Star Formation in Nearby Galaxies
Jacqueline Wightman
McMaster

22) The Kennicutt-Schmidt Law and Gas Scale Height in (Ultra-)Luminous Infrared Galaxies
Christine Wilson
McMaster University

23) Who killed the dwarfs?
Chengyu Xi
University of Waterloo

Clusters & Groups of Galaxies

24) Most relaxed SPT galaxy clusters
Hassan Abdul-Reda
Université de Montréal

25) Novel observations of the optical nebulae in brightest cluster galaxies
Julie Hlavacek-Larrondo
Université de Montréal

26) Hα Imaging Spectroscopy of Emission Line Galaxies in z~0.25 Clusters using SITTELE
Qing Liu
University of Toronto

27) GOGREEN post-starburst galaxy analysis
Karen McNab
University of Waterloo

28) Outflows, mini-halos and filaments in the supermassive cluster MACSJ1447.4+0827, oh my!
Myriam Prasow-Émond
Université de Montréal

29) An Offset Cooling Flow Exhibiting Formidable Stellar Formation Rate in Z=1.7 Galaxy Cluster
Carter Rhea
L'Université de Montréal

30) Using Galaxy Density to Trace the Assembly of the Virgo Cluster
James Taylor
University of Waterloo

31) Star formation histories of cluster galaxies and field galaxies in the GOGREEN survey
Kristi Webb
University of Waterloo

AGN & Supermassive Black Holes

32) The importance of realism in image-based deep neural network classifications of galaxy interactions
Connor Bottrell
University of Victoria

33) Change-points in Sgr A*'s X-ray flaring rate: Fact or artifact?
Elie Bouffard
McGill University

34) Gemini Imaging of the Host Galaxies of Changing-Look Quasars
Paul Charlton
McGill University

35) Event Horizon Dynamics: X-ray and Multi-wavelength Variability of Sgr A* and M87
Daryl Haggard
McGill University/McGill Space Institute

36) Connecting Changing-Look Quasars' Optical/X-ray Spectral Shapes and Accretion Rates
Xiangyu Jin
McGill University

37) Shocking Quasar Outflows
Courtney Mulholland
York University

38) Titans of the Early Universe: The seeds of the most massive high-z quasars
Tyrone E.Woods
University of Birmingham

Interstellar Medium & Star Formation

39) The Study of the Spatially-Resolved HII Regions of M33 with SITELLE at CFHT
Dhruv Bisaria
Queen's University

40) Revealing the Formation of Cosmic Fullerenes in the Planetary Nebula Tc 1
Jan Cami
Western University

41) Distances to Milky Way Water Masers with Gaia
Mark Gorski
Western University

42) Dense Cores Under Pressure : Results from GAS
Helen Kirk
Herzberg Astronomy & Astrophysics, National Research Council of Canada

43) Interaction between HVCs of Neutral Hydrogen and the Galactic Magnetic Field
Roland Kothes
Dominion Radio Astrophysical Observatory

44) An Extraordinary Submillimeter Flare in a T Tauri Binary System
Steve Mairs
James Clerk Maxwell Telescope

45) 3D Optical Spectroscopic Study of NGC 3344 with SITELLE: I. Identification and Confirmation of Supernova Remnants
Ismael Moumen
Université Laval/CFHT

46) A Search for Supernova Light Echoes in NGC 6946 Using SITELLE
Michael Radica
McMaster University

47) SIGNALS: The Star-formation, Ionized Gas, and Nebular Abundances Legacy Survey
Laurie Rousseau-Nepton
CFHT

48) What new insights does SITELLE unveil about NGC 6888 and NGC 2359?
Marcel Sévigny
Université Laval

49) Using Abel's Reconstruction to Extract Dense Regions from Observed Molecular Clouds
Ayushi Singh
University of Toronto

50) Herschel/SPIRE Spectral Observation of Spitzer Extended Green Objects
Locke Spencer
University of Lethbridge

51) APEX Observations of the CO Envelope around the Young FUor-type Star V883 Ori
Jacob White
Konkoly Observatory

High Energy Astrophysics & Compact Objects

52) Supernova Neutrinos with nEXO
Soud Al Kharusi
McGill University

53) General Relativistic Corrections to Flux for Rotating Neutron Stars
Charlee Amason
University of Alberta

54) The White Dwarf Crystallization Sequence Uncovered by the Gaia Mission
Pierre Bergeron
Université de Montréal

55) Rotational evolution of neutron stars
Jorge Calderon Noguez
University of Alberta

56) Gravitational-Wave Astrophysics at The University of Tokyo's Research Center for the Early Universe
Kipp Cannon
University of Tokyo

57) Optical and Timing Analysis of MAXI J1820+070 via Data Pipeline for OMM PESTO Camera
Valérie Desharnais
McGill University

58) The Neutron Star in Supernova Remnant 1E 0102)2-7219
Pavan R) Hebbar
University of Alberta

59) Searching the Kepler Field for Self-lensing Systems
Kelsey Hoffman
Bishop's University

60) The X-ray Emissivity of Low-Density Stellar Populations
Mario Ivanov
University of Alberta

61) The First Hard X-Ray Survey of the Central 30 Parsec of the Galactic Center Searching for Faint High Mass X-Ray Binaries
Yi Won Kim
Taft School

62) On the Masses of Millisecond Pulsars
Lorne Nelson
Bishop's University

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Poster Abstracts

Galaxy & Star Formation

1) Milky Way Analogues and Their Environments

Laura Chajet
York University
Michael De Robertis, Songwei Li

Finding analogues to the Milky Way and the Local Group and comparing them to our own could provide important clues on galaxy formation and evolution.

We study the environment of Milky Way Analogue (MWA hereafter) galaxies, defined as spiral galaxies that occupy a well defined locus in the colour-absolute magnitude g-r-Mi plane.

We select our MWA candidates from the SDSS-DR14, restricted to Galactic latitudes |b| ≤ 15º and limit the search to a redshift range 0.01 ≤ z ≤ 0.03. The lower boundary was adopted to avoid including sources whose peculiar velocities could dominate the Hubble flow, while the upper limit was chosen to allow selection of satellites as bright as the Large Magellanic Cloud.

To characterize the environments of these candidates, we select galaxies within an angular separation from the MWA host such that the projected distance is ≤ 1 Mpc and the relative radial velocity is ≤ 350 km s-1.

We present an analysis of a number of physical properties (e.g., activity, star-formation rate, metallicity, etc.) of both the hosts and their satellites and companions. In particular, we compare the environments of systems that contain a second bright and massive galaxy – that could be considered as Local Group Analogues – to those where the host is the only dominant structure. Results show the satellite population of our sources to be dominated by star-forming galaxies, consistent with other recent lower-redshift samples, suggesting that the Milky Way's satellite population is not typical. We also find "star–forming" is the dominant subclass among MWAs, as well.

2) A Probabilistic Measurement of the Gaia DR2 Zero Point Parallax, and its Impact on the Hubble Constant

Victor Chan
University of Toronto
Jo Bovy

In April 2018, the Gaia satellite released parallax and photometry measurements of over one billion sources in its second data release (DR2). Gaia's parallax measurements are precise to the tens of micro-arcseconds, and a significant zero point offset of similar order has been reported in the literature. A robust understanding of Gaia's systematics presents an opportunity for an independent and precise geometric distance anchor that can be used to verify the locally measured Hubble constant. I will present a Bayesian approach to determining the Gaia DR2 zero point parallax with the photometry of red clump stars. I will highlight how hierarchical modelling can also account for the zero point's dependence on sky position, observed magnitude, and colour, followed by a discussion of the implications of Gaia's present and future measurements on the Hubble constant.

3) Satellite Galaxies around Massive Centrals from 20 sq deg of very deep CFHT and Subaru Imaging

Lingjian Chen
Saint Mary's University
Marcin Sawicki, Thibaud Moutard, Anneya Golob

Satellite galaxies around massive central galaxies can provide important information for environmental effects on galaxy evolution in groups or clusters. We used the sample of ~2729000 of 0.3<z<0.9 galaxies from our very deep (i=27), large-area (20 sq deg) CFHT+Subaru dataset (CFHT-CLAUDS + Subaru HSC-SSP surveys). From this unprecedented dataset, we selected 5000 massive (logM/M_sun>11.15) central galaxies and investigated the radial number density distribution of satellite galaxies around them.

We found that the number density of satellites can be described by the NFW profile at large projected distance from the central galaxy but deviate from the NFW profile in the inner regions (typically within 100 kpc). This shows that satellites are not good tracers of the host dark matter halo, but are subject to environmental processing. By dividing the satellite galaxy sample, we found that low-mass satellite galaxies (9.5< logM/M_sun <10.2) have more significant deviation from the NFW profile in the inner regions than high mass satellites (logM/M_sun >10.2). By dividing the central galaxy sample, we found that central mass does not have a strong effect on the slope of radial distribution of satellites, only the total number of satellites is affected. We found a galaxy conformity signal when we separated star-forming and quiescent centrals. Additionally, we compared our satellite distribution with IllustrisTNG simulation, and found that they agreed well.

Our results support the satellite population formation scenario in which the specific shape of the distribution might have to do with migration of satellites, which involves various effects in dense environment around massive centrals such as dynamical friction and the tidal stripping of mass from satellite-hosting sub-halos.Satellite galaxies around massive central galaxies can provide important information for environmental effects on galaxy evolution in groups or clusters. We used the sample of ~2729000 of 0.3<z<0.9 galaxies from our very deep (i=27), large-area (20 sq deg) CFHT+Subaru dataset (CFHT-CLAUDS + Subaru HSC-SSP surveys). From this unprecedented dataset, we selected 5000 massive (logM/M_sun>11.15) central galaxies and investigated the radial number density distribution of satellite galaxies around them.

4) The relationship between molecular gas and star formation at ~kpc scales in galaxies from the CARMA-EDGE survey

Ryan Chown
McMaster University
Christine D. Wilson, Laura Parker, Cheng Li

Recent surveys of spatially resolved molecular in galaxies, such as CARMA-EDGE (Bolatto et al., 2017), have enabled multiwavelength studies (e.g. from optical to radio) of galaxies on ~kpc scales. I will first present recent results using CARMA-EDGE and optical integral-field data from CALIFA (Sanchez et al., 2012) where we find that galaxies with centrally enhanced star formation are either barred or interacting and have relatively high molecular gas concentrations (Chown et al., 2019). I will then show our ongoing work on the same sample of galaxies, where we explore the correlations between WISE 12 um emission and CO (1-0) from EDGE, and compare global SFR-CO correlations to resolved correlations on ~kpc scales. Our goal is to understand the extent to which bars and/or galaxy interactions impact spatially resolved SFR and molecular gas correlations, using both optical (CALIFA) and infrared (WISE 12um) star formation indicators.

5) The star formation histories of dwarf galaxies in Local Group simulations

Ruth Digby
University of Victoria
Julio Navarro, Azadeh Fattahi

Dwarf galaxies are both intrinsically important to theories of galaxy evolution, and useful tools to study the physical drivers that influence larger systems. Their star formation histories (SFHs) provide clues to the dominant processes that govern galactic evolution at different mass scales, and in different epochs and environments. Observationally, our understanding of galactic evolution is hampered by progenitor bias and the challenge of deriving robust SFHs from CMDs or integrated spectra. Simulations are therefore vital to the development of the field. Cosmological simulations of our local environment yield dwarf galaxies whose SFHs exhibit clear trends with stellar mass and environment. These trends are consistent with those of SFHs derived from CMDs of well-resolved stellar populations. In this talk, I will present the SFHs of dwarf galaxies measured from cosmological simulations, and discuss how their results influence interpretation of observational data.

6) Differences in galaxy simulation results arising from different codes

Dennis Gallant
McMaster University
James Wadsley

Simulations are an important component in the study of galaxy evolution. Due to the long timescales involved, it is impossible to watch a galaxy evolve in real time observationally. With simulations, however, we can construct galaxies based on what we see in reality, and then watch how they evolve or develop over billions of virtual years. A major flaw of galaxy simulations, however, is the wide variety of length scales involved. It is impossible to achieve a high enough resolution to describe an entire galaxy from first principles, and thus many assumptions and approximation will have to be made. Different codes will make use of different assumptions, and therefore be stronger in different areas. The Agora High-Resolution Galaxy Simulations Comparison Project (Kim et al 2016, ApJ 833:2) compared simulations of galaxies evolved from the same initial conditions in several different codes, and found that the final results differ in a number of ways, both morphological and quantitative. This work will further investigate those differences by evolving those same initial conditions in two codes, the AMR (Adaptive Mesh Refinement) code Ramses and the SPH (Smoothed Particle Hydrodynamics) code Gasoline. Disc galaxies simulated in each code will be compared side-by-side and their differences will be explained by examining the different methods and assumptions employed by each code.

7) Are the Models Used in Current Galaxy Simulations Reliable?

Hector Robinson
McMaster University
James Wadsley, Dennis Gallant

We present a suite of simulations investigating galaxy formation in the smoothed-particle hydrodynamics (SPH) code Gasoline. We specifically focus on the sub-grid models used for star formation and stellar feedback to determine whether or not they are physically motivated and match observations of the physics occurring in real galaxies. We simulate a Milky-Way-like galaxy and characterize the conditions of where stars form and distribute energy. We also perform high-resolution tests of the interstellar medium surrounding individual star particles to determine if the way in which the energy and momentum from stellar feedback is redistributed is realistic. This work furthers that of The Agora High-Resolution Galaxy Simulations Comparison Project. By comparing the simulated galaxies to those from other codes with identical initial conditions and input physics, it can be determined whether or not the scientific standard of reproducibility is upheld in galaxy simulations.

8) Exploring Dwarfs around the Local Group with the Solo Survey

Clare Higgs
University of Victoria
Alan McConnachie

Dwarf galaxies are a fascinating regime in which to study galaxy evolution and the wide variety of processes involved in shaping the systems we observe today. Dwarfs are intrinsically sensitive to both internal processes, like star formation, and environmental effects, like interactions with nearby galaxies. However, their large scale morphologies can be difficult to observe given their generally low surface brightnesses. Nearby dwarf galaxies are the most accessible as we can observe their resolved stellar populations from the ground.

The Solo (Solitary Local) Dwarf Galaxy Survey aims to characterize and understand the faint end of the luminosity function for isolated systems, free from interactions with massive galaxies, like the Milky Way or M31. Solo is focused on dwarf galaxies within 3 Mpc and which are more than 300 kpc distant from the Milky Way and M31. The survey consists of wide field, g and i band, CFHT/MegaCam and Magellan/MegaCam imaging for all known dwarfs that meet this distance criteria. The proximity of the sample allows us to use resolved stellar population analysis to examine their faint, extended structure and probe their structural properties to extremely low surface brightness values (>33 mags/sq.arcsec). Current work has focused on the 12 closest dwarfs, which all lie approximately within the zero velocity surface of the Local Group. We determine their global structures and parameterize their 1- and 2-D surface brightness profiles. We examine trends within this sample and compare their properties to the satellite dwarfs of the Milky Way and M31. These comparisons illuminate some of the environmental processes that influence the structures of low mass galaxies. Dwarf galaxies are a fascinating regime in which to study galaxy evolution and the wide variety of processes involved in shaping the systems we observe today. Dwarfs are intrinsically sensitive to both internal processes, like star formation, and environmental effects, like interactions with nearby galaxies. However, their large scale morphologies can be difficult to observe given their generally low surface brightnesses. Nearby dwarf galaxies are the most accessible as we can observe their resolved stellar populations from the ground.

9) Predicting Peculiar Velocities

Amber Hollinger
University of Waterloo
Michael Hudson

Galaxies, on average, are expected to be receding with velocities according Hubble's Law. The gravitational attraction of objects to surrounding structure results in deviations known as peculiar velocities (PVs). PVs are the only practical way of measuring the underlying distribution of dark matter (DM) on large scales in the nearby Universe. Given the mass and distance of galaxies, we can predict their velocities and compare them against the measured values. This calculation allows the measurement of certain cosmological parameters, such as the current mass density of the Universe. We are using large cosmological N-Body simulations of DM halos as a proxy for galaxies to test our understanding of linear perturbation theory. The goal of this project is to determine how well we can calibrate the link between predicted and true peculiar velocities in an unbiased way, and to apply our methods to real data.

10) The volume-corrected rotation curve shapes of nearby disk galaxies

Lindsay Holmes
Royal Military College of Canada
Lindsay Holmes, Kristine Spekkens

We use the DiskFit galaxy modelling code to perform an extensive kinematic analysis of 644 galaxies in the Calar Alto Legacy Integral Field spectroscopy Area survey (CALIFA). We attempt to fit a rotation-only model to the Ha velocity field for each galaxy, and successfully model 334/644 of them. For each system, DiskFit determines the rotation curve and best fitting disk parameters (e.g. inclination, position angle, centre position) along with robustly estimated uncertainties. In this contribution, we exploit our kinematic models and the volume completeness of CALIFA to derive the first volume-corrected rotation curve shapes of nearby galaxies as a function of stellar mass.

11) Exploring the substructure of the Milky Way stellar halo

Jaclyn Jensen
University of Victoria
Alan McConnachie, Guillaume Thomas

Current limitations in understanding the structure of the Milky Way stellar halo has been revolutionized by robust stellar surveys such as Gaia within ~10 kpc of the stellar neighborhood. In this study, we examine this structure at much larger distances (Galactocentric radius of 15 – 220 kpc), as traced via blue horizontal branch (BHB) stars. These BHBs are identified in the deep u-band photometry of the Canada-France Imaging Survey (CFIS), cross-matched with the griz-band of Pan-STARRS, to cover ~4000 square degrees of the Northern sky. We apply a clustering algorithm to map the hierarchical nature of halo substructure, identifying globular clusters, dwarf galaxies and stellar streams within the CFIS footprint, and classifying their relationship to the larger scale structure of the halo.

12) Using Atomic Gas to Constrain Ultra-Diffuse Galaxy Formation Mechanisms

Ananthan Karunakaran
Queen's University

We search for atomic gas (HI) reservoirs in Ultra-Diffuse Galaxy (UDG) candidates around the Coma Cluster. These peculiar objects, with physical sizes similar to that of the Milky Way but with 1% of the number of stars, have spurred great interest in understanding their origin. Are they formed through bursty star-formation early on in their evolution, or do they lie at the high-spin extreme of the galaxy population? Do different formation mechanisms dominate in cluster (high-density) environments, where most UDGs have been discovered, compared to the field (low-density)? In order to determine their formation mechanism, distance estimates are required to confirm candidates as bonafide UDGs.

However, due to their intrinsic faintness, many optical follow-up methods to estimate distances as well as other physical properties are expensive. An alternative is to exploit the HI reservoirs of gas-rich UDGs. Using the HI line we can obtain a measure of the HI gas content, the dynamical mass (dark matter content), and distance through the redshift of the line. We have performed deep HI observations with the Robert C. Byrd Green

Bank Telescope on a subset of UDG candidates discovered in the SMUDGes (Systematically Measuring Ultra-Diffuse GalaxiES) pilot survey, which searched a ~290 square degree region around the Coma Cluster. The information obtained from HI detections can be used to directly compare to predicted trends from hydrodynamical simulations and semi-analytic models of UDG formation. In this contribution, we will report on our efforts to constrain the formation mechanisms of UDGs using their HI content.

13) The Cosmic Web: Impacts on Galaxy Quenching in Clusters

Sachin Kotecha
McMaster University
Charlotte Welker, James Wadsley

We present a novel perspective on galaxy quenching by examining how filaments of the cosmic web plunging into clusters affect galaxies in simulations. How and why galaxies shut off star formation remain open questions, but it has been noted that galaxies acquire cold gas through filaments of the cosmic web. This idea, along with new data with an unrivalled combination of statistics and resolution, leads us to an innovative method for learning how the large scale environment of a galaxy affects quenching. We employ the recent Three Hundred Project, which has built up a catalogue of over 300 galaxy clusters run with multiple smoothed-particle hydrodynamic (SPH) simulations.

From the data, we identify and track the evolution of filamentary structure of the cosmic web, and we utilize a halo finder to locate where galaxies are at these times. Furthermore, we hope to differentiate the effect feedback with a galaxy's environment has had on its quenching from effects by smaller scale internal feedback. This research is positioned to be foundational, as the Hector instrument and the Euclid mission, which are set to be launched in 2020 and 2021 respectively, will also begin to look at quenching from an evolutionary standpoint in relation to the cosmic web.

14) Interplay between models of stellar feedback and dust in high redshift galaxy inference

Jordan Mirocha
McGill University
Charlotte Mason

In recent years, many semi-empirical models of galaxy formation have shown that while the star formation efficiency (SFE) of galaxies must depend on the mass of their host dark matter halos it need not depend on cosmic time.

However, simple models of stellar feedback predict that the SFE will increase with redshift simply because halos forming earlier are more tightly bound (at fixed mass) than those forming later, and are thus more resilient to feedback. Boosting the SFE of course makes early galaxies brighter and more massive at a given halo mass, and thus may cause tension with pre-existing measurements. In this work, we show that scenarios in which the SFE grows with redshift are permitted by current observations so long as star formation in high redshift galaxies is increasingly obscured. Despite low dust masses, high dust column densities (and thus optical depths) can still be achieved in high-z galaxies if dust reservoirs are concentrated around sites of star formation.

Furthermore, if the 'patchiness' of the dust distribution alone sets the probability that galaxies are Lyman-alpha emitters (LAEs), our models generate realistic LAE populations at $3 < z < 6$ without fine tuning. We discuss the prospects for testing this scenario further using future observations with JWST, ALMA, and 21-cm experiments like the Hydrogen Epoch of Reionization Array (HERA).

15) Simulating Galaxy Studies with CASTOR

Emily Pass
University of Waterloo
Michael Balogh

The Cosmological Advanced Survey Telescope for Optical and ultraviolet Research (CASTOR) is a proposed Canada-led space telescope that would perform wide-field, high-resolution imaging in three ultraviolet and blue-optical bands. In this work, we simulate images of the COSMOS field, as would be observed by CASTOR during its primary survey (texp ≈ 20 minutes), and during a candidate deep survey (texp ≈ 100 hours). Our images are based off the COSMOS i-band selected catalogue, with synthetic sources added to simulate completeness up to i = 30 mag. Source extraction is performed on these images to estimate CASTOR's limiting magnitudes for galaxy studies, which we determine to be 26.9 ± 0.2 mag in the UV-band, 26.1 ± 0.3 mag in the u-band, and 25.5 ± 0.3 mag in the g-band at SNR = 5 for CASTOR's primary survey. The deep survey reaches ~3 magnitudes deeper.

Furthermore, we explore the feasibility of a particular galaxy study with CASTOR; namely, CASTOR's sensitivity to galaxies transitioning between the blue and red sequences as a result of quenching. We find that CASTOR would be sensitive to a transitioning population regardless of quenching timescale. However, CASTOR's deep survey would be required for such an analysis; red sequence galaxies with $z \gtrsim 1$ are too UV-faint to be detected in the primary survey images.

16) Sizes of globular clusters systems and their host dark matter halos

Bailey Robison
University of Waterloo
Michael Hudson

The size of an entire system of globular clusters (GCs) that surround a galaxy reveals important clues about the history of the galaxy and the dark matter (DM) halo that it inhabits. The size of the globular cluster system (GCS) depends not only on the formation and destruction histories of the GCs themselves, but also on the assembly, merger, and accretion history of the host DM halo. A linear relationship between the total mass of the GCS and the mass of the DM halo has been previously uncovered. Here, we extend this to GCS sizes. We find that the radial density profile of these GC systems are well fit with a de Vaucouleurs profile. This enables us to assign a size to the GCS from the effective radius of the de Vaucouleurs fit. We compare these sizes to DM halo masses, which are calibrated from weak lensing. We find a tight relationship (˜0.2 dex scatter) between the effective radius of the GC system and the virial radius (and virial mass) of its host DM halo, for halos with masses greater than ~1012 solar masses. This relationship is strengthened when combining our results with those from the literature. The steep non-linear dependence of this relationship (R_{e, GCS} ~ R_{200}^{2.5 - 3} ~ M_{200}^{0.8 - 1}) is currently not well understood, but is an important clue regarding the assembly history of DM haloes and of the GC systems that they host.

17) Confronting Stellar Population Models with Integrated Spectroscopy of Galactic Globular Clusters from 3600 A to 1 micron

Joel C. Roediger
NRC Herzberg Astronomy & Astrophysics Research Centre

The globular clusters that orbit the Milky Way are a treasure trove, providing evidence on a wide range of topics of astrophysical interest, from the scale of individual stars to the entire Galaxy itself. The relative ease with which they can be observed, the massive volume of published data on them, and their very nature have also garnered the population of Galactic globular clusters (GGCs) an exalted status in the field of stellar population synthesis (SPS). This field seeks to interpret the integrated light from extragalactic stellar systems in terms of their underlying physical characteristics and relies on GGCs to enable baseline calibrations of the models that connect data to inference.

Over the past decade, SPS analyses have begun to target galaxies at red/optical wavelengths and found tantalizing evidence that the stellar IMF varies systematically with galactic properties, like mass and metallicity. These results motivate the study of GGCs over an as-yet little explored wavelength regime and in this talk I will describe our survey with the Gemini Observatory to obtain integrated red/optical spectroscopy of these objects.

By combining our data with published blue/optical spectroscopy for the same targets, we are able to address pressing issues surrounding SPS, such as (i) the limiting accuracy of model-inferred ages, chemical abundances, and mass functions for old stellar populations; and (ii) systematic biases between the analysis of blue versus red spectroscopy. This talk will focus on the urgent need for these data, highlight interesting empirical trends, and present detailed examinations of our modelling for a few clusters.

18) GALFIT parametric fits of resolved stellar mass maps of disk galaxies in the Hubble Frontier Field

Vivian Tan
York University

Environmental effects on morphology and star formation history of galaxies is an important topic in galaxy evolution. It has been hypothesized that disk galaxies of similar mass tend to have similar spatial distribution of stellar mass, regardless of star formation rate. The infrared (usually J-band) image of a galaxy is also said to be a close proximity for its stellar mass distribution. We test if these assumptions are true by using GALFIT to parametrically fit one component Sersic galaxy models to disk galaxies in the Hubble Frontier Fields, both fits to their resolved stellar mass map and to the F160W infrared image. We compare the change in effective radius and Sersic index between the infrared image and the mass maps, and between different populations of star forming and quiescent galaxies in a cluster environment versus in a field environment. We find the Sersic indices tend to be higher for fits of a galaxy's mass map when compared to the fit of its F160W image, and the effective radius also becomes slightly smaller.

19) A Collection of New Dwarf Galaxies in the Centaurus A Group

Matthew Taylor
Gemini Observatory
Paul Eigenthaler, Thomas Puzia, Roberto Muñoz, Karen Ribbeck, Hong-Xin Zhang, Yasna Ordenes-Briceño, Mia Sauda Bovill

Recent years have seen an acceleration in the discovery rate of dwarf galaxies in the Local Universe. The subsequent unveiling of coherent satellite phase-space structures like groups and planes has led to a renaissance in the study of low-surface brightness dwarf galaxies, including their utility in near-field cosmological studies. In an effort to push this field further, optical u'g'r'i'z' imaging of 22 deg^2 centred on the nearby giant elliptical galaxy NGC5128, as part of the "Survey of Centaurus A's Baryonic Structures" campaign, has been searched for new dwarf galaxies in the Centaurus A group.

We will present first results of the stellar mass and stellar population properties for several dozens of promising new candidates, including several dwarf pairs appearing within a few pc in projection that may indicate physical associations. These new dwarf galaxies extend the size-luminosity relation toward fainter total luminosities and smaller sizes for known dwarf galaxies outside the Local Group, and are broadly consistent with the properties of nearby dwarf spheroidal galaxies. Altogether, these new results show NGC5128 to be the host of a large reservoir of low-mass dwarf galaxies that is at least as rich as that of the Local Group and is ripe for detailed follow-up observations.

20) Chemical mapping of the stellar halo of the Milky Way

Guillaume Thomas
NRC Herzberg Astronomy & Astrophysics

The stellar halo is formed of stars that was initially lying in dwarf galaxies and globular clusters, which have been disrupted by the tidal field of the Milky Way. Therefore the morphology, and the chemo-dynamics profile of the stellar halo are the direct imprint of the accretion history of our Galaxy. Using to the deep u-band of the Canada-France-Imaging Survey (CFIS) in combinaison to the griz bands of PS1 and the G band from Gaia DR2, we developed a machine learning based algorithm to disantangle the giants from the dwarfs and to obtain their distance and their metallicity with a high precision, using only their photometry. With this data we explored the profile of the stellar halo for different metallicities.

21) Environmental Dependence of Resolved Star Formation in Nearby Galaxies

Jacqueline Wightman
McMaster
Laura Parker

In order to understand the evolution of galaxies over time, it is necessary to determine the relative importance of external and internal factors that affect galaxy star formation. We use a sample of galaxies in the Mapping Nearby Galaxies at Apache Point Observatory (MaNGA) survey to investigate the dependence of star formation on other galaxy properties as well as properties of the host environment.

Using Integral Field Unit (IFU) spectroscopic data, we create star forming maps of galaxies from the equivalent width of H-alpha flux in each spatial pixel (spaxel) as well as BPT (Baldwin, Phillips, & Terlevich, 1981) diagnostic diagram information. We classify each spaxel as star forming or not, and quantify both the size of the star forming disk and the fraction of star forming spaxels in each galaxy. We then compare these measurements to other galaxy properties, such as stellar mass, as well as environmental properties, such as X-ray brightness and halo position, for galaxies living in groups and clusters.

We know that galaxies in rich environments are preferentially quenched compared to galaxies in the field, and with the resolved MaNGA data we are exploring whether star formation is first shut down on the outer edges of galaxies or near their centers.

22) The Kennicutt-Schmidt Law and Gas Scale Height in (Ultra-)Luminous Infrared Galaxies

Christine Wilson
McMaster University
Bruce Elmegreen, Ashley Bemis

We present a new analysis of high-resolution ALMA data for 5 luminous or ultra-luminous infrared galaxies that gives a slope for the Kennicutt-Schmidt (KS) relation of 1.74+/-0.08 for gas surface densities >1000 Mo/pc^2. The CO velocity dispersion scales approximately as the square root of the gas surface density, giving a nearly constant gas scale, H, of 150-170 pc. This constancy of H implies that the average mid-plane density scales linearly with the gas surface density, which in turn implies that the gas free-fall time varies as the inverse square root of the gas surface density, thereby explaining most of the super-linear slope in the KS relation. Consistent with these relations, we also find that the efficiency of star formation per free-fall time is about constant, 4-8%, and the gas depletion time decreases at high gas surface densities, reaching only 16 Myr at 6000 Mo/pc^2. The variation of velocity dispersion and the constancy of H with gas surface density are in tension with some feedback-driven models.

23) Who killed the dwarfs?

Chengyu Xi
University of Waterloo
James Taylor

Despite the great success of the standard LCDM model in predicting and explaining the large-scale structure of the universe and its evolution, it still faces challenges at smaller scales (< 1 Mpc). Dwarf galaxies seem to be the main "victims". Their total number within the virial radius of the Milky Way is only observed to be around 50 (including the tiniest ones, with masses of only 300 solar masses), which is much lower than the thousands of potential objects predicted by LCDM. Dwarf "housing conditions" are also a matter of debate, as they seem to occupy smaller subhalos than expected.

To find out whether the theoretical expectations about small-scale structure are just wrong, or whether some mysterious evil force has been brutally suppressing the dwarfs, we need to survey more dwarf populations outside our Local Group. I will present the method we used to assess nearby populations, and present some of the results of our investigations.

Galaxy Clusters & Groups

24) Most relaxed SPT galaxy clusters

Hassan Abdul-Reda
Université de Montréal

The four clusters, SPT-CLJ0000-5748 SPT-CLJ2331-5051 SPT-CLJ2043-5035. and the Phoenix cluster of the SPT SZ survey are important to study due to their high redshift. The analysis of these clusters will allow us to better understand their place in cluster evolution, and the evolution of clusters itself. However, the most interesting feature they exhibit is the fact that they are the most relaxed in the survey. Indeed, at a redshift of z>0.5 for each, for them to be relaxed so early in the life of the Universe defies our expectations concerning the birth and evolution of galaxy clusters. In particular, studying the X-Ray emission from these clusters can inform us on the activity of large structures in the early universe. With 118ks of observation from the Chandra X-Ray Observatory, the study of their morphology gives us a great quantity of information. In fact, at least two of these clusters exhibit signs of sloshing motion, which means that cluster mergers were already taking place at the time. The observation of X-Ray cavities allows us to understand the activity taking place at the center of their Brightest Cluster Galaxies and the supermassive black hole they host.

25) Novel observations of the optical nebulae in brightest cluster galaxies

Julie Hlavacek-Larrondo
Université de Montréal
M.-L. Gendron-Marsolais, L. Drissen, T. Martin, M. McDonald, A. Fabian, A. Edge, S. Hamer, B. McNamara, G. Morrison

Clusters of galaxies exhibit some of the most spectacular examples of optically bright, line emitting nebulae. These nebulae surround the central galaxies, are filamentary in nature and can extend over 100 kpc in size. The nebulae are directly related to how gas cools and gets re-heated by black hole feedback. They are therefore fantastic laboratories for understanding the fundamental process of gas cooling/heating in galaxies.

Here, we present novel observations from the

CFHT of the giant filamentary nebula surrounding NGC 1275, the brightest cluster galaxy in the Perseus cluster. We produce for the first time a H_ alpha and NII velocity map of the nebula in its entirety (~100 kpc; 4 arcmin) and reveal a previously unknown rich velocity structure. Rather surprisingly, the nebula appears to harbor an extremely complex and chaotic velocity structure although some trends are observed to correlate with X-ray structures (bubbles, shocks, trends with distance from the AGN). We also compare these measurements to recent Hitomi measurements of the X-ray gas, enabling us to better understand gas cooling and heating in massive galaxies.

26) Hα Imaging Spectroscopy of Emission Line Galaxies in z~0.25 Clusters using SITTELE

Qing Liu
University of Toronto
Howard Yee, Laurent Drissen, Irene Pintos-Castro, Suresh Sivanandam, Adam Muzzin, Bau-ching Hsieh

Environmental effects are crucial to the understanding of the evolution of galaxies in dense environments such as galaxy clusters. Thanks to the large field-of-view (11' X 11') of SITELLE, the unique Imaging Fourier Transform Spectrograph at CFHT, we are able to obtain 2D spectral information for a large and complete luminosity-limited sample of galaxies out to the cluster infall region at the same time.

We will introduce an ongoing project using SITELLE to observe Hα-[NII] in galaxy clusters at z~0.25. These data will allow us to study environmental effects on the star formation in cluster galaxies in more detail, such as their morphologies and kinematics. A pipeline has been developed to identify emission line galaxies (ELGs) from the datacube.

We will present some preliminary results on the spatial offset between the Hα emission and stellar continuum, using the acquired data of two galaxy clusters, Abell 2390 and Abell 2465. We find that the offsets in ELGs point preferentially towards and away from the cluster center, as an indication of ram pressure stripping occurring in galaxies falling into the cluster. Our study is the first analysis of such type of observation, and demonstrates the uniqueness and promise of 2D spectroscopy on galaxy clusters using SITELLE.

27) GOGREEN post-starburst galaxy analysis

Karen McNab
University of Waterloo
Michael Balogh

I am working with the Gemini Observations of Galaxies in Rich Early ENvironments (GOGREEN) galaxy cluster data in order to distinguish which galaxies underwent rapid, recent star formation quenching, which we deem post-starburst, along with determining where they lie physically in the cluster, and then working to compare the photometry and spectroscopy of this subset of quiescent galaxies in order to determine their dynamics, and shed light on the mechanisms that alter their star formation histories from galaxies not in the cluster.

28) Outflows, mini-halos and filaments in the supermassive cluster MACSJ1447.4+0827, oh my!

Myriam Prasow-Émond
Université de Montréal
Julie Hlavacek-Larrondo, Myriam Latulippe, Carter Lee Rhea, Annabelle Richard-Laferrière, Marie-Lou Gendron-Marsolais

The star formation rate in the most extreme cool core clusters of galaxies is expected to reach values of several thousand solar masses per year; however, the central AGN (Active Galactic Nucleus) is believed to be responsible for quenching this star formation by injecting energy into the intracluster medium. The energy is thought to be injected through relativistic jets creating cavities readily seen at X-ray wavelengths in the intracluster medium. In this talk we present MAC J1447+0827: one of the most extreme and strongest cool core clusters ever discovered which has been recently observed by Chandra, HST and the JVLA. We will present these new data and demonstrate the fascinating observed structures such as relativistic outflows, mini-halos, filaments, and plume structures.

29) An Offset Cooling Flow Exhibiting Formidable Stellar Formation Rate in Z=1.7 Galaxy Cluster

Carter Rhea
L'Université de Montréal
Julie Hlavacek-Larrondo, Tracy Webb, Micheal McDonald

SpARCS104922.6+564032.5 is one of the most massive and extreme clusters of galaxies known to date. It stands out as harboring a still assembling brightest cluster galaxy (BCG) undergoing extreme stellar formation at $z=1.7091$ ($\

sim$800 $M_{\odot}/year$), with evidence of a minor-merger occurring north-west of the BCG and a curved tidal tail extending south-east of the BCG. We present the first X-ray images for the cluster. Our 170 ks ($\approx$50 hour) of Chandra observations are groundbreaking not only due to the exceptional nature of the cluster but also because the object is the first of its ilk to ever be imaged so deeply in the X-rays. Using several techniques for calculating galactic substructure and proxies of cooling flows, we develop a more coherent image of the mechanism responsible for the rampant stellar formation of the BCG. These results have direct consequences for our understanding of how the most massive over densities in the Universe form and evolve with time.

30) Using Galaxy Density to Trace the Assembly of the Virgo Cluster

James Taylor
University of Waterloo
Jihye Shin, Nathalie Ouellette, Stephane Courteau

The mean density interior to the visible edge of a galaxy has been suggested as an indicator of formation redshift since before the current cosmological model existed. I will discuss how this density is expected to scale with mass and redshift in LCDM, and demonstrate how in practice, it seems to trace the assembly history of the Virgo cluster, the nearest large cluster and one with a complex multi-component structure. I will also review several recent results on the mass distribution in the inner parts of galaxies. Together these results suggest a complex picture of how galaxies assemble and evolve dynamically.

31) Star formation histories of cluster galaxies and field galaxies in the GOGREEN survey

Kristi Webb
University of Waterloo
M. Balogh, S. McGee, A. Muzzin, G. Rudnick, G. Wilson, A. Biniano, J. Chan, P. Cerulo, M. Cooper, R. Demarco, D. Gillbank, C. Lidman, J. Nantais, A. Noble, L. Old, I. Pintos-Castro, R. van der Burg, A. Reeves, K. McNab, and the GOGREEN collaboration

Galaxies in dense clusters experience environmental quenching processes in addition to the secular processes which affect field galaxies. The timescale of the quenching processes can be used to constrain the physical mechanisms which suppress star formation. With the Gemini Observation of Galaxies in Rich Early Environments (GOGREEN) survey, we have collected a sample of ~500 spectra of quiescent galaxies, half of which are members of clusters, at $1 < z < 1.5$ when the star formation rate was twice as high as it is today. We explore the differences of the populations, as a function of both environment and mass, through modelling their star formation histories and comparing spectral features. In combination with existing observations at lower redshifts, we will establish the role of large scale structure in these populations through the last two-thirds of the age of the universe.

AGN & Supermassive Black Holes

32) The importance of realism in image-based deep neural network classifications of galaxy interactions

Connor Bottrell
University of Victoria
Maan Hani (Victoria), Hossen Teimoorinia (NRC), Sara Ellison (Victoria), Mallory Thorp (Victoria), Jorge Moreno (Pomona), Paul Torrey (Florida) & Chris Hayward (CCA)

Observations and theoretical predictions alike show that mergers transform galaxies — from changes in AGN activity, star-formation rates, and gas metallicity distributions to angular momenta and morphologies. However, putting these findings in an evolutionary context requires large galaxy interaction samples and the ability to connect these changes to specific stages in a merger. In this talk, I will discuss ways that more complete samples and more accurate merger stage classifications can be obtained by combining the hydrodynamical simulations, synthetic observations, and deep learning.

Specifically, I train convolutional neural networks using synthetic observations from a suite of hydrodynamical merger simulations run with the FIRE-2 model. The simulations offer an important advantage over real observations — ground truth target classes for interaction stage. Synthetic observations of the simulations are produced with various levels of realism (e.g. projected stellar mass and dust-inclusive radiative transfer) to answer the following questions: (1) What is gained/lost by making the images more realistic? (2) How realistic do the images need to be in order to achieve high performance in classifying mergers in realistic images? (3) How sensitive is the network performance to image quality? (4) Is a network that is trained on synthetic observations for one survey easily transferable to another survey of higher or lower image quality?

33) Change-points in Sgr A*'s X-ray flaring rate: Fact or artifact?

Elie Bouffard
McGill University
Daryl Haggard, Michael Nowak, Joey Neilsen, Nicolas Cowan

An unusual object, G2, had its pericenter passage around Sgr A* in Summer 2014. Two distinct research teams have claimed that following G2's pericenter encounter the rate of Sgr A*'s bright X-ray flares increased significantly. However, these authors used data from different X-ray observatories, which all have different sensitivities.

About a year before G2's closest approach, the magnetar SGR J1745-29 erupted in close proximity to Sgr A* and faded to a luminosity comparable to Sgr A*'s quiescence several years later. The Chandra X-ray Observatory is the only X-ray instrument that can spatially distinguish between Sgr A* and the magnetar. However, a part of the magnetar's flux contaminates Sgr A*'s light curve even with Chandra. This effect was not robustly characterized in previous studies.

Here, we use X-ray data from the 3 Ms observations of the Chandra X-ray Visionary Program (XVP) in 2012 as well as an additional 1.5 Ms up to the most recent observations in 2018 from the same telescope. Our total dataset has an exposure of about 4.5 Ms. We use Bayesian Blocks to detect flares and make distributions of flare properties. Using these distributions, appropriate statistics, and proper accounting for different Chandra instrument modes, we simulate X-ray flares and reproduce the observed distributions to investigate whether there is a significant change in the bright (or in any flare category) flaring rate post-G2 or post-XVP. In contrast to previous studies, we observe no such statistically-robust change point.

34) Gemini Imaging of the Host Galaxies of Changing-Look Quasars

Paul Charlton
McGill University
John J. Ruan, Daryl Haggard, Scott F. Anderson, Michael Eracleous, Chelsea L. Macleod, Jessie C. Runnoe

Changing-look quasars are a newly-discovered class of luminous active galactic nuclei that undergo rapid (≲10 year) transitions between Type 1 and Type 1.9/2, with an associated change in their continuum emission. We characterize the host galaxies of four faded changing-look quasars using broadband optical imaging. We use gri images obtained with the Gemini Multi Object Spectrograph (GMOS) on Gemini North to characterize the surface brightness profiles of the quasar hosts and search for [O III] λ4959,λ5007 emission from spatially extended regions, or voorwerpjes, with the goal of using them to examine past luminosity history. Although we do not detect, voorwerpjes surrounding the four quasar host galaxies, we take advantage of the dim nuclear emission to characterize the colors and morphologies of the host galaxies. Three of the four galaxies show morphological evidence of merger activity or tidal features in their residuals. The three galaxies which are not highly distorted are fit with a single Sérsic profile to characterize their overall surface brightness profiles. The single-Sérsic fits give intermediate Sérsic indices between the n=1 of disk galaxies and the n=4 of ellipticals. On a color-magnitude diagram, our changing-look quasar host galaxies reside in the blue cloud, with other AGN host galaxies and star-forming galaxies. On a color-Sérsic index diagram the changing-look quasar hosts reside with other AGN hosts in the "green valley". Our analysis suggests that the hosts of changing-look quasars are predominantly disrupted or merging galaxies that resemble AGN hosts, rather than inactive galaxies.

35) Event Horizon Dynamics: X-ray and Multi-wavelength Variability of Sgr A* and M87

Daryl Haggard
McGill University/McGill Space Institute

The last century has seen exciting tests of general relativity and the LIGO-Virgo observatories have now definitively discovered black holes. And yet we are only beginning to approach the event horizon with electromagnetic observations. Sagittarius A* and M87 are two of the closest supermassive black holes targeted by the Chandra X-ray Observatory, as well as VLT's GRAVITY instrument, the Event Horizon Telescope, and many more. They offer an exciting opportunity for coordinated, multi-wavelength campaigns, which are poised to identify the origin of observed X-ray and IR variability, connect it to horizon-scale structure in the submm, and distinguish between competing models: hot spots, inflow/outflow, reconnection regions, shocks, or even magnetosphere gaps. I will review recent highlights from Chandra and multi-wavelength observations of Sgr A* and M87 and prospects for future discovery.

36) Connecting Changing-Look Quasars' Optical/X-ray Spectral Shapes and Accretion Rates

Xiangyu Jin
McGill University
Marie-Joëlle Gingras, Joseph Hountalas, John Ruan, Daryl Haggard

We present early results from a multi-wavelength study of ten changing-look quasars. Optical spectra from SDSS, ARC 3.5m, Multiple Mirror Telescope, Magellan Telescope and Hobby-Eberly Telescope, combined with X-ray data from Chandra, XMM-Newton, and the ROSAT PSPC sky survey, give us a thorough view of changing-look quasars' optical/X-ray spectral shapes at different epochs. We investigate possible connections between their spectral shapes and accretion rates, and compare these with simulated results.

37) Shocking Quasar Outflows

Courtney Mulholland
York University
Patrick Hall, Toru Misawa, Jesse Rogerson

Most accretion disks surrounding quasars produce a wind that ejects material outwards. It has been theorized that this wind can travel through the quasar host galaxy, sweeping up ambient interstellar medium (ISM) gas into a kpc-scale outflow. It is expected that quasar outflows are initially energy conserving, so outflowing gas does not cool efficiently and continues to expand outwards as a hot bubble consisting of an inner wind, a region of hot shocked wind, and an outer shell of shocked, swept-up ISM gas. This bubble may contribute to expelling ISM gas needed for active star formation from the quasar host galaxy, a crucial part in AGN feedback that transforms galaxies from blue and star-forming to ``red and dead”.

We have connected past models of shocked wind in order to study their implications from an observational perspective. Our model describes the velocity and density within these different regions of the shock bubble, which are then used to calculate additional observable quantities such as the column density and deceleration of the gas. Even with constant energy input, our model predicts a deceleration of the expansion of the bubble with time as more ISM is swept up.

Such a deceleration of quasar outflows has rarely been observed because it is difficult to distinguish from short-term features within the observed spectra. We have therefore proposed to observe deceleration directly at lower velocities in CaII absorption in the outflow of SDSS J030000.56+004828.0 (J0300). Future work will include comparing the deceleration of J0300 using new observations to our theoretical model, and expanding the model to include a radially dependent ISM density. Trends within the observable quantities can then be studied further using a range of ISM densities and quasar wind velocities.

38) Titans of the Early Universe: The seeds of the most massive high-z quasars

Tyrone E. Woods
University of Birmingham
Alexander Heger, Lionel Haemmerle, Daniel J. Whalen

The discovery of billion solar mass quasars at redshifts of 6-7 challenges our understanding of the early Universe; how did such massive objects form in the first billion years? Though other possibilities remain, observational constraints and numerical simulations increasingly favour the "direct collapse" scenario. In this case, an atomically-cooled halo of primordial composition accretes rapidly onto a single stellar core, ultimately collapsing through the post-Newtonian instability to produce a supermassive (~100,000 solar mass) "seed" black hole.

I will present a systematic study of the lives and deaths of these "supermassive stars," using the 1D implicit hydrodynamics and stellar evolution code KEPLER. We include post-Newtonian corrections to gravity and a detailed treatment of nuclear burning processes using an adaptive network. We find a simple relation between the infall rate and the final mass at collapse, provide the first detailed simulations of the observable features of these objects, and briefly discuss the possibility of their contributing to early chemical enrichment.

Though many questions remain, the next generation of great observatories will open unprecedented windows to the birth of the first supermassive black holes. This has the potential to finally reveal their origin and growth in the first billion years, as well as the signatures of their formation history in the local Universe.

With this broader picture in mind, I'll introduce some aspects of our upcoming white paper for LRP 2020, identifying opportunities in the next decade for the Canadian astronomical community to play a leading role in resolving many of the most fundamental problems regarding the origin of supermassive black holes, by leveraging our strong involvement in e.g., the James Webb Space Telescope, Euclid, and the Thirty Meter Telescope.

Interstellar Medium & Star Formation

39) The Study of the Spatially-Resolved HII Regions of M33 with SITELLE at CFHT

Dhruv Bisaria
Queen's University
Laurie Rousseau-Nepton, Kristine Spekkens

Understanding the relationships between H II region parameters is important for determining the extent to which local versus global mechanisms impact the star formation process. We present a photoionization analysis of the emission from the ionized gas surrounding star forming regions in M33. With a mosaic of four fields (4 x 11'x11') of the SITELLE Imaging Fourier transform Spectrometer at CFHT, we observed most of the galaxy disk and its H II regions. We obtained the flux maps in O II, H-beta, O III, H-alpha, N II, and the S II doublets, and used the Astrodendro package on the emission maps to identify individual H II regions. Then, we compared those flux maps with photoionization models using the NebulaBayes package, which uses a Bayesian approach over a grid of photoionization models to extract the metallicity (Z), ionization parameter (U), and pressure (P/k) of individual pixels. Abundances (Z, U, P/k) are plotted against flux, velocity dispersion, and galactocentric distance. In particular, we find that HII region metallicity and flux are correlated, with metallicity decreasing as a function of flux. In this contribution, we will present the SITELLE maps and HII region parameters and discuss their implications for star formation models.

40) Revealing the Formation of Cosmic Fullerenes in the Planetary Nebula Tc 1

Jan Cami
Western University
Jan Cami, J. Bernard-Salas, E. Peeters, I. Aleman, M. Leal-Ferreira, G. Pagomenos, B. Ochsendorf, A.G.G.M. Tielens, R. Wesson, D. Stock, N.L.J. Cox, F. Kemper, G. Doppmann, J. de Buizer

In recent years, fullerenes (and in particular C60) has been detected in a variety of astrophysical environments — from the circumstellar carbon-rich surroundings of evolved stars to interstellar reflection nebulae and young stellar objects. Understanding how these species form, evolve and respond to their environment yields important insights into astrochemistry and the characteristics of large aromatics in space, thought to be the main reservoir of organic material in space.

I will present an overview of what we have learned about cosmic fullerenes from mid- and far-infrared observations (using the Spitzer Space Telescope, SOFIA/FIFI-LS and HAWC+, and Gemini/T-ReCS) of the peculiar planetary nebula Tc 1, as well as from theoretical calculations and recent laboratory experiments, and show how fullerenes have significantly changed our understanding of interstellar chemistry.

41) Distances to Milky Way Water Masers with Gaia

Mark Gorski
Western University
Pauline Barmby

The 22.235 GHz H2O maser is most commonly associated with high mass star formation (HMSF), however there are many environments that give rise to water maser emission including: low mass star formation, planetary nebulae, and active galactic nuclei (AGN). These masers trace shocked gas in the environments around young or evolved stars, and AGN. As such these masers indicate where energy is injected into the Interstellar medium (ISM). Therefore, understanding the distribution of water masers in the Galaxy is important for understanding the impact of feedback on the galactic environment.

We provide distance estimates to ~100 H2O maser sites in the MW. We have matched optical counterparts to the H2O southern Galactic Plane Survey (HOPS) with Gaia data release 2. We Identify two groups of stellar counterparts associated with evolved stars and the stellar main sequence. Utilizing the Gaia derived distances we are able derive luminosities of water maser spots in the Milky Way.

42) Dense Cores Under Pressure : Results from GAS

Helen Kirk
Herzberg Astronomy & Astrophysics, National Research Council of Canada
Ronan Kerr, James Di Francesco, Rachel Friesen, Jaime Pineda

The Green Bank Ammonia Survey (GAS) is a 200+ hour survey on the Green Bank Telescope to map ammonia in nearby molecular clouds, revealing the temperature and kinematics of the dense gas in these star-forming environments. I will present the results of an analysis of the stability of dense star-forming cores in several nearby star-forming regions, using a combination of GAS data and information from the JCMT Gould Belt Survey. A comparison of the thermal pressure, non-thermal motions, self-gravity, and ambient pressure shows that most of the dense cores are bound. Intriguingly, the majority of this binding is due to pressure, rather than an individual core's self gravity. If a similar result is found in a larger range of nearby molecular cloud environments, this will point to pressure, a factor often ignored in energetic analyses of cores, being a key element in the formation of stars.

43) Interaction between HVCs of Neutral Hydrogen and the Galactic Magnetic Field

Roland Kothes
Dominion Radio Astrophysical Observatory
Bailey Forster, Tyler Foster, Jo-Anne Brown, Alex Hill

The interstellar medium of our Galaxy is threaded by magnetic fields and filled with cosmic ray particles accelerated to relativistic speeds at the shock fronts of supernova explosions. Linearly polarized synchrotron emission is generated by the interaction of cosmic ray electrons with the magnetic field, and carries the imprint of the magnetic field direction at the point of origin. The plane of polarization is changed by Faraday rotation as the synchrotron emission propagates through regions where a magnetic field and free electrons are present. Here we report the discovery of observational evidence showing a well- known grouping of high-velocity HI clouds sweeping up the ambient Galactic magnetic field in the high disk-halo interface region as they collide with one another while raining back down onto the Milky Way's mid-plane. This suggests a thin "skin" of ionized gas surrounds each high velocity cloud, and is the first ever observational indication of enigmatic halo objects like HVCs indeed can dramatically compress and alter large-scale magnetic fields, supporting theoretical models of HVC collision and interaction with the Galactic disk.

44) An Extraordinary Submillimeter Flare in a T Tauri Binary System

Steve Mairs
James Clerk Maxwell Telescope
Steve Mairs, Bhavana Lalchand, Geoffrey C. Bower, Jan Forbrich, Graham S. Bell, Gregory J. Herczeg, Doug Johnstone, Wen-Ping Chen, Jeong-Eun Lee, Alvaro Hacar

The JCMT Transient Survey is a 3-year observing program that monitors over 1,000 young stellar objects embedded in 8 nearby star-forming regions on monthly timescales. In this talk, I will briefly describe the methods used to identify protostellar variability at submillimetre wavelengths and highlight an extraordinary stellar flare event that occurred in the binary T Tauri system "JW 566" in the Orion Molecular Cloud. The flare was detected at both 450 and 850 microns by SCUBA-2 on 2016 November 26 (UT). The emission faded by nearly 50% during the 31 minute integration. The event may be the most luminous known flare associated with a young stellar object and is also the first coronal flare discovered at submillimeter wavelengths. We interpret this event to be a magnetic reconnection that energized charged particles to emit gyrosynchrotron/synchrotron radiation.

45) 3D Optical Spectroscopic Study of NGC 3344 with SITELLE: I. Identification and Confirmation of Supernova Remnants

Ismael Moumen
Université Laval/CFHT
C. Robert / Université Laval; D. Devost / CFHT; R. P. Martin / University of Hawaii at Hilo; L. Rousseau-Nepton / CFHT; L. Drissen / Université Laval; T. Martin / Université Laval

In this poster, we present a SITELLE optical identification and confirmation of a large sample of Supernova Remnant (SNR) candidates in the nearby spiral galaxy NGC 3344. SITELLE, the imaging Fourier transform spectrograph of the Canada-France-Hawaii Telescope (CFHT), providesspectroscopic capabilities in the visible (350 to 900 nm, with filters) with a large field of view (11′x11′) and a high spatial resolution (0.32′′ limited by the seeing), which are ideal to cover the whole disk of NGC 3344. Using 3 filters, we measured the strong emission lines [OII]λ3727, Hβ, [OIII]$\lambda\lambda$4959,5007, Hα, [NII]$\lambda\lambda$6548,6583, and [SII]$\lambda\lambda$6717,6731. A sample of 129 SNR candidates have been identified based on four criteria that include the emission line ratio [SII]/Hα > 0.4. The whole set of emission lines have been used to describe the SNR properties and to confirm the shock-excited nature of these sources using a self-consistent spectroscopic analysis based on Sabbadin plots and BPT diagrams. With this analysis, we end up with 42 Confirmed SNRs, 45 Probable SNRs, and 42 Less likely SNRs. Using shock models, the Confirmed SNRs seems to have shock velocities below 250 km/s and a metallicity ranging between LMC and 2 x solar. A trend for a metallicity gradient was observed for the confirmed SNR.

46) A Search for Supernova Light Echoes in NGC 6946 Using SITELLE

Michael Radica
McMaster University
Doug Welch, Laurie Rousseau-Nepton

Among discovered supernova light echo systems, core collapse supernovae (CCSNe) are under-represented, likely due to a combination of lower luminosity (than SN type Ia), more luminosity dispersion, and higher probability of dust absorption. In the Milky Way and Magellanic Clouds, the only CCSN light echo system detected to date is that of SN1987A. To better understand the likelihood of detecting light echoes from such SNe as a function of age, we applied for SITELLE time on the CFHT to obtain H-alpha waveband spectroscopy of the face-on spiral NGC 6946 – the most productive galaxy for CCSNe known, with ten eruptions in the past century.

We report our initial findings from this survey, and describe the opportunities and limitations of such integral field unit spectroscopy for late-time light echo detection.

47) SIGNALS: The Star-formation, Ionized Gas, and Nebular Abundances Legacy Survey

Laurie Rousseau-Nepton
CFHT
L. Rousseau-Nepton, R.-P. Martin, C. Robert, L. Drissen, P. Amram, SIGNALS Collaboration

October 2018 marked the beginning of a new large program at the Canada-France-Hawaii Telescope: SIGNALS, the Star-formation, Ionized Gas, and Nebular Abundances Legacy Survey. During the next four years and with 55 nights of telescope time in hand, our collaboration will observe almost all the extragalactic HII regions within a distance of 10 Mpc using the Imaging Fourier Transform Spectrograph (IFTS), SITELLE. The goal is to get spectral information over the strong emission lines of the visible (i.e. [OII]3727, Hbeta4861, [OIII]4959,5007, [NII]6548,6583, Halpha6563, HeI6678, [SII]6716,6731) with a spectral resolution of 5000 (on Halpha) at a mean spatial resolution of 15 parsecs. SITELLE, with its FOV of 11 arcminutes and its 4 million spaxels, is the perfect instrument for such a survey. In order to build a sample of more than 50,000 HII regions located in different galactic environments, SIGNALS will cover about 40 galaxies that are actively forming stars. Along with ancestry data in the IR and UV, our collaboration aims at studying resolved star-formation activity, understanding the impact of the local environment on the star-formation process, and providing the science community with a unique dataset along with new tools to study star formation. I will introduce this ambitious project and will show some preliminary results from the M33 data.

Our collaboration is still growing. If you are interested in joining the force, please contact me at r-nepton@cfht.hawaii.edu

48) What new insights does SITELLE unveil about NGC 6888 and NGC 2359?

Marcel Sévigny
Université Laval

We will present some results from our detailed SITELLE study of NGC 6888 and NGC 2359, two Wolf-Rayet nebulae, and how those new results are improving our understanding of massive stars evolution. Among other results, we will present a detailed temperature map of some filaments in NGC 6888, numerous emission line characterizing those late stages and a very interesting first map of the [NeIII] 3869 line. Finally, velocity maps of both nebulae are particularly impressive since they provide a detailed insight into the interaction of multiple phases of stellar wind with the interstellar medium.

49) Using Abel's Reconstruction to Extract Dense Regions from Observed Molecular Clouds

Ayushi Singh
University of Toronto
Chris Matzner

Because we observe interstellar clouds in projection, it is challenging to discriminate them from foreground and background emission. We typically need to perform such an extraction when studying their properties, for instance in the virial analysis of star forming regions. Simple approaches tend to neglect the fact that some of this excess emission is contiguous with the region under study. We introduce a new method using Abel's transformation that can extract a dense cloud from an observed molecular region with higher accuracy. We demonstrate the application of this method on various simulated clouds as well as on observed data.

50) Herschel/SPIRE Spectral Observation of Spitzer Extended Green Objects

Locke Spencer
University of Lethbridge
Geoffrey R.H. Sitwell, David A. Naylor, Matthijs H.D. van der Wiel

Extended Green Objects (EGOs) are a class of Massive Young Stellar Object (MYSO) with active outflows powered by ongoing accretion. Discovered by the Spitzer GLIMPSE survey, these sources are believed to represent a poorly understood stage of massive star formation due to their association with 6.7 GHz and 44 GHz CH3OH masers (both tracers of massive star formation), and PAHs — another tracer of star formation. Four EGO sources were selected for follow-up observation with the European Space Agency (ESA) Herschel space telescope based on their association with both types of masers, and as tracers of shocked gas outflows such as H2 and SiO transitions.

Herschel observations of the sources revealed rich molecular environments and complex gas dynamics. The observations also revealed a background of NII emission surrounding all of the sources, but not strongly correlated with the source emission profiles. Further investigations with the ALMA observatory discovered that one of these EGO sources contained 19 separate cores.

We present a current summary of the four EGO sources observed by Herschel, and explore the potential of SPICA observation of EGO sources. The SPICA SMI instrument will overlap much of the Spitzer waveband and can detect PAH emission in these sources. The SPICA Safari instrument will see bright ionized emission lines, some of which overlap Herschel spectral coverage, and others at shorter wavelengths corresponding to higher energy transitions. The enhanced spectral resolution provided by SPICA will provide better understanding of the physical interactions taking place within these unique sources.

51) APEX Observations of the CO Envelope around the Young FUor-type Star V883 Ori

Jacob White
Konkoly Observatory

Most young stars are thought to undergo episodic accretion events during their pre-main sequence evolution, evidenced by outbursts that increase the system's apparent brightness by several magnitudes. The accretion-driven outbursts of young FU Orionis-type stars may be a common stage of pre-main sequence evolution and can have a significant impact on the circumstellar environment, as it pertains to the growth of solids and eventually planets.

We present APEX observations of the CO gas in the envelope around V883 Orionis, a young outbursting star. We mapped the extended envelope in CO(6-5) with SEPIA science verification data, and the CO(4-3), CO(3-2), and 13CO(3-2) lines with FLASH+ data. Utilizing the thermo-chemical code PRODIMO, we tested several envelope models and made constraints on the mass, radius, and infall rate. We find that multiple outbursts are a possible explanation for the observed envelope and outflow structure, consistent with episodic accretion.

High Energy Astrophysics & Compact Objects

52) Supernova Neutrinos with nEXO

Soud Al Kharusi
McGill University
nEXO Collaboration

The nEXO experiment is a proposed neutrino-less double beta decay (0$\nu\beta\beta$) search in the isotope Xe-136. The experiment's stringent low-background requirements necessitate a muon veto water shield in order to reduce contributions from external radiation. Photomultiplier tubes inside the water will measure Cherenkov light of passing muons; this active shield is referred to as nEXO's Outer Detector. We will discuss the Outer Detector's employment as a supernova neutrino observatory, and what kind of physics we can learn via supernova neutrino astronomy both with nEXO and beyond.

53) General Relativistic Corrections to Flux for Rotating Neutron Stars

Charlee Amason
University of Alberta
Sharon Morsink

Rapid rotation can significantly affect observed NS fluxes. General relativistic considerations must be taken into account to produce accurate models. The oblate geometry of a rapidly rotating NS is of particular importance, as the decreased surface area should produce an observable decrease in the measured flux. Flux from a NS with a model hydrogen atmosphere is compared to an otherwise identical NS with only blackbody emission.

54) The White Dwarf Crystallization Sequence Uncovered by the Gaia Mission

Pierre Bergeron
Université de Montréal
P. Bergeron, P. Dufour, G. Fontaine, S. Coutu, S. Blouin, C. Genest-Beaulieu, A. Bédard, B. Rolland

We present a determination of the fundamental parameters of white dwarfs discovered by the Gaia mission using the so-called photometric technique, which relies on the exquisite Gaia trigonometric parallax measurements, as well as photometric data from Pan-STARRS, the Sloan Digital Sky Survey (SDSS), and Gaia. We then discuss the mass distribution as a function of effective temperature for the white dwarfs spectroscopically identified in the Montreal White Dwarf Database (MWDD). We pay particular attention to the recent discovery of the signature of crystallization in the Gaia color-magnitude diagram for hydrogen-line (DA) white dwarfs, and present evidence that the core composition of most of these white dwarfs is, in bulk, a mixture of carbon and oxygen, an expected result from stellar evolution theory, but never empirically well-established before.

55) Rotational evolution of neutron stars

Jorge Calderon Noguez
University of Alberta
Sharon Morsink

Neutron stars are small and fast spinning remnants of stars, which makes them one of the densest objects in the universe. They have the strongest magnetic fields and gravitational forces of all stars. As a consequence of these properties, neutron stars have two types of mass: the baryonic mass, which is the mass of all the particles that make up the star, and the true mass, which is the combination of this baryonic mass, the rotational energy, and the gravitational potential energy. In this work, we will present the rotational evolution of various neutron stars from their maximum spin frequencies to a static state. We will show how the mass and radius change during the spin-down process of these rapidly rotating objects.

56) Gravitational-Wave Astrophysics at The University of Tokyo's Research Center for the Early Universe

Kipp Cannon
University of Tokyo
H. Fong, S. Morisaki, H. Ohta, M. Shikauchi, L. Tsukada, D. Tsuna, T. Tsutsui, K. Ueno

A survey of the exciting activities of the gravitational-waves research group at The University of Tokyo's Research Center for the Early Universe presented to encourage future collaboration.

57) Optical and Timing Analysis of MAXI J1820+070 via Data Pipeline for OMM PESTO Camera

Valérie Desharnais
McGill University
Nicholas Vieira, Daryl Haggard, John Ruan, Tom Maccarone

We describe the development of an optical data pipeline for processing images from the Planètes Extra-Solaires en Transit et Occultations (PESTO) camera of the Observatoire du Mont-Mégantic (OMM). Processing methods include flat corrections, image stacking and segmentation, world coordinate system (WCS) solutions via astrometry.net and meteorological corrections. Analytical methods include light curves and Lomb-Scargle periodograms. We apply this pipeline to 4 epochs (9 July and 28 September 2018, 12 March and 18 March 2019) of data of the X-ray transient binary black hole system MAXI J1820+070. We are able to confidently conclude the non-detection of quasi-periodic oscillations (QPOs) during any of the observations.

58) The Neutron Star in Supernova Remnant 1E 0102.2-7219

Pavan R. Hebbar
University of Alberta
Craig Heinke

Core-collapse supernovae from massive stars can produce neutron stars (NSs), black holes or no compact remnant at all. Thus, identifying NSs in supernova remnants allows us to verify the theories of core collapse. Studying the different manifestations of these young NSs in X-rays allows us to probe their cooling mechanisms and provide crucial clues towards the dense matter equation of state. We re-analysed numerous Chandra X-ray observations of the bright supernova remnant (SNR) 1E 0102.2-7219 in the Small Magellanic Cloud, to validate the detection of a neutron star (NS) in the SNR by Vogt et al. 2018. We find that a blackbody + power-law model is a decent fit, suggestive of a relatively strong magnetic field and synchrotron radiation, suggesting a normal young pulsar. Among realistic NS atmosphere models, a carbon atmosphere with B = 10^{12} G best fits the observed X-ray spectra. The thermal luminosity of the NS (~ 8 * 10^{33} ergs/s) is higher than most rotation-powered pulsars indicating that a high magnetic field heats the NS. We also show that the bright diffuse emission from the SNR can significantly affect the quality of these fits. However, we notice that the blackbody + power-law model and NS with C atmosphere remain the best-fit models and their parameter values do not change significantly for the different background models used. Our results point towards the need for instruments with a better spectral and angular resolution, and a larger effective area, as ideal probes to study young NS in SNRs.

59) Searching the Kepler Field for Self-lensing Systems

Kelsey Hoffman
Bishop's University
Jason Rowe

We are searching through the 4 year public Kepler data set (Q1-17) for self-lensing systems. In a gravitationally bound binary system consisting of a compact object and non-degenerate star, the compact object can act as a lens as it orbits the host star. Time-series photometry of such a system would show an increase in brightness, appearing as an inverse transit, as the compact object passes between the host star and the observer. A self-lensing survey directly measures the occurrence rate of bound stellar remnants. We are performing a systematic search of the 4 year Kepler data set in order to identify inverse transits which are the result of microlensing in the system. As part of the search we have employed injection tests in order to characterize our search algorithm. Here we present the progress of our tests and search.

60) The X-ray Emissivity of Low-Density Stellar Populations

Mario Ivanov
University of Alberta
Craig Heinke, Gregory Sivakoff, Natalia Ivanova, Ashley Ruiter, Craig Sarazin, Maureen van den Berg

The dynamical production of low-mass X-ray binaries and brighter cataclysmic variables (CVs) in dense globular clusters is well-established. We investigate how the X-ray emissivity of fainter X-ray binaries (principally CVs and coronally active binaries) varies between different environments. We compile calculations (largely from the literature) of the X-ray emissivity of old stellar populations, mostly open and globular clusters, including all globular clusters with well-defined parameters within 6 kpc of the Sun.

We investigate three literature claims of unusual X-ray sources in low-density stellar populations, since these objects would have large impacts on our results. We show that a suggested quiescent neutron star in the open cluster NGC 6819 is a foreground M dwarf. We show that the suggested diffuse X-ray emission from an old nova shell in the globular cluster NGC 6366 is actually a background galaxy cluster. And we show that a suggested population of quiescent X-ray binaries in the Sculptor Dwarf Galaxy is mostly (perhaps entirely) background galaxies. We find that above densities of 10,000 solar masses per parsec cubed, the X-ray emissivity of stellar populations increases, due to dynamical production of X-ray emitting systems. Below this density, globular clusters have lower X-ray emissivity than the other populations, and we do not see a strong dependence of X-ray emissivity due to density effects. We find a correlation between X-ray emissivity and binary fraction (at the 2-sigma level), and 1-sigma correlations with metallicity and age. However, the available data is relatively sparse, and sampling via bootstrap techniques gives less significant correlations.

61) The First Hard X-Ray Survey of the Central 30 Parsec of the Galactic Center Searching for Faint High Mass X-Ray Binaries

Yi Won Kim
Taft School
Jung Kyu Jang, Eric Wang

This investigation reports the finding of three potential High Mass X-ray Binary (HMXB) candidates using Nuclear Spectroscopic Telescope Array (NuSTAR) in the central 30 parsec of the Galactic Center (GC) near the supermassive black hole Sagittarius A*. With the follow up data of the GC by NuSTAR which observed 70 new hard X-ray sources, we aimed to search for faint HMXBs. To determine high-mass infrared counterparts of $M \gtrsim 10\ M_\odot$, we utilized the Spitzer IRAC GC survey and conducted source registration on Chandra observations to minimize the absolute astrometric errors, which are unique for each observation. Various characteristics of these HMXB candidates including stellar types, pulsations, and luminosities were analyzed by spectral and timing analysis. This was followed by a stellar density calculation to further verify that the high-mass infrared counterparts are associated with each of its HMXB candidates. This investigation shows the likelihood of the existence of other faint HMXBs in the GC that are undiscovered due to lack of sensitivity of previous telescopes.

62) On the Masses of Millisecond Pulsars

Lorne Nelson
Bishop's University
Jerome Quintin

Precise measurements of the masses and radii of neutron stars are essential to our understanding of various physical phenomena including extreme relativistic effects and the equation of state of cold nuclear matter. Thanks mainly to the very precise timing measurements of binary millisecond pulsars (wide circular-orbit binaries containing recycled pulsars), we know that neutron stars can have a wide range of masses spanning from 1.17 to approximately 2.0 Msun.

But the following questions arise: (1) What is the maximum mass that a neutron star can have? and, (2) Why is the mass-transfer process that leads to the spin-up of the neutron star so non-conservative? We show that X-ray irradiation feedback during the accretion phase of the formation of bMSPs causes quasi-periodic episodes of Eddington-limited mass transfer that strongly attenuate mass accretion by the NSs. This results in the formation of bMSPs with greatly reduced masses than would have otherwise been expected from fully conservative mass transfer and leads to very good agreement with the observational results. Most importantly, our model has very little impact on the long-term, secular-average evolution of the low/intermediate-mass X-ray binary systems that are the progenitors of bMSPs. Finally the intriguing implications of our model for the newly discovered transitional millisecond pulsars (tMSPs) will also be discussed.

63) Neutral Helium Line Profiles through the Simulation of Local Interactions in White Dwarfs

Patrick Tremblay
Université de Montréal
Patrick Tremblay, Alain Beauchamp, Pierre Bergeron

White dwarf stars are classified according to their spectral absorption features. In the case of hot white dwarfs, the main broadening mechanism is due to the Stark effect. For the past 25 years, we have been considering the Stark effect for neutral helium lines in the so-called DB white dwarfs using the analytical standard Stark broadening theory in both the impact regime (in the center of the lines) and the quasi-static regime (in the wings) for the electrons, while neglecting the effect of ion motion. Although this is probably a good approximation based on previous theoretical work, the transition between the two regimes for the electrons and the contribution of the ion very near the core might be poorly represented. To solve this problem, we propose to produce a series of simulations to treat the local dynamics and interactions around a neutral helium atom, considering both electrons and ions in motion. We will show that such simulations require some consideration in order to reduce the computational time while also being physically adequate. We also discuss how we can transform the product of the simulations into a line profile, and how this will affect future work.

64) Inverse Population Synthesis, Searching for The Origins.

Kenny Van
University of Alberta
Natalia Ivanova

The formation of neutron star low-mass X-ray binaries is an ongoing challenge in stellar evolution. Neutron star low-mass X-ray binaries are systems contain a neutron star accreting material from a donor where the mass transfer is driven by magnetic braking. There are significant discrepancies between the observed mass transfer rates and the theoretically predicted values, in some cases differing by up to an order of magnitude. Using the MESA stellar evolution code we tested modified magnetic braking which scales the default "Skumanich" prescription and a "Reville" prescription. Using these different magnetic braking prescriptions we can produce the observed mass transfer rates at the detected mass ratio and orbital period. Using the simulated results we can work backwards and show the possible progenitors to a given observed low-mass X-ray binary. We show the possible progenitor systems of a given group of low-mass X-ray binaries for different magnetic braking prescriptions and analyze how each prescription effects which progenitors successfully reproduce observations.

65) Searching for ZZ Ceti white dwarfs in the Gaia survey

Olivier Vincent
Université de Montréal
Pierre Bergeron, David Lafrenière

The Gaia satellite recently released parallax measurements for nearly 400,000 white dwarf stars, allowing for precise measurements of their physical parameters. Combined with Pan-Starrs photometry, effective temperatures and masses were determined for all white dwarfs within 100 pc, and a sample of pulsating white dwarf candidates was selected within the ZZ Ceti instability strip. We report the results of a photometric follow-up, currently underway, aimed at identifying new ZZ Ceti stars among this sample using the PESTO camera at the Mont-Mégantic Observatory.

66) Apparent soft excess identified in the quiescent Be/X-ray pulsar RX J0812.4-3114

Yue Zhao
Department of Physics, University of Alberta
Craig O. Heinke, Sergey S. Tsygankov, Aarran W. Shaw

A Be X-ray pulsar (BeXRP) is a high-mass X-ray binary (HMXB) that harbours a highly magnetised neutron star (NS) and a Be-type optical companion. Systems of this kind are manifested by bright X-ray outbursts that occur on periastron passages as the NS regularly passes through the decretion disc around the Be star (Type-I outbursts). In quiescence, the X-ray spectrum is characterised by a soft, blackbody-like component (thought to be thermal emission from NS surface) and/or a hard power-law, considered to be non-thermal radiation due to continued low-level accretion. It is quite ubiquitous that in bright and intermediately bright sources, the soft component is prominent that leads to apparent excesses, thought to be thermal emission from a small area consistent with heated magnetic polar caps.

In our XMM-Newton observation of the BeXRP RX J0812.4-3114 (J0812), a clear soft excess is unambiguously identified when the source is in a low-luminosity (L_X~10^33 erg/s) state. The spectrum is best characterised by a two-component model, comprised of a hard power-law (Gamma~1.3) and a blackbody component with kT_bb~0.1 keV. Intriguingly, the soft excess seems to originate from a rather large blackbody radius of R_bb ~10km, consistent with thermal emission from the entire NS surface. The hard power-law shows pulsations at P=31.908, suggesting continued low-level accretion, while no evidence for pulsations was found in the soft excess. We compared thermal X-ray luminosity (L_q) predicted by the standard deep crustal heating model with the observed quiescent luminosity and found that J0812 is consistent or above the prediction of standard photon cooling mechanism. The NS in J0812 might, therefore, be so young that it has not fully cooled from the heat of the supernova.

Stars & Stellar Populations

67) On the variability and dust-driven winds of AGB stars

Zhuo Chen
University of Alberta
Natasha Ivanova

Asymptotic giant branch (AGB) stars are among the most poorly understood stellar objects. AGB stars are known to have dramatic variability in their magnitudes at periods consistent with their dynamical timescales, between 200 and 800 days. Typical bolometric magnitude changes by about 0.4, while AGB spectra are characterized by strong infrared excesses. AGB stars' amplitude of variability is typically less in the infrared than in the optical: for example, the magnitude amplitude of R Horologii in V band can be as large as 7.66, whereas in M band is only 0.45. All such features imply that AGB stars are dust-enshrouded, and the dust formation radius varies over the pulsation period. The standard to-the-date theoretical approach is to model the pulsation as a piston. Piston's velocity is taken to vary sinusoidally at a specific radius and the change in AGB star's luminosity is modeled by a set of other parameters, taken ad hoc.

We propose that a relation between the piston parameters and the luminosity variation could be established self-consistently. This relation can only be found if we solve the equation of state and the Euler equations together with a new Riemann solver that applies a general equation of state. By resolving the luminosity variation in the atmosphere of AGB stars, we could further track the dust-formation and the dust-driven winds dynamically. Our models are capable of producing mass loss rates, wind velocities, and the corresponding light curves which are consistent with observations.

68) A honest science story of a humble discovery: new properties of hot-wind clumps.

André-Nicolas Chené
Gemini Observatory
Nicole St-Louis, Anthony F. J. Moffat

The scientific processes leading to new discoveries, big or small, are often presented as a linear story linking the initial hypothesis directly to the final result. This is how we are taught the work of the "Giants" that came before us. This is how we are presented the highlights in our field. This is even how journal editors and referees want us to write our own papers.

But Science is an adventure that rarely goes as planned. We encounter dead ends more often than breakthroughs and it is sometimes frustrating to compare our lives as researcher to the false perceptions we are given of others, especially in our junior years.

In this presentation, I will cover the main steps that led my collaborators and myself to a single plot that seems to bring something new and interesting in the field of hot stellar winds. In our upcoming 2020 paper, you will read that we have measured the line profile variability in the spectra of nearly 100 Wolf-Rayet stars observed over the past 18 years. And in the result section, you will find that the amplitude and the width of those variations, attributed to density clumps, scale with the temperature at the base of the wind, itself determined by the Potsdam atmospheric models, PoWR. This can, at least, allow us to probe interesting characteristics of the stellar winds, and at best change the way clumping is defined in the atmospheric models. But only here am I allowing myself to admit that we never planned to work on that specific aspect in the first place, that many parts of the project were shots in the dark and that we have encountered long periods of time during which we questioned ourselves about what to make of all those data.

69) A Deep Polarimetric Study of the Asymmetrical Debris Disk HD 106906

Katie Crotts
University of Victoria
Brenda Matthews

HD 106906 is a young, possible binary star system, located in the Lower Centaurus Crux (LCC) group. This system is unique among known systems, in that it contains an asymmetrical debris disk, as well as an ejected 11 Mjup planet companion, HD 106906 b, at a separation of 650 AU. The debris disk is nearly edge on, and extends roughly from 50 AU to >500 AU, where previous polarimetric studies with the Hubble Space Telescope have shown the outer regions to have high asymmetry. Deeper data have been taken with the Gemini Planet Imager (GPI), which we have extracted from the GPI Data Reduction Pipeline and will be using to perform a deep polarimetric study of HD 106906's asymmetrical disk. The data were taken in the H-band, where the filter throughput peaks at 1.647µm, and spans ~1.5-1.8µm at >= 50% throughput. Polarimetry is important in the study of debris disks, as it helps us constrain their dust grain characteristics, as well as allowing us to obtain high-contrast images. This in turn, grants us the ability to effectively analyze disk morphology, which is crucial in aiding our understanding of disk evolution and planet formation.

70) The Effects of Metallicity on Convective Overshoot Behaviour in Models of Delta Scuti Stars

Veronika Dornan
Mount Allison University
Catherine Lovekin

Delta Scuti variables are stars which exhibit periodic changes in their luminosity through radial and non-radial pulsations of their surfaces. Lovekin and Guzik (2017) found a strong correlation between Delta Scuti stars' pulsation constant (Q) as a function of effective temperature and the amount of convective overshoot within the star. However, only models with metallicities of Z=0.02 were examined, leading us to question the metallicity dependence of this relationship. We collected the data in this research through creation of a grid of stellar models using MESA (Paxton et al. 2010), and analyzed the models' pulsation properties using the GYRE (Townsend & Teitler 2013). By varying the models' mass, rotation speed, convective overshoot, and metallicity we determined that the relationship found by Lovekin and Guzik does hold for stars of other metal compositions and may have a quantifiable metallicity dependence, although statistically weak. In addition, we found a second relation between Q as a function of effective temperature and convective overshoot at higher effective temperatures as well. The cause of this new relation was found to be due to the deepest surface convection zone depth of the models.

71) Measuring rotation periods of the lowest mass stars

Benjamin George
University of Western Ontario
Stanimir Metchev, Paulo Miles-Páez

Most low-mass late-M dwarf stars (M7-M9) exhibit magnetic activity, driven by their fully convective interiors. Analogously to the sun, this generates stable surface inhomogeneities (sun spots) that rotate with the star, creating per cent-level flux variations. We seek to measure rotation periods of late-M dwarfs by observing these flux variations. Most of our targets are too faint (R > 16 mag) for TESS to observe reliably. Yet, because of their proximity to the Sun and their low intrinsic luminosities, they are excellent candidates to study as potential exoplanet hosts. We used the 1.3m SMARTS and 0.9m WIYN ground-based telescopes to monitor for variability. We report I-band photometric monitoring for 13 fast rotating (vsin(i) > 30 km/s) M7-M9 dwarfs. Four (31%) exhibit photometric periodicity in the 2-4 h range, as expected from their fast rotation. A comparison for one target between our data and TESS data finds that, while ground-based data has a lower photometric scatter, extended uninterrupted monitoring with TESS can still reveal low-level amplitude variations not seen with larger apertures from the ground.

72) Revealing the nature of HD63401

Pavlo Kashko
Université de Moncton
V. Khalack, O. Kobzar, D. Tvardovskyi, M. Perron-Cormier

We used the data on photometric variability of southern stars provided recently by the space telescope TESS to identify the magnetic chemically peculiar (mCP) stars through the analysis of their light curves. HD63401 is one of the detected mCP stars for which we estimated its rotational period 2.41420 +_0.00005 d. The modified ZEE-

MAN2 code has been employed to carry out an abundance analysis of high-resolution and high signal-to-noise spectra obtained for HD63401 with ESPaDOnS and to derive average abundance of chemical elements in stellar atmosphere of this star. The analysis of Balmer line profiles yielded estimates of effective temperature, gravity, radial velocity and vsin(i) in HD63401 that were used for the abundance analysis.

73) Project VeSElkA: Search for abundance stratification in slowly rotating CP stars

Viktor Khalack
Université de Moncton

Competition between the radiative and gravitational forces in a hydrodynamically stable stellar atmosphere can lead to an appearance of vertical stratification of chemical abundances due to the atomic diffusion mechanism. An abundance analysis of slowly rotating CP stars has been carried out basing on their high-resolution spectra obtained with ESPaDOnS, NARVAL and HERMES. The code ZEEMAN2 was used in a semi-automatic mode to analyze hundreds of line profiles in each spectrum and to study an abundance variation with optical depth for different chemical species. It was found that in HD22920 only silicon and chromium tend to increase their abundances towards the deeper atmospheric layers. Evidences of vertical stratification of iron and chromium abundances were found in the stellar atmospheres of HD95608, HD116235, HD41076 and HD148330. In HgMn stars HD53929 and HD63975 stars phosphorus tends to increase its abundance towards the upper atmospheric layers. In stellar atmosphere of HD157087 some metals show significant abundance increase towards the deeper atmospheric layers. Meanwhile, not all studied stars show signatures of vertical abundance stratification of chemical species.

74) High resolution spectroscopy of extremely metal-poor stars from the CFHT Pristine Survey

Collin Kielty
University of Victoria
Kim Venn, Else Starkenburg, Nicolas Martin, Anke Arentsen, Spencer Bialek, Carmela Lardo, Federico Sestito

We present Gemini-GRACES high-resolution spectroscopic observations and detailed chemical abundance analyses of 13 extremely metal-poor (EMPs; [Fe/H]<-3.0) stars discovered in the CFHT Pristine survey. EMP stars are rare, and have shown a variety of interesting element ratios in previous studies, interpreted as due to variations in their supernovae progenitors The GRACES spectra has enabled us to determine the chemical abundance patterns of these stars, including the alpha (O, Mg, Ca), odd- Z (Na, Al, Sc, Mn, Zn), and especially the neutron capture elements (Y, Sr, Ba, Eu) which are sensitive to progenitor mass, metallicity, and rotation rates, supernovae explosion energies, mixing, and fallback, and explosion symmetries or progenitor binarity. These elemental abundances have allowed us to identify rare classes of chemically peculiar stars, such as CEMP-no, alpha-challenged, and r-process rich stars, which are currently linked to specific epochs or events in galactic chemical evolution scenarios and provide critical constraints on the characterization of the first stars and supernovae. Furthermore, this sample quadruples the number of EMP stars observed with GEMINI as part of the Pristine survey, enabling the exploration of potential observational biases due to the narrow CaHK filter being used by the Pristine survey.

75) Analyses slowly rotator chemically peculiar magnetic stars with TESS

Oleksandr Kobzar
Université de Moncton
O. Kobzar, V. Khalack, C. Lovekin, A. David-Uraz, J. Sikora

From the end of 2018, the Transiting Exoplanet Survey Sattelite (TESS) provide the results on stellar photometry to the astronomical community. We are using the TESS data to search for chemically peculiar stars with a significant magnetic field (mCP stars). In general, mCP stars show an inhomogeneous distribution of elements in their stellar atmospheres that leads to spectroscopic (line profile) and photometric (light curve) variations with the rotation period. From the analysis of TESS data, we are trying to detect mCP stars assuming the model of inclined magnetic rotator that should result in a signal at the frequency of stellar rotation and at its first harmonics. From the analysis of data from the sectors 5, 6 and 7 observed with TESS we have compiled a list of candidate mCP stars with long rotational periods, some of which show stellar pulsations. We are interested in slowly rotating mCP stars with a hydrodynamically stable stellar atmosphere where atomic diffusion can be effective and lead to abundance stratification. For the bright candidates we use their available spectra to derive vsin(i) and select the slowly rotating mCP stars. For each star, we have used the code Period04 to analyze the light curves and to measured frequencies and amplitudes of periodic signals with high precision.

76) The intermediate-mass binary star Capella: an example of binary evolution of an evolved magnetic Ap star?

Olivia Lim
University of Montreal
Gregg A. Wade, Oleg Kochukhov, Matthew E. Shultz, Evelyne Alecian

Magnetic fields in stars can affect multiple stellar evolution processes. Despite their important contribution, their presence is often neglected due to their complexity and/or the lack of comprehension of their impacts on the stars. Our understanding of magnetism in stars can be improved by studying binaries. The binary star Capella is a particularly interesting candidate for such an investigation: not only has it been observed and analyzed for decades, but it also hosts a magnetic field. Using polarimetric observations from the spectropolarimeter Narval, we examined the orbital and magnetic properties of Capella through spectral line profiles computed by Least Squares Deconvolution. We confirmed the orbital parameters and detected clear Zeeman signatures for the primary component and weaker signatures for the secondary. By measuring the longitudinal magnetic field of the primary, we derived an estimate of its rotational period, confirming rotation synchronized with orbital motion. We applied the Oblique Rotator Model to estimate the magnetic dipole parameters of the field on the primary. We performed magnetic Doppler imaging to model the time-variable line profiles, deriving a field topology of the primary qualitatively consistent with that derived from parametric modeling. The unusually slow rotation of the primary combined with its relatively strong magnetic field suggest that it could be a magnetic Ap star descendant. To explore this hypothesis, we modeled the tidal evolution of the system, concluding that slow initial rotation of the primary (as expected from an Ap star progenitor) provides a natural explanation of the current properties of the system.

77) Abundance Stratification in the Chemically Peculiar Star HD148330

Mathieu Perron-Cormier
Université de Moncton
Viktor Khalack, Patricia Lampens, Lore Vermeylen

We have analysed 18 high resolution and high signal to noise spectra of HD148330 obtained recently with the spectropolarimeter ESPaDOnS at the CFHT and with the echelle spectrograph HERMES at the Mercator telescope. The effective temperature and surface gravity were estimated with the help of FITSB2 code by fitting of the Balmer line profiles. For each spectrum, several hundreds spectral lines were simulated using the ZEEMAN2 code. We have estimated the average abundancies of 38 elements among which scandium, cobalt, yttrium, zirconium, barium and Rare Earth Elements (REE) were found to be significantly overabundant. We also found significant abundance stratification in function of optical depth for calcium, cobalt, iron, manganese and nickel.

78) Using carbon stars as standard candles so as to probe fundamental laws of physics

Paul Ripoche
University of British Columbia
Jeremy Heyl, Harvey Richer

Carbon stars were discovered for the first time by Secchi (1868), thanks to the characteristic Swan bands in their spectrum. Carbon stars are usually evolved cool luminous red giant stars and are therefore located in the asymptotic giant branch (AGB), on the Hertzsprung-Russell diagram.

Since carbon stars are very luminous, very red and have a characteristic known composition, our goal is to determine an accurate selection criteria and then derive a universal luminosity function, in order to use those stars as standard candles. Thanks to the next generation of telescope (e.g. James Webb Telescope, TMT and ELT), carbon stars could be detected at distances further than Cepheids or TRGB stars, that is to say about 50-60 Mpc. Those distances could possibly be large enough that the effects of the galaxies' peculiar velocities are not important, yielding a two-step distance ladder to the scale of the Universe. The final goal is to eventually improve the measurement of the Hubble constant and then be able to probe fundamental laws of physics.

Carbon stars have been known for a long time to show redder near-infrared colours with respect to oxygen-rich stars, and therefore, they occupy a specific region of near-infrared colour-colour diagrams. We used the 2MASS All-Sky Point Source Catalog and the Gaia DR2, in order to get a color-magnitude diagram and a color-color diagram of the Magellanic Clouds, in the near-infrared 2MASS bands.

The carbon stars in both of the Magellanic Clouds show a luminosity function centered at about -6.2 mag (in absolute magnitude). This consistency in the luminosity functions, is a promising result towards the use of carbon stars as standard candles. The same work is currently done with the carbon stars in the Milky Way, and further work will study the ones in M31.

79) Effects of the amplitude of the anharmonic radial pulsations on the shapes of the radial velocity curves of rotationally and tidally distorted pulsating variable stars

Tarun Sachdeva
Thapar Institute of Engineering and Technology, Patiala, Punjab, India
Ankush Pathania and Arvind Kumar Lal

In this paper we have studied the effect of the amplitude of the anharmonic radial pulsations on the shapes of the radial velocity curves of the Polytropic models of pulsating variable stars. We have used the anharmonic theory of pulsating variable stars as proposed by Rosseland (1949) in conjunction with Mohan and Saxena (1983, 1985) approach to obtain the anharmonic pulsation equation of rotationally and tidally distorted Polytropic models of pulsating variable stars. The methodology of Prasad (1949) has been used to solve the anharmonic pulsation equation of the rotationally and tidally distorted Polytropic models of the pulsating variable stars. We have solved the equation of the anharmonic radial pulsation for fundamental and first two modes. Numerical computations have been performed to determine the solution of anharmonic pulsation equation of certain rotationally distorted and rotationally and tidally distorted Polytropic models of stars with index for certain values of relative amplitude of pulsation. The radial velocity curves for certain Polytropic models have been then obtained. The value of the skewness coefficient has also been computed in each case for certain values of amplitude. The result thus obtained has been analyzed and certain conclusion based on the present study has been finally drawn.

80) Spectral analysis of magnetic chemical peculiar star HD24712

Dmytro Tvardovskyi
Université de Moncton
Tvardovskyi D., Khalack V., Kashko P., Kobzar O., Perron-Cormier M.

Using the high-resolution and high SNR spectra of HD24712 obtained with ESPaDOnS we have carried out its abundance analysis. HD24712 is a chemically peculiar star of $\alpha 2$ CVn type of variability that shows access of iron peak elements. From the analysis of photometric measurements recently obtained for HD24712 with the special telescope TESS we have estimated the period of its stellar rotational and detected the flux variability due to the horizontal stratification of elements abundance in its stellar atmosphere. We have studied the variability of line profiles and their magnetic widening with the phase of stellar rotation with aim to reconstruct the magnetic field configuration assuming the model of oblique magnetic rotator.

Transients

81) An All-Sky Search for Long-Duration Radio Transients

Hannah Dykaar
University of Toronto
Bryan Gaensler, Casey Law

Transient sources encode key information capable of advancing our understanding of the universe. As large coverage and highly sensitive interferometric surveys become available, slowly-evolving radio transients have become newly discoverable. By comparing data from two VLA surveys, Faint Images of the Radio Sky at Twenty cm (FIRST) and the VLA Sky Survey (VLASS), I have identified a list of over 1000 radio-emitting transients detected by FIRST whose emission has either disappeared or significantly decreased over the decades separating the two surveys. One transient in particular, located in the nucleus of a nearby galaxy, has a radio lightcurve consistent with a tidal disruption event.

82) A very massive neutron star: relativistic Shapiro delay measurements of PSR J0740+6620

Emmanuel Fonseca
McGill University
H. Thankful Cromartie, Scott M. Ransom, Paul B. Demorest, on behalf of the NANOGrav Collaboration

We report on timing measurements of PSR J0740+6620, a radio millisecond pulsar observed by the North American Nanohertz Observatory for Gravitational Waves (NANOGrav). Initial NANOGrav observations of this binary pulsar led to a marginal measurement of the Shapiro time delay, which quantifies relativistic variations due to propagation of the signal through varying amounts of spacetime curvature induced by its companion white dwarf. With strategic observations of J0740+6620 at specific orbital configurations, we have improved the neutron-star mass measurement via the Shapiro delay to be 2.17(10) solar masses (68.3% credibility). At its current level of precision, PSR J0740+6620 is the most massive neutron star known using established timing techniques.

We also discuss near-future prospects of improving this measurement using timing data acquired with the Canadian Hydrogen Intensity Mapping Experiment.

83) CHIME Monitoring of Pulsars and the Interstellar Medium towards them

Aarya Patil
University of Toronto
CHIME/Pulsar collaboration

Observed pulsar signals exhibit variations in intensity over frequency and time due to propagation effects induced by the interstellar medium (ISM). An extreme effect of the interstellar medium is the so-called Extreme Scattering Event which causes strong, frequency-dependent changes in brightness of radio sources. Variations in a pulsar's average profile due to dense structures crossing the line-of-sight had only been reported in the form of echoes produced by the Crab nebula surrounding PSR B0531+21, until a recent evidence of another echo was found for the pulsar PSR B2217+47.

We are developing an automated detection pipeline to monitor variations in all the northern hemisphere pulsars observed by the CHIME (Canadian Hydrogen Intensity Mapping Experiment) telescope and in turn find echoes. We aim to do this using data from the CHIME/Pulsar backend because it has the sensitivity to monitor practically all known pulsars in the Northern sky, and can do so with high cadence. A by-product of this analysis would be a catalogue of average pulse profiles for the known northern sky pulsars. Our analysis will also allow alerting other telescopes to monitor interesting events close to real time, thus promoting collaborative scientific discovery. In this poster, I will be presenting the latest progress of this work and how it will help in investigating the properties of the Ionised Interstellar Medium.

Cosmology

84) Measuring growth rate of cosmic structure through small scale clustering in SDSS with corrected fibre collision

Michael Chapman
University of Waterloo
Faizan G. Mohammad, Will J. Percival

We make use of recently proposed statistical techniques, new data sets, and advanced modelling to measure small scale clustering in SDSS data to place improved constraints on the growth rate of cosmic structure. Previous attempts to constrain the growth rate through SDSS-III BOSS small scale clustering were limited by the fibre collision issue, where physical limitations prevent targeting two objects within 62" of each other in a single pass of the BOSS spectrometer. The resulting data set is biased because it excludes close angular pairs, which possess a different radial distribution than the rest of the sample.

The recently proposed pairwise inverse probability (PIP) weighting scheme provides the first unbiased correction to measurements affected by fibre collision, by calculating the probability each pair in the sample could have been observed. We apply PIP weights to the recently completed SDSS-IV eBOSS emission line galaxy (ELG) and luminous red galaxy (LRG) samples to measure the monopole, quadrupole, and hexadecapole of the redshift space correlation function and projected correlation function on small scales. These measurements will then be compared to redshift space distortion emulators, making use of modern computational techniques to efficiently compute the expected redshift space clustering of galaxies for a variety of cosmologies. The resultant fit will be used to constrain the growth rate of structure, and thus the underlying cosmology.

85) A Modified Zel'dovich Approximation for Fuzzy Dark Matter

Alex Laguë
University of Toronto
Renée Hložek, J. Richard Bond, George Stein

Fuzzy dark matter (FDM) is a well-motivated dark matter candidate which is proposed to resolve the small-scale tensions of the LCDM model of cosmology. When simulating FDM, the initial density field is modified to account for the suppression on small scale of the matter power spectrum which is due to the manifestation of a "quantum pressure" at scales approaching the de Broglie wavelength of the FDM particles. However, the velocity field derived from the Zel'dovich approximation is implicitly assumed to be pressure-less by design. We correct for this inconsistency by including a scale-dependent sound speed in the evolution equations for the linear growth factor which propagates the effects of the quantum pressure to the velocity field and the growth of structure. We later investigate the impacts of these corrections in a Lagrangian-perturbation-theory-based simulation to quantify the potential improvements to the FDM constraints by including this supplementary term. Finally, we look at possible predictions of this model for specific dynamic observables such as redshift space distortions and the kSZ effect.

86) Quantum Gravity Theory

Zhian luan
China Petroleum University (HD)

I will present on the Fundamental Physics Constants: 1. Newton Constant of gravitation, 2. Boltzmann Constant, 3. Planck Constant, 4. Elementary Charge, 5. Speed of Light in Quantum Coherent State, 6. Maximum speed of a photon, 7. Electron mass, 8. Photon mass. (See: arXiv:1803.07298v2, 13 Jul 2018, J.J. Wei and X.F. Wu) Using our solutions of Lindelöf hypothesis, we obtain a mass chain with almost periodic algebra.

87) Optimizing spectroscopic follow-up of LSST transients with active learning

Connor Sheere
University of Toronto
Tina Peters, Renée Hložek

Taking spectra of distant objects is expensive. Any strategy for spectroscopic follow-up given a photometric detection should therefore be optimized to most efficiently use the limited spectroscopic resources available. Active Learning (AL) is a strategy that is used in conjunction with a machine learning classifier to optimally select follow-up targets, which then become part of the training set. We will present the results of applying a specific AL light curve classification framework to the recent Photometric LSST Astronomical Time-series Classification Challenge (PLAsTiCC) simulations. By selecting objects for follow-up which were the least well-classified by the learning algorithm, this method can reduce the contamination in photometric classifications relative to conventional methods. This is of vital importance for doing SNe Ia cosmology. Given the many new classes of transients included in the PLAsTiCC data set, we extend our analysis from the standard twofold classification of SNe Ia vs. non-Ia to a higher dimensional boundary between different classes.

88) Percent-level calibration of weak gravitational lensing

Isaac Spitzer
University of Waterloo
Michael Hudson

Weak lensing provides an important probe into the dark matter distribution of the universe. The accuracy of weak lensing measurements is dependent on the ability to achieve unbiased shape measurements of the background source galaxies. However, shape measurement algorithms are known to be biased due to complicating factors such as noise, seeing, and the pixelization of the light as it is measured by the CCD. Therefore, the bias in the shape measurement algorithms must be closely studied and corrected for, as certain applications of weak lensing require the bias to be reduced to less than 1%. In order to achieve such a level of precision, simulated weak lensing observations are created with a known shear applied to each galaxy. The simulations are intended to match the observing conditions present in the Canada-France Imaging Survey (CFIS) so as to capture as many of the sources of bias as possible. The bias can then be measured by comparing the measured shear to the known shear applied to the simulated sources. Additional sources of bias, such as selection biases due to galaxy detection algorithms, are also explored.

89) Eppur Si Muove II: Further evidence that we're all moving

Raelyn Sullivan
University of British Columbia
Douglas Scott, Dagoberta Contreras

The Cosmic Microwave Background (CMB) radiation is an image of the universe in its earliest observable moments. The CMB is nearly uniform, but the spectra in each pixel differ slightly, reflecting temperature fluctuations in the early Universe. These anisotropies provide important constraints for cosmological models of the early Universe, but they are not purely driven by primordial fluctuations. The largest anisotropy is the dipole, thought to be mainly due to a Doppler shift stemming from the relative movement of the Solar System with respect to the CMB's rest frame. This boost also affects the higher-order spherical harmonic terms by modulation and aberration effects, with the modulation having the same spectral shape as the thermal Sunyaev-Zel'dovich (tSZ) effect. Previous efforts at extracting the dipolar modulation from CMB data have neglected the angular dependence of this modulation. By appropriate cross-correlation of measurements of the CMB and of the tSZ effect we can exploit the full angular dependence of the dipolar modulation signal, and find a more statistically significant detection of the effect. Can we use such additional CMB signatures to tell whether the dipole is entirely due to motion or has an intrinsic contribution?

90) Constraining Axion Potentials with Cosmosis

Harrison Winch
University of Toronto
Harrison Winch, Renee Hlozek

Axions and axion-like particles (ALPs) are promising candidates for dark matter. However, due to the wide range of theoretical models predicting axion-like particles, it is prudent to consider and constrain all possible properties these particles could possess, in order to distinguish between otherwise similar dark matter candidates. One such property is the shape of the axion potential function, which deviates from the standard harmonic potential in some models. In this project, we redesigned the axionCAMB software to evolve the axion field in the presence of an arbitrary potential function, and calculated how observables (such as CMB and matter power spectra) change as a result. We then used Planck 2015 CMB likelihoods to constrain the shape of a cosine potential, parameterized by the axion decay constant f_a, using Cosmosis. Preliminary results suggest that f_a can be constrained to values above $\sim 10^{16}$ GeV, which is consistent with the existing literature. In addition to constraining f_a (which could provide insight into the high-energy origins of ALP dark matter), this modified axionCAMB software has many other potential applications (no pun intended), as it can utilize the full range of cosmological data to constrain a variety of theoretical axion models.

Extrasolar Planets

91) Dust Evolution & Planet Traps: Effects on Planet Populations

Matthew Alessi
McMaster University
Ralph Pudritz, Alexander Cridland

The wealth of recently discovered exoplanets has revealed the existence of planet populations on the mass-period diagram. Our work aims to understand the factors in planet formation processes that shape this distribution. We combine an evolving physical and chemical disk model and the core accretion model of planet formation in a population synthesis approach.

A key feature of our model is the inclusion of planet traps – barriers that prevent rapid type-I migration. The traps we include are the water ice line, heat transition, and the dead zone outer edge. We explore the effects of radial dust drift, an effect indicated by ALMA disk observations, by comparing planet populations that include its effects to those in which a constant disk dust-to-gas ratio has been assumed. When considering a constant dust-to-gas ratio, our model produces many super Earths and Neptunes, with the majority having orbital radii outside of 1 AU. Including dust evolution has a large affect on our planet populations, and many more super Earths orbiting between 0.1-1 AU are produced.

Additionally, efficient radial drift leads to an enhancement of solids at the ice line, and a large number of gas giants near 1 AU are formed as a consequence. We also find that the ratio of the number of super Earths to warm Jupiters produced depends sensitively on the initial disk size when dust evolution treatment is included. By comparing these two treatments of the dust, we are able to identify the degree to which radial drift needs to be slowed to better agree with the observed planet distribution.

92) Mass Loss from the Exoplanet WASP-12b Inferred from Spitzer Phase Curves

Taylor J. Bell
McGill University
Michael Zhang, Patricio E. Cubillos, Lisa Dang, Luca Fossati, Kamen O. Todorov, Nicolas B. Cowan, Drake Deming, Robert T. Zellem, Kevin B. Stevenson, Ian J. M. Crossfield, Ian Dobbs-Dixon, Jonathan J. Fortney, Heather A. Knutson, Michael R. Line

As an exoplanet orbits its star, we see variations in the light emitted by the planet which are normally interpreted as the planet's hot and cold hemispheres rotating in and out of view. However, observations of the ultra-hot, Jupiter-mass exoplanet WASP-12b show an anomaly; unlike every other planet observed to date, the infrared signal from WASP-12b shows two peaks in brightness per planetary orbit, rather than one. This effect is an order of magnitude stronger than what would be expected for tidal distortion. This and various other characteristics of the lightcurves suggest we are seeing light emitted from a dense stream of gas flowing directly from the planet to the star as the planet is slowly being consumed. Stranger still, this effect is seen only at 4.5 μm, while the planet appears normal at 3.6 μm. This strong wavelength dependence is indicative either of CO emission from the stripped gas at the longer wavelength or blackbody emission from cool, < 600 K stripped gas.

93) A study of the five planet system HIP41378 with K2, Spitzer, and TESS

David Berardo
Massachusetts Institute of Technology
Ian Crossfield, Michael Werner, Erik Petigura, Jessie Christiansen, David Ciardi, Courtney Dressing, Benjamin Fulton, Varoujan Gorjian, Thomas Greene, Kevin Hardegree-Ullman, Stephen Kane, John Livingston, Farisa Morales, Joshua Schlieder

HIP41378 is a bright (V = 8.9) star with five transiting planets that has been observed with K2 (Campaigns 5 & 18), Spitzer, and recently with TESS. Here we present the results of these observations, laying out what we have learned about the system so far as well as what remains to be learned. The original C5 observations showed two Neptune-sized multiply transiting planets (b and c) as well as three larger planets (Rp = 0.33RJ, 0.47RJ, 0.88RJ) which each transited once. During the C18 observations, two of the single transiting planets (d & f) were seen to transit again, placing tight constraints on their allowed periods.

This system is thus an excellent study of under-constrained exoplanet systems, which will be a common scenario with TESS due to its short observation length. We compute orbital solutions for the allowed periods of planets d and f, which we use to check for overlapping orbits, both between themselves but also with the inner planets, placing further constraints on the possible periods these planets may have. In addition to this, we also look at two Spitzer observations of the system, which caught a single transit of planets b and c each. Occurring approximately halfway between the two K2 observations, this additional data point indicates a strong TTV signal for planet c. We discuss the future efforts being made to characterize the system, which will allow us to precisely determine the periods of d and f, characterize the TTVs of planet c, recover the transits of planet e, and further enhance our view of this remarkable dynamical laboratory.

94) The transit of HD189733b in the eye of SPIRou. I- A search for atmospheric molecular signature

Anne Boucher
Université de Montréal
David Lafrenière, Antoine Darveau-Bernier, Stefan Pelletier, Romain Allart, Étienne Artigau, Neil Cook, Björn Benneke, Christophe Lovis, René Doyon

Where and how exoplanets are forming in the protoplanetary disk? Do they migrate or do they stay put? How is the atmosphere influenced by the radiation of the host star? What does influence chemical disequilibrium in the atmosphere? Being able to determining the abundances of the major chemical constituents, the dynamics, the temperature profile and other properties of exoplanet's atmosphere is crucial to answer all these questions and many more, and to better understand their formation and evolution processes as a whole. The primary goal of my project is to characterize in such manner the atmosphere of several exoplanets, going from hot Jupiters to warm Neptunes. This is achieved using the transit spectroscopy method and the high-resolution of the SPIRou instrument at CFHT. After briefly presenting the method and the main features of SPIRou, I will present preliminary results that we obtained thus far.

95) Ground-based transit spectroscopy of the TRAPPIST-1 system with a PCA approach

Jonathan Chan
Université de Montréal

The TRAPPIST-1 system presents an unprecedented opportunity to study the atmospheres of potentially habitable Earth-like planets; 7 planets orbit an ultra-cool M8V star, whose extremely small stellar radius results in large transit signatures normally only seen for hot Jupiters. We are able to probe the characteristics of the planets' atmosphere through transmission spectroscopy while the planet and its atmosphere transit in front of the host star. Here we present the results of 3 nights of transit observations from Palomar Observatory, making use of the WIRC-POL instrument and a newly developed, PCA-based, PSF modelling approach to photometric and spectroscopic extraction.

96) Universally hot nightside temperatures on short-period gas giants

Dylan Keating
McGill University
Nicolas B. Cowan, Lisa Dang

This poster will present results of a meta analysis of the full-orbit phase curves of twelve hot Jupiters, ranging from HD 189733b to the ultra-hot Jupiter WASP-33b. Using published phase curves at multiple wavelengths for each planet, we inferred the wavelength dependent day side and night side brightness temperatures, and used Gaussian process regression to estimate effective temperatures for the day and night sides of each planet. We found that even though dayside temperatures on these planets increase linearly with increasing amounts of stellar irradiation, their nightside effective temperatures are all clustered around 1100K, with a slight upward trend. Neither model we attempted to fit could explain the nightside trend— our favoured explanation is that these planets all have very similar cloud species on their nightsides, which condense slightly above ~1100K and radiate at similar temperatures to one another.

97) Transit Follow-up at the CFH Telescope in the Era of TESS : A Demonstration with TRAPPIST-1

François-René Lachapelle
U. Montréal
François-René Lachapelle, Lauren Weiss, Loïc Albert, David Lafrenière, Jonathan Gagné

TESS will study hundreds of thousands of selected bright stars in the search for transits. A long list of candidates will necessitate ground-based follow-up observations at higher signal-to-noise and spatial resolution compared to what TESS can achieve. The Canada-France-Hawaii Telescope offers the opportunity for such a detailed transit follow-up. Our paper will demonstrate the capabilities of MegaCam and WIRCam for precise transit light curve observations. We present a transit timing analysis demonstration based on 3 light curves that include transits of TRAPPIST-1 d and g. We achieved a photometric precision below 2 mmag with both instruments using a 10s exposure per 60s duty cycle with MecaCam and 5s exposure per 13s duty cycle with WIRCam. A MCMC analysis of the transit using the Batman Python package led to a timing precision of 63s on TRAPPIST-1 g with MegaCam and 16s with WIRCam.

98) An empirical transit spectrum of Earth

Evelyn Macdonald
McGill University
Evelyn Macdonald, Nicolas Cowan

The Atmospheric Chemistry Experiment's Fourier Transform Spectrometer on the SCISAT satellite has been measuring infrared transmission spectra of Earth during solar occultations since 2004. We use these data to build an infrared transit spectrum of Earth. Regions of low atmospheric opacity, known as windows, are of particular interest, as they permit observations of the planet's lower atmosphere. Even in the absence of clouds or refraction, imperfect transmittance leads to a minimum effective thickness of around 4 km in the 10–12 μm opacity window at a spectral resolution of R=10^3. Nonetheless, at R=10^5, the maximum transmittance at the surface is around 70%. In principle, one can probe the troposphere of an Earth-like planet via high-dispersion transit spectroscopy in the mid-infrared; in practice, aerosols and/or refraction likely make this impossible. We simulate the transit spectrum of an Earth-like planet in the TRAPPIST-1 system. We find that a long-term near-infrared campaign with JWST could readily detect CO2 and H2O, establishing the presence of an atmosphere. A mid-IR campaign or longer NIR campaign would be more challenging, but in principle could detect O3 and CH4.

99) Dragonfly's Eyes on Exoplanets

Christopher Mann
Université de Montréal

For my PhD project, I am using the Dragonfly optical telescope array to observe exoplanet transits. Dragonfly is an instrument developed by researchers at the University of Toronto and Yale University to study ultra-diffuse galactic structure. Due to high sensitivity requirements, their observations cannot be made in the presence of a near-full moon. As such, I am developing the interpersonal network and a software pipeline in order to use this telescope on bright nights for the study of exoplanet transits. Once the capabilities of the telescope are fully explored in the context of stellar lightcurves, we will employ it as a follow-up instrument for TESS candidate planets and other uncertain detections. Tightening the characterization of these transiting planets will help to provide high-quality targets for directed next generation observations like JWST. It may also prove extremely useful in other time-series variability studies yet to be proposed.

100) The Gemini Planet Imager Survey - mid campaign statistics

Christian Marois
NRC Herzberg
GPI Campaign team

The Gemini Planet Imager (GPI) is part of a first generation of facility-class extreme adaptive optics instruments that have been optimized to detect and characterize, in the near-infrared, young planets orbiting nearby stars, or exoplanets. After four years of science operation at Gemini South, and many discoveries, the instrument campaign team has now completed the statistical analysis of the first half of a large 600 stars campaign. I will present our team findings for the underlying distributions of substellar companions with respect to their mass, semi-major axis, and host star mass. With the campaign mostly completed, the GPI team is now looking toward the future of the instrument, in deploying key upgrades to enable new exciting science capabilities.

101) Characterizing Hot Jupiter Atmospheres Through High Resolution Eclipse Spectroscopy

Melissa Marquette
McGill University
Nick Cowan

By combining analysis conducted using simplified toy models, full blown GCMs, and ultimately real data, we aim to explore the limits of what atmospheric conditions are detectable in the spectra of hot Jupiters. Given that multiple molecular species, including H2O and CO (Brogi et al. 2013), have already been robustly detected using high resolution spectroscopy (Birkby 2018), we seek to push these detections further by using high resolution spectra taken during secondary eclipses to infer how these spectral lines may have been altered by the conditions under which they were produced (e.g. their shape, depth) and use that to inform us about atmospheric characteristics. To do this, we combine simplified toy models that demonstrate the scale of the effects of atmospheric conditions on spectral lines with full blown GCMs capable of creating a more realistically complex portrait of what these effects might look like in the resulting spectra we observe. This will inform our target selection and observational strategy to conduct future observations using the SPIRou spectopolarimeter on the Canada-France-Hawaii telescope, as well as our ultimate handling of the data to enable us to extract as much information as possible.

102) Water Cycling and Atmospheric Loss on Terrestrial Exoplanets

Keavin Moore
McGill University
Nicolas Cowan

M-dwarfs are the most common stars in the Galaxy, and are host to many rocky planets. The volatile budget of a terrestrial planet importantly determines the amount of water in various reservoirs, from the surface oceans to the large volume sequestered in the mantle. This water is constantly cycled between these reservoirs, through regassing from the surface, and degassing from the mantle. Water may also be lost from the surface through the atmosphere due to the large flux of XUV radiation during the early evolution of the host M-dwarf. I aim to create a coupled model of water cycling and atmospheric loss on terrestrial planets orbiting M-dwarfs to determine the planetary water distribution, including surface water content, throughout the planet's lifetime.

103) Warm Litte Ponds on the Late-Accreting Earth: The Fates of Nucleobases Delivered by Meteorites and Interplanetary Dust Particles

Ben K.D. Pearce
McMaster University
Ben K. D. Pearce, Ralph E. Pudritz, Dmitry A. Semenov, Thomas K. Henning

Warm little ponds (WLPs) are commonly considered as sites for the emergence of life on Earth because their wet-dry cycles promote the linking of long chains of building blocks known as nucleotides into the first genetic polymers: ribonucleic acid (RNA) (Pearce et al., 2017).

Nucleotides are characterized by their nucleobases: adenine, guanine, uracil, and cytosine. Potential sources of nucleobases to these environments are delivery by meteorites and interplanetary dust particles (IDPs), or lightning and photochemical reactions in the early atmosphere (Chyba & Sagan, 1992; Pearce et al., 2017, 2019).

During the Hadean eon, the rate of meteoritic bombardment was ~1 to 1000x10^12 kg/y (Chyba, 1990), which is approximately 8 to 11 orders of magnitude greater than today (Bland et al., 1996). At this time, interplanetary dust particles were floating down to the surface at a rate of ~6x10^8 kg/y (Chyba & Sagan, 1992). Guanine, adenine, and uracil are found in meteorites with abundances of 0.25 to 515 parts per billion (ppb) (Pearce & Pudritz, 2015)

I will describe our theoretical model for the fates of nucleobases delivered to WLPs on the early Earth. Before they can be made into polymers by wet-dry cycles, they suffer various loss and destruction mechanisms including hydrolysis, photodissociation, and seepage.

Using data from the lunar cratering record, we also separately calculate the number of carbon-rich meteorite depositions in WLPs that formed on the rising continental crust from 4.5–3.7 Bya.

Nucleobases delivered by meteorites maintain ppb–ppm-level concentrations in WLPs for up to a few years, allowing suffient time for reaction and polymerization. Nucleobases delivered by IDPs, on the other hand, remain negligible within ponds. UV light rapidly destroys nucleobases, however <1 mm of sediment can completely shield nucleobases against photodestruction (Carrier et al., 2017).

We conclude that RNA polymerization (and possibly life) could have occurred 4.2 Bya, well before the Late Heavy Bombardment.Warm little ponds (WLPs) are commonly considered as sites for the emergence of life on Earth because their wet-dry cycles promote the linking of long chains of building blocks known as nucleotides into the first genetic polymers: ribonucleic acid (RNA) (Pearce et al., 2017).

104) Probing the Formation of Giant Planets with SPIRou

Stefan Pelletier
Université de Montréal
Björn Benneke

Observations of Hot Jupiters offer an unprecedented opportunity to probe planet formation by measuring the carbon to oxygen (C/O) ratios in the atmospheres of giant planets. To this day however, a convincing C/O measurement has yet to be obtained, even for the gas giants in our Solar System. The reason for this is simple: instruments aboard space-based observatories are relatively small and thus have intrinsically low spectral resolutions (R<100 for HST and Spitzer). This makes obtaining a robust C/O measurement by unambiguously detecting both carbon- and oxygen-bearing molecules something currently only possible from the ground using much higher resolution infrared spectrographs.

Perfect for this task is the brand new, extremely high (R~70000) resolution and very wide (0.98-2.45µm) wavelength coverage SPIRou instrument recently installed at the Canada-France-Hawaii Telescope. In this talk I will present the results of some of the very first SPIRou Hot Jupiter observations and show how we can combine these with state-of-the-art modelling frameworks to not only detect, but constrain the abundances of molecules in exoplanet atmospheres. This has the potential to provide the community with the first robust measurement of a carbon to oxygen ratio of any gas giant planet which would shed light onto long-withstanding questions about planetary formation.

105) Wolf 503 b and the Exoplanet Radius Gap

Merrin Peterson
Université de Montréal
Björn Benneke, Trevor J. David, Courtney D. Dressing, David Ciardi, Ian J. M. Crossfield, Joshua E. Schlieder, Erik A. Petigura, Eric E. Mamajek, Jessie L. Christiansen, Sam N. Quinn, Benjamin J. Fulton, Andrew W. Howard, Evan Sinukoff, Charles Beichman, David W. Latham, Liang Yu, Nicole Arango, Avi Shporer, Thomas Henning, Chelsea X. Huang, Molly R. Kosiarek, Jason Dittmann, and Howard Isaacson

Recent studies of the radius distribution of small exoplanets have revealed a gap in the population near 1.5-2.0 Earth radii, informally dividing these planets into “super-Earths” and “sub-Neptunes”. This division may be caused by photoevaporation, which could be investigated directly using measurements of the bulk density and atmospheric mass fraction of these planets. However, these properties are very poorly constrained for most planets near the radius gap as the majority of these planets orbit distant, dim stars and are not amenable to radial velocity follow-up or transit spectroscopy. Here we present the discovery and validation of a 2 Earth radius planet in direct proximity to the radius gap, orbiting the bright (J=8.32), nearby (D=44.5 pc) high proper motion K3.5V star Wolf 503 (EPIC 212779563) from K2 campaign 17. The magnitude of its host star makes Wolf 503 b an ideal candidate for future transit spectroscopy with the James Webb Space Telescope. A radial velocity campaign on the HARPS spectrograph is ongoing to determine its mass and bulk density. Wolf 503 b and 55 Cnc e are currently the most favorable planets for follow-up observations at this critical radius, and are now being joined by new, nearby candidate planets from TESS. As part of this growing sample of small characterizable planets, Wolf 503 b offers a key opportunity to better understand the origin of the radius gap as well as the nature of the intriguing populations of “super-Earths” and “sub-Neptunes” as a whole.

106) A Canadian Micro-satellite Dedicated to Photometric Observations of Exoplanets

Jason Rowe
Bishop's University
K. Hoffman, P. Miles-Paez, S. Metchev, L. Nelson, J-C. Leclerc, N. Gollu, F. Pelletier, C. Goldblatt, JJ. Kavalaars

An ultra-violet and infrared imaging space telescope on-board a small-sat platform has the ability to characterize the atmospheres of known transiting extrasolar planets, and to detect new, potentially habitable, rocky planets around low-mass stars and brown dwarfs. We are studying the scientific return a 15-cm imaging space telescope can provide to survey a sample brown dwarfs and bright exoplanet hosting stars. An IR photometric survey of brown dwarfs will search for transiting Earth-sized in the habitable zone. A UV transit survey of exoplanets transiting bright stars will enable a systematic study of atmospheric scattering and evaporation. We present our mission concept and mission goals which are funded as part of a CSA science maturation study.

10) Overcoming planet formation barriers via the streaming instability

Josef J. Rucska
McMaster University
James Wadsley

Dust grains are a crucial component of disks around young stellar systems where current observations and theory show that planets form. Dust grains must grow 10 orders of magnitude in size to become planets. However, one of the early steps in this growth phase faces stringent theoretical constraints. The metre barrier relates to two well-studied physical mechanisms which inhibit grain growth beyond centimetre sizes. We report on numerical studies of the streaming instability (SI), a proposed mechanism for promoting dust concentration and overcoming the dust growth metre barrier. We employ the Athena astrophysics code to study the SI in the linear phase and the non-linear or saturated phase, and follow the development of the instability to the gravitationally unstable regime where planetesimals — the building blocks of planets — can form. We present work targeted at creating a broader understanding of the underlying mechanisms of the SI, which will detail the ability of the instability to concentrate dust and create planetesimals in protoplanetary disks, and ultimately kick start the planet formation process.

108) Don't Blink: detecting transiting exoplanets with MASCARA

Geert Jan Talens
Université de Montréal
P. Dorval, I. Snellen, R.Stuik., G.Otten, J. Spronck, A.-L. Lesage

Exoplanets transiting bright stars make ideal candidates for atmospheric characterization studies using ground- and space-based telescopes. Nevertheless, the brightest stars had until recently not been targeted by transit surveys as they quickly saturate detectors and are sparsely distributed across the sky, requiring short exposure times and a large Field-of-View. The Multi-site All-Sky CAmeRA (MASCARA) is a transit survey aimed at finding planets around these bright stars at $4 < V < 8$. MASCARA consists of two stations, located in the northern hemisphere at the Observatorio del Roque de los Muchachos and in the southern hemisphere at La Silla observatory, respectively. Each station observes the entire local sky down to airmass 3, obtaining photometry of over 70,000 bright stars. A sister survey, bRing, allows for continuous coverage for dec<-40 degrees. In this talk I will give an overview of the MASCARA project and present confirmed planets and planet candidates.

109) A Spitzer search for transiting exoplanets around ultra-cool dwarfs viewed equator-on

Megan Tannock
University of Western Ontario
Paulo A. Miles-Páez, Stanimir A. Metchev, Enric Palle, María Rosa Zapatero Osorio, Megan E. Tannock, Dániel Apai, Étienne Artigau, Adam J. Burgasser, Gregory N. Mace, Amaury H.M.J. Triaud

While exoplanet population studies predict that small rocky planets should be common around very low-mass stars and brown dwarfs (ultra-cool dwarfs), the planetary system around the M8 star TRAPPIST-1 remains as the only one known to date. We are conducting a Spitzer Cycle 14 survey to search for transiting exoplanets around 15 ultra-cool dwarfs viewed equator-on. Spin-orbit alignment expectations dictate that the planetary systems around these ultra-cool dwarfs should also be oriented nearly edge-on. In this work we will describe our survey and will present preliminary results.

110) Non-Detection of Additional Planets in Larger Orbits Around HR 8799

William Thompson
University of Victoria
Christian Marois, Quinn Konopacky

Of all the planetary systems that have been directly imaged, HR 8799 is the best studied. Though four gas giants have been discovered out to a radius of 68 AU, the system is known to host a large debris disk including a planetesimal belt extending between 100 and 310 AU. It is therefore worth searching for additional companions beyond the orbit of the furthest known planet, but none have so far been detected. In this work, we reduce the deepest integration yet of the system at L′ and large radii using a new optimized LOCI pipeline implemented in Julia and set strong upper limits on the existence of large planets out to a radius of 175 AU. This non-detection has implications for the study of debris disks and planet formation.

Education & Public Outreach

111) Public Outreach with AstroMcGill

Taylor J. Bell
McGill University
AstroMcGill Team

AstroMcGill serves as the education and public outreach branch of the McGill Space Institute. Our activities range from monthly public lectures and Astronomy on Tap events attended by hundreds of people, to solar eclipse viewing parties drawing ~8000 people to safely view the eclipse from the McGill campus. We will summarize our numerous outreach activities and our future plans.

112) A Data-Driven Approach to Assessing and Increasing Diversity and Inclusivity in Canadian Astrophysics: A First Step and a Call For Partners

Carolina Cruz-Vinaccia
McGill University
Taylor J. Bell, Hope Boyce, Lisa Dang, Jordan Mirocha, Dave Purnell, Dallas Wulf

In anticipation of the Canadian Long Range Plan 2020 (LRP2020) call for white papers on issues relating to equity, diversity, and inclusion in the field of astronomy, we have begun the process of collecting demographic information for the undergraduate, graduate, and faculty population of the Physics Department at McGill University (where the Astrophysics program is housed).

We will present our current dataset, which includes self-identified, binary gender information for both applicants and registered students between the years of 2002 and 2018 (N>5000). This dataset provides a powerful tool for quantitatively assessing the status of women in the department over time, and for guiding internal department initiatives to foster greater inclusivity and diversity. Standardizing metrics and coordinating methods for collecting data about diversity will allow for measurement of progress over time within departments, as well as comparisons across departments to better assess the state of the field. For LRP2020, we hope to expand this work to include institutions across Canada, with the ultimate goal of improving the climate for women and underrepresented minorities in astronomy at the national level.

113) Physic Matters - McGill Physics Outreach Group

Lisa Dang
McGill University
Lisa Dang, Auriane Canesse, Nikolas Provatas

The outreach group in the Department of Physics at McGill University aims to communicate the excitement and fascination of physics to the public, students, and other interested groups in our community. The McGill Physics Outreach team is comprised of a group of dedicated volunteers that strive to promote physics education and cultivate a passion for science in the community.

Through public lectures, as well as our educational outreach, namely the McGill Physics Hackathon, the Space Explorers program and Inquiry institute, we hope to make physics accessible and enjoyable to the public. Here we present our curent outreach initiatives.The outreach group in the Department of Physics at McGill University aims to communicate the excitement and fascination of physics to the public, students, and other interested groups in our community. The McGill Physics Outreach team is comprised of a group of dedicated volunteers that strive to promote physics education and cultivate a passion for science in the community.

114) Women in Physics Committee at McGill University

Daryl Haggard
McGill University/McGill Space Institute
Tami Pereg-Barnea, Cynthia Chiang, Sarah Harrison, Lilian Childress, Carolina Cruz-Vinaccia, Melissa Medina, Lena Engström, Talia Martz-Oberlander, Hope Boyce, Maddy Anthonisen, Auriane Cannesse, Hannah Wakeling, Eloise Chakour

The Women in Physics Committee at McGill University pursues a range of inreach and outreach activities to support equity and inclusion in STEM. This poster will outline our efforts to offer equity resources and education for our faculty, staff, and students, as well as outreach workshops/panels in our local Cégep communities.

115) The landscape of Canadian astronomical research – capacity and engagement

Denis Laurin
Canadian Space Agency
Damian Kruschat (Waterloo), Sabrina D'Amour (Bishop's)

A database demonstrating a broad spectrum of Canadians working in astronomy and astrophysics has been assembled over the last two years. The purpose of the database is to illustrate the current landscape and organizational structure in this area of advanced research, with emphasis in space astronomy. The database includes stakeholders and HQP (highly qualified personnel) in astronomy and related technologies at all levels at universities, government and industry. With over a thousand individuals identified, various statistics are generated to gauge the capacity in different research areas, identify strengths and weaknesses, through associations, specialized institutes, space mission participation and accomplishments. Overall the results attest to a strong and well structured community that has resulted and is ready to continue to demonstrate capacity to deliver world-class science.

116) Past and current Canadian Space Agency contributions to space astronomy

Denis Laurin
Canadian Space Agency
Sarah C. Gallagher

The Canadian astrophysics community long range planning exercise for the 2020s will decide and articulate Canadian priorities in a consultative, community process much like the US Decadal Survey. Over the past decades, Canada has contributed to space astronomy missions flown by several partner space agencies, most significantly with two instruments for JWST (NRISS and FGS). Looking ahead, the Canadian Space Agency is currently supporting science and technology development for several new space astrophysics missions with sensitivity from the microwave to X-rays. The focus has been on contributions that exploit the intersection of Canadian industrial expertise and scientific initiative. Though international contributions have historically focused on instrument hardware that earned seats at the science team table, the CSA has recently expanded the scope of mission contributions to include calibration, ancillary data sets, and science-only support. With a strong and well organized astronomy research community, making very efficient use of available government resources, Canadian astronomers aim to strategically focus efforts to maximize the science impact.

117) Designing the Maunakea Spectroscopic Explorer Education and Public Outreach Programme

Kelly Lepo
McGill University
Mary Beth Laychak, Jesse Rogerson

The Maunakea Spectroscopic Explorer (MSE) is a plan to reimagine the iconic 3.6-m Canada-France-Hawaii Telescope (CFHT), taking the observatory from a 3.6 m telescope to a dedicated facility for highly multiplexed, large aperture, optical and near-infrared spectroscopy, with a 11.25 m telescope and a 4000 fiber multi-object spectrograph. The facility is currently in its preliminary design phase and will begin science operations in late 2029.

The design process of the MSE includes the design of its Education and Public Outreach (EPO) programme. MSE EPO Working Group is currently analyzing the needs and expectations of each partner (including Canada) and performing a survey of EPO activities at other comparable astronomical observatories. The working group will recommend a broad MSE outreach strategy - including preliminary budget estimates - to the MSE Management Group.

In this interactive poster, we hope to get feedback from you, the Canadian astronomical community, about what the MSE EPO program should look like. What types of programs and resources would be useful? How can the public interact with MSE data products? How do we get the Canadian public excited about the MSE when we won't have any beautiful astronomical images to share? How can MSE EPO work with other Canadian/International observatories and institutions to amplify each other's EPO efforts?

118) ASTRO 101: Black Holes

Sharon Morsink
University of Alberta
Sharon Morsink, Stephen Lane

Astro 101: Black Holes is a new introductory-level astronomy course offered at the University of Alberta for the first time in the 2018/19 academic year. The course is offered as a free on-line, non-credit course on Coursera, as well as an academic, for-credit on-line course for University of Alberta students. The goal of the course is to use the appeal of black holes as a means to teach concepts from introductory physics and astronomy to an audience of non-science majors. In this poster we will provide an overview of the course along with some samples of the students' Creative Work assignments.

119) Astronomy for Canadians Indigenous People (ACIP)

Ismael Moumen
Université Laval/CFHT

It's been more than 150 years and until today, Indigenous people in Canada continue to endure hard conditions (higher rates of unemployment, poor education, bad housing and poor job prospects) despite government efforts to improve this situation. One of these key issues is the lower levels of education and the higher level of dropout. Several government efforts have tried to solve this problem but the political approach does not seem to be sufficient and all suggested programs had limited success rates.

In ACIP project, we propose to follow a society-society approach to improve the situation of Indigenous people in Canada by using Astronomy as a tool for development of young Canadian Indigenous People. This non-governmental new approach will have an important impact in reducing inequality in the Canadian society. Canada has numerous Indian reserves for its Indigenous (First Nations) people. For this Pilot Project, we will target one of the Indian reserves in the Province of Quebec (Canada) to benefit from its proximity to the Mont-Mégantic Observatory that will be used in this project. Our target will be young students (8 to 14 years old). Our project has two components: (i) Visiting schools in the Indian reserve(s) to reach young Indigenous students and (ii) Bring a group of students to visit the Observatory of Mont-Mégantic during the Popular Astronomy Festival of Mont-Mégantic. Society using Astronomy as a tool of social development can help in improving the situation of Indigenous people in the Indian reserves.

120) Experiential Learning in Astronomy

Jesse Rogerson
Canada Aviation and Space Museum

Experiential learning, that act of learning through meaningful hands-on experience, experimentation, and reflection, can help bridge the gap between learning astronomical theory in the classroom and how the science of astronomy is conducted. Without understanding of how astrophysics is done, with what tools, and by whom, students may have trouble understanding the topics, and also may not see themselves in this career.

The Las Cumbres Observatory (LCO) provides observing time to educational institutions through its Global Sky Partners initiative. In this talk, I will demonstrate how I utilised the LCO observing time in a Ottawa high school science class to both teach the principles of observational astronomy and the science of exoplanets and variable stars. Students participated in an inquiry-based and hands-on driven exercise to observe a cepheid variable star and a exoplanet host star, and then attempted to analyse the resulting data.

In a classroom setting, experiential learning can be well structured, but on the floor of a museum, such as the Canada Aviation and Space Museum, it can be much more difficult. I will demonstrate a simple Citizen Science experiment using the LCO network that can be deployed digitally to include a much wider audience.

This talk will also discuss the broader impact of Citizen Science, museums and science centres, and how education and public outreach can evolve in the coming decade.Experiential learning, that act of learning through meaningful hands-on experience, experimentation, and reflection, can help bridge the gap between learning astronomical theory in the classroom and how the science of astronomy is conducted. Without understanding of how astrophysics is done, with what tools, and by whom, students may have trouble understanding the topics, and also may not see themselves in this career.

Facilities, Instruments & Methods

121) JWST - Are you Ready for Launch?

Loïc Albert
Université de Montréal

Canada participates to the James Webb Space Telescope (JWST) by providing an instrument, FGS/NIRISS. With launch firmly scheduled in March 2021, are we ready, as a community, to answer the call for time proposals for cycle 1? Any of the four JWST instruments can be requested. The deadline is May 2020. We, the instrument team, can help you master the exposure time calculator and time proposal tools if you have a project idea. Let's talk.

122) The Final Design of NFIRAOS for TMT

David Andersen
NRC HAA
Glen Herriot, Jenny Atwood, Peter Byrnes, Jeff Crane, Adam Densmore, Joeleff Fitzsimmons, Tim Hardy, Kate Jackson, Dan Kerley, Olivier Lardiere, Jean-Pierre Veran

The Narrow Field Infrared Adaptive Optics System (NFIRAOS) is the first-light facility Multi-Conjugate Adaptive Optics (MCAO) system for the Thirty Meter Telescope (TMT). NRC HAA and our industrial subcontractors are developing NFIRAOS and its real-time controller. NRC HAA successfully presented the design of NFIRAOS at a final design review in June 2018. In this poster, we will present the final design of NFIRAOS and its subsystems and highlight some of the important performance budgets and design solutions made along the way.

123) Creation and support of the OMM archive at CADC

Sylvie F. Beaulieu
Observatoire du Mont-Mégantic
Daniel Durand, Sharon Goliath, Étienne Artigau

We are presenting a very new way of implementing and populating an astronomical archive using only CADC software running under a Docker environment. The system, developed for the CPAPIR instrument of the OMM allows the execution on the client machine at UdM, where CPAPIR FITS files are being transferred from the OMM observatory, and then processed one night at a time. The operator can simply execute a Docker container composed of all the necessary software on the night containing all the FITS file to 1) transfer the FITS files into the CADC, 2) produce the extra files like the previews and footprint computation, and 3) extract, verify and populate observation catalogue with the proper metadata for the CADC archive.

124) Impact of telluric line absorption on near infrared precision radial velocimetry

Simon-Gabriel Beauvais
Université de Montréal
Étienne Artigau, René Doyon

Radial velocimetry is a well established method used to determine exoplanets mass and period, among other things. The method generally uses cross-correlation as its basis to determine the Doppler shift of an object throughout several observations. With the advent of high-resolution spectroscopy in the near infrared, new techniques are required to take full advantage of the increased precision of the instruments. These techniques must also demonstrate strong resilience in the face of tellurics, as they are problematically omnipresent at those wavelengths. We propose a new algorithm that manages to reach a precision well below the cm/s RMSE on simulated observations in the near infrared. We then use this algorithm to make predictions relating to the impact of tellurics and their removal on radial velocity measurements and compare the results with available data.

125) The voyages of StarNet - its continuing mission: deep learning of stellar spectra in all wavelength regimes

Spencer Bialek
University of Victoria
Spencer Bialek, Sebastien Fabbro, Kim Venn

Due to the successful application of our deep learning framework, StarNet, in the prediction of stellar properties of infrared spectra from the APOGEE survey, we present an analysis of FLAMES-UVES optical spectra from the Gaia-ESO survey. We demonstrate that StarNet can be used in any spectroscopic survey (as long as an appropriate synthetic spectra dataset is available) to provide accurate and efficient predictions for any number of spectra. We also provide recommendations for how StarNet can best be used as the primary data processing pipeline for upcoming spectroscopic surveys.

126) Beginning a Second Century of Astronomical Observations at the Dominion Astrophysical Observatory

David Bohlender
NRC Herzberg
Dmitry Monin

Just before 10PM PDT on the evening of 6 May 2018 we commemorated the beginning of the second century of astronomical research on the venerable 1.8-m Plaskett Telescope at the DAO by obtaining a high S/N spectrum of beta CVn in 30 seconds with the telescope's Cassegrain spectrograph, almost precisely 100 years after the first-light 30-minute observation of the same star. Today the DAO 1.8-m and 1.2-m telescopes continue to carry out imaging, spectroscopic, and spectropolarimetric research programs on every clear night. In this poster we remind CASCA 2019 attendees of the capabilities of the DAO telescopes and their instruments. We will also review progress in our efforts to automate the operation of the Plaskett telescope using lessons learned from robotic operation of the 1.2-m telescope and McKellar spectrograph as well as innovative use of new hardware and software systems to protect the 1.8-m telescope and dome during such operation.

127) CASTOR: A Flagship Canadian Space Telescope

Patrick Côté
NRC Herzberg Astronomy & Astrophysics Research Centre
CASTOR Team

The Cosmological Advanced Survey Telescope for Optical and uv Research (CASTOR) recently completed a 15-month CSA Science Maturation Study that updated both the mission design and science case, explored international partnership opportunities, and produced new estimates for mission cost and schedule. In this talk, I will summarize results from this study and update the community on the status of this proposed Canadian flagship mission, which was identified as a top priority in Canadian space astronomy in LRP2010.

128) Canadian Gemini News

Stephanie Côté
NRC Herzberg Astronomy & Astrophysics
Canadian Gemini Office

We will provide updates on Gemini operations over the last year,and show some statistics on Canadian use of Gemini for semesters 2019A and 2019B.The status of Gemini upcoming instruments and upgrades will be reviewed. Please stop by the poster to meet the Canadian Gemini Office staff who will be available to answer your questions about Phase I, Phase II, data reductions, etc.

129) The Extrasolar Planet Polarimetry Explorer (ÉPPÉ): an All-Canadian Space Mission for Exoplanet Characterization

Nicolas Cowan
McGill University
Taylor Bell, Stan Metchev, Paolo Miles-Páez

ÉPPÉ is a concept study for a micro-satellite to study extrasolar planets with differential polarimetry. High-precision optical and near-infrared polarimetry, with possible ultraviolet extension, will be used to explore the molecular and aerosol content of exoplanetary atmospheres. In addition to transiting planets, ÉPPÉ will also be sensitive to non-transiting exoplanets that dominate the population. A space-based mission designed with polarimetry in mind has never been built. Yet the technique offers unique sensitivity and diagnostic power to characterize exoplanet-scattered light. The all-Canadian ÉPPÉ collaboration builds on Canadian legacy in Space Astronomy, and will establish space-based precision polarimetry as Canada's trademark in exoplanetary astrophysics and astrobiology.

130) A Bibliometric Analysis of Canadian Astronomy Faculty

Dennis Crabtree
NRC Herzberg

I have created a database of Canadian astronomy faculty and have retrieved publication and bibliometric data from NASA ADS for each individual. In addition, I have retrieved Altmetric information (media and social media mentions) for each paper. I analyze this dataset and provided insights into the growth and evolution of our community.

131) A Guest Observer Program for the Near Earth Object Surveillance Satellite (NEOSSat)

Jean Dupuis
Canadian Space Agency
Denis Laurin, Viqar Abbasi, Stefan Thorsteinson, Jason Rowe and David D. Balam

We present a plan for a Guest Observer (GO) program for Canadian astronomers with the Near Earth Object Surveillance Satellite (NEOSSat). NEOSSat is a dual purpose satellite developed and operated collaboratively by CSA and DRDC and for which the primary objectives were to perform the HEOSS (High Earth Orbit Space Surveillance) Space Situational Awareness (SSA) mission and the NESS (Near Earth Space Surveillance) asteroid astronomy mission. Innovative observations of near-Earth asteroids and comets are enabled by NEOSSat's ability to accurately track, precisely stabilize, and image at low solar elongations from any point over its sun-synchronous polar orbit. Furthermore, we demonstrate that NEOSSat is capable of conducting photometric studies at a level of precision sufficient to enable asteroseismology studies and other variability analyses of stars and exoplanet systems.

It is CSA's intention to offer observation time on NEOSSat for astronomical observations through an open call for proposals starting later this year to the Canadian astronomical community. It is anticipated that up to half of the time would be made available for astronomical imaging. There will be no proprietary data period, and the data will be distributed through an open data portal.

132) A Modern Correlator for DRAO's Synthesis Telescope

Pamela Freeman
University of Calgary
Jo-Anne Brown, Tom Landecker, Keith Vanderlinde

The Synthesis Telescope (ST) at the Dominion Radio Astrophysical Observatory in Penticton, British Columbia continues to produce high quality images with decades-old technology. However, we can increase the capability and longevity of the ST by utilizing modern digital technology and signal processing techniques. As part of a larger upgrade to the ST, we are developing a new correlator based on the hybrid FPGA/GPU design recently employed on the Canadian Hydrogen Intensity Mapping Experiment. Since limiting radio frequency interference is important at DRAO's RF quiet site, we have characterized the instrument in radio frequencies, both with an air-cooled and a liquid-cooled design. We present our proof of concept correlator design, and discuss the effects of liquid cooling on RFI production.

133) Quantum Yield Measurement of UV-sensitive Electron Multiplying CCD from Photon Counting Test Data

Robert Gleisinger
University of Victoria
Neil Rowlands, Alan Scott, Olivier Daigle

Electron multiplying charge coupled devices (EMCCDs) allow for sub-electron effective read noise, and thus for imaging at extremely low flux levels, by incorporating an electron multiplication register into the standard CCD architecture between the readout register and the readout electronics. In the ultraviolet, quantum yield creates an additional source of stochastic gain which can be difficult to quantify using existing techniques. We demonstrate a new method for measuring the quantum yield gain of these devices using images which are part of the existing test regimen for new EMCCDs. With this method, we were able to recover the quantum yield used to create simulated images within an accuracy of ~5% but results in significantly higher quantum yield estimates than existing methods on real test data from "astro-no-coat" e2v EMCCDs. Results from our method are more in line with predictions based on the reflectance of uncoated silicon than previous estimates.

134) Colibrì: Taking the Pulse of Black Holes and Neutron Stars

Jeremy Heyl
UBC
Ilaria Caiazzo, Kelsey Hoffman, Sarah Gallagher, Samar Safi-Harb, Daryl Haggard and the Colibrì Collaboration

We are developing a concept for a new Canadian-led X-ray observatory — Colibrì. The main objective of the Colibrì mission is to study the structure of accretion flows in the near vicinity of black holes and neutron stars and the study of emission from the surfaces of neutron stars. The Colibrì mission will look for answers to the questions: How do accretion disks transport material? How are relativistic jets launched? What is the structure of the spacetime surrounding black holes? What are the masses and radii of neutron stars? With high spectral and time resolution, and high throughput, Colibrì will allow the study of accretion disks and coronae, including reflection and re-emission of radiation by the disk, and observations of isolated and accreting neutron stars. The Colibrì concept concept is based on multiple aperture non-imaging X-ray collectors similar to NICER but with cryogenically cooled transition edge detectors for high energy resolution and sensitivity. Colibrì aims to achieve an energy resolution finer than 1eV at 2keV, and count rates up to 10kHz, in an energy range of 0.5-10 keV. The timing of Colibrì aims to be better than 1 micro-sec, matching the innermost orbit period for a 10 solar-mass black hole. The total effective area of Colibrì is to be at least 2000 cm2 at 6.4 keV. This concept study is being funded by the Canadian Space Agency.

135) Astrosat - status and results after 3 years in operation

John Hutchings
DAO

Launched in September 2015, the Astrosat orbiting observatory is operating well, observing from hard X-ray to UV-blue wavelengths. I will present the spacecraft status, some recent science programs and results, and look ahead to the next steps in collaboration between Canada and India.

136) Separation of spectral absorption lines by source using Bayesian analysis.

Klay Kulik
University of Western Ontario
Jan Cami

Astronomical spectra contain absorption lines from three separate sources: the stellar atmosphere, the interstellar medium, and the Earth's atmosphere. To perform sensitive surveys of interstellar lines, one would ideally divide out the stellar and telluric lines to remove spectral line contamination and confusion. However, even the best stellar and telluric models cannot reproduce many of the subtle details in the high-quality astronomical observations we currently have access to, and hence this is not possible. Here, we present a novel approach where we use Bayesian analysis to separate an observed astronomical spectrum into three separate source components. Reliably separating these three components will greatly increase the sensitivity of interstellar surveys, and also be of interest for researchers studying stellar spectra or the Earth's atmosphere.

137) SPICA: the next observatory class infrared space astronomy mission

David Naylor
University of Lethbridge
Doug Johnstone, NRC-Herzberg

On 7 May 2018 ESA selected SPICA: the SPace Infrared telescope for Cosmology and Astrophysics, an ESA/JAXA observatory class infrared mission, as one of the three finalists under the M5 Cosmic Vision call. SPICA will provide imaging, spectroscopic and polarimetric capabilities in the 5 to 350 μm range. SPICA features a ~2.5 m class telescope cooled to <8 K. The combination of a new generation of sensitive detectors and effectively zero emission from the telescope, will allow astronomers to achieve sky-limited sensitivity over this wavelength range. SPICA will be over two orders of magnitude more sensitive than Herschel cover the full wavelength range between 5 and 350 μm, including the missing octave between 28 - 55 μm, which lies outside of both the Herschel and JWST domains. SPICA will be the only observatory of its era to bridge the wavelength gap between JWST and ALMA, providing a unique window into fields ranging from galaxy formation and evolution to star-formation and protoplanetary disks. The current status of the project and Canada's potential role will be reviewed.

138) LiteBIRD's Projected Constraints of Inflationary Models

Simran Nerval
University of Toronto
Renee Hlozek

The Light satellite for the studies of B-mode polarization and Inflation from cosmic background Radiation Detection (LiteBIRD) is a proposed cosmic microwave background (CMB) polarization satellite. It will measure the B-mode polarization of the CMB and will be able to probe the strong B-mode signal that is predicted by inflation to be at low multipoles (large-scales). I have created a noise model for LiteBIRD that accounts for the 1/f noise from the scanning velocity and propagated the errors on the measurements to the constraints on cosmological parameters. The main parameter of interest is the tensor-to-scalar ratio (r) which is a measure of the changes in spacetime compared to the density of matter during inflation, or observationally the amplitude of the B-mode signal at low multipoles. I will discuss the LiteBIRD forecasts on some select models of inflation.

139) On-sky calibration of millimetre polarimeters with the cosmic microwave background

Gavin Noble
McGill University
Matt Dobbs

In the past few decades, cosmic microwave background (CMB) anisotropy surveys have transitioned from moderate-scale experiments to large international collaborative efforts. The number of independent detecting elements in these experiments has grown exponentially, with this trend expected to continue in the near-future. This is a major challenge for instrument calibration, where traditional approaches do not scale well with rapidly-increasing detector-numbers. We present an alternative method, using the CMB as a calibration source for individual detectors. We demonstrate this approach with the South Pole Telescope polarimeter (SPTpol) receiver — measuring per-detector angles with degree-scale precision — and conclude that this is a viable method for characterizing current and next-generation CMB instruments.

140) Pre-Cursor Astronomy Technology Research and Development Activities NRC/HAA

Scott Roberts
NRC/HAA
Dean Chalmers

We provide an overview of the pre-cursor research and development activities that are on-going in the Astronomy Technology Directorate at NRC/Herzberg Astronomy and Astrophysics. Pre-cursors are R&D projects supported by the ATD solely, or in collaboration with universities and industry, that develop astronomical telescope and instrumentation technology to a readiness level that can be applied to Canadian Astronomical Facilities through formal funded projects. These include R&D activities related to adaptive optics including test benches, detectors, MEMS, millimetre wavelength low noise amplifiers and receivers, radio composite dishes and correlators.

141) CHORD - the proposed next-generation Canadian Hydrogen Observatory and Radio-transient Detector

Jon Sievers
McGill University
for the CHORD Collaboration

The Canadian Hydrogen Observatory and Radio-transient Detector (CHORD) is a proposed facility that will consist of (1) a series of "outrigger" stations located across the continent that provide VLBI localization capability for transient events; and (2) a large, close-packed "core" array of ultra-wideband precision dishes located at DRAO that provides the sensitivity critical for cosmic mapping and unprecedented event rates for the transient survey.

This instrument will allow Canadian astronomers to address three exciting areas of astrophysics: (1) elucidating the nature of fast radio bursts and their precise location within galactic hosts; (2) mapping the distribution of matter on cosmic scales to reveal the detailed evolution of structure in the Universe; and (3) measuring fundamental physics parameters, such as probing neutrino properties and testing General Relativity.

The science reach, design process, and plans for the CHORD experiment will be presented.

142) BRITE-Constellation in the era of TESS

Gregg Wade
Royal Military College of Canada
Gregg Wade

The Bright Target Explorer (BRITE) Constellation is a network of 5 nanosatellites operated with the goal of obtaining high-precision, high-cadence, long-duration multicolour photometry of the brightest stars in the sky. The first BRITE satellites were launched over 6 years ago. Eighteen months past, the Transiting Exoplanets Survey Satellite (TESS) was launched. The TESS target sample includes many of the bright stars accessible to BRITE. Given that TESS targets will be observed at higher precision and cadence than is achievable by BRITE, it is reasonable to evaluate the continuing relevance of the BRITE mission. In this talk I will describe the unique values of the BRITE-Constellation in the era of TESS, and the strong complementarity between the two missions, that maintains BRITE as a unique asset in the modern landscape of space astronomy.

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