RÉSUMÉS/ABSTRACTS

Alexandre Adam: "Free-Form Reconstruction of Gravitational Lenses using Recurrent Inference Machine"

Modeling strong gravitational lenses in order to quantify the distortions of the background sources and reconstruct the mass density in the foreground lens has traditionally been a major computational challenge. This requires solving a high dimensional inverse problem with an expensive, non-linear forward model: a ray-tracing simulation. As the quality of gravitational lens images increases with current and upcoming facilities like ALMA, JWST, and 30-meter-class ground-based telescopes, the task of fully exploiting the information they contain requires more flexible model parametrization, which in turns often renders the problem intractable. We propose to solve this inference problem using an automatically differentiable ray-tracer, combined with a neural network architecture based on the Recurrent Inference Machine, to learn the inference scheme and obtain the maximum-a-posteriori (MAP) estimate of both the pixelated image of the undistorted background source and a pixelated density map of the lensing galaxy. I will present the result of our method applied to the reconstruction of simulated lenses using IllustrisTNG mass density distributions and HST background galaxy images. I will also discuss how our method shows promise to produce MAP estimates for the data sets which have challenged traditional reconstructions methods for over 15 years. I will also discuss avenues for possible extensions of this framework to produce posterior samples in a high dimension space using simulation-based inference.

Johua Aiken: "The Effects of Attenuated Magnetic Braking in Cataclysmic Variables"

Cataclysmic variables (CVs) are close interacting binary stars with a white dwarf (WD) accretor and a typically unevolved donor star. The two dominant orbital angular momentum loss (AML) mechanisms present in CV evolutions are magnetic braking (MB) and gravitational wave radiation (GR). For MB, angular momentum is directly removed from the rotation of the donor star until it becomes fully convective, after which GR becomes the sole AML mechanism. In previous attempts to model the evolution of CVs, MB turns off completely and only GR drives the evolution of the system. In this talk, I present an alternative model which allows an attenuated amount of MB to dissipate angular momentum after the donor star's core becomes fully convective. Using the MESA stellar evolution code, I also explore the model's effects on the late evolutionary stages of CVs and show that this model can easily solve the 'minimum orbital period' problem.

Tara Akhound-Sadegh: "Deep learning the symmetries of dynamical systems"

Neural networks have proven very successful in a variety of applications, such as image recognition and translation. However, they still struggle when modeling complex physical systems. Recent developments in machine learning, and specifically in deep learning have drawn inspirations from concepts in physics to achieve a better performance on deep models. For example, some of these models have been inspired by conservation laws in physics, building models that are equivariant to some specific symmetry transformations (such as rotations), meaning that a symmetry transformation of the input results in a predictable transformation of the output. The goal of this project is to use mathematical concepts, such as group theory and representation theory, to develop a deep model that is able to learn the underlying symmetry of the observation space using only a series of observations of the environment as its input.

Romain Allart: "The search for extended exoplanet atmospheres through the helium triplet with SPIRou"

À Venir

Damien Beaulieu: "Exploring the HII regions of NGC925 as observed by SITELLE"

> Ionized gas is a key component for understanding star formation within galaxies. As part of SIGNALS, a survey that focuses on the emission regions of 40 nearby star-forming galaxies, NGC925 was observed with SITELLE, an imaging Fourier transform spectrometer for the optical spectrum built in Québec City (U. Laval and ABB) and installed at the Canada-France-Hawaii Telescope. This work mainly focuses on HII regions, establishing the physical characteristics of these regions will yield reliable insight regarding the influence of local environments on star formation and the different star forming mechanisms throughout the galaxy. At a distance of 9.2 Mpc, NGC925 is a fine candidate in SIGNALS framework, due to SITELLE's high spatial resolution of 0.32"/pixel and large field of view of 11' x 11', HII regions are differentiated from one another over the whole galaxy. Using Hα to locate emission regions, we compute BPT diagrams of these regions using the emission line ratios [OIII]/Hβ, [NII]/Hα and [SII]/Hα. A catalog of HII regions is compiled from these diagrams. These early results reveal that NGC925 presents an asymmetric distribution of HII regions with different physical properties, suggesting that different mechanisms may be responsible for driving its star formation.

Björn Benneke: "A temperate Earth-sized planet with tidally-heated interior transiting an M6 star"

> Embargoed abstract.

Mohit Bhardwaj: "Deciphering the origins of fast radio bursts using local Universe bursts"

> Fast radio bursts (FRBs) are one of the greatest unsolved mysteries in modern astronomy. Though a plethora of models has been proposed to explain FRBs, the origin of these extremely energetic millisecond-duration radio pulses remains a topic of great debate, owing to the paucity of well-localized FRBs. One of the promising methods to narrow down their origins is by identifying their hosts and/or multiwavelength counterparts. Unfortunately, due to the limited sensitivity of telescopes, multi-wavelength follow-up is most promising for local Universe FRBs (distance ¡ 100 Mpc). The Canadian Hydrogen Intensity Mapping Experiment (CHIME)/FRB project has been detecting FRBs since July 2018, and many of them have sufficiently low dispersion measure (DM) suggesting a nearby origin. Even better, the localization of low-DM FRBs to a few arcminute precision using the CHIME/FRB baseband system can result in a reliable host association for nearby FRBs. In this talk, I'll discuss the CHIME/FRB discovery of six nearby Universe FRBs, as well as the constraints we derived from these nearby sources on different proposed FRB progenitor models.

Julie Bolduc-Duval + Carolina Cruz-Vinaccia + Nathalie Ouellette: "Succès de vulgarisation en temps de pandémie"

> Nous ferons un survol des nouvelles activités de vulgarisation et d'éducation en astronomie offertes par les membres du CRAQ dans les deux dernières années. Plusieurs d'entres elles ont été de grands succès, malgré les défis de la pandémie.

Anne Boucher: "Avec ou sans CO? : Amélioration des contraintes sur l'abondance du CO et autres détections dans l'atmosphère de WASP-127b avec SPIRou."

> L'étude atmosphérique de WASP-127b par Spake et al. 2021 a montré un spectre de transmission très riche montrant clairement la présence d'aérosols, d'H2O, de Na, ainsi que de CO2 super-solaire provenant d'un signal fort dans la bande IRAC2 de Spitzer à 4.5um. Cependant, la quantité de CO2 n'a pas pu être déterminée précisément en raison de la couverture en longueur d'onde limitée des télescopes spatiaux Hubble et Spitzer qui empêche la détection du CO2 et du CO de façon indépendante. Cela conduit à des rapports C/O et des conclusions contradictoires. Nous avons donc voulu démêler le tout à l'aide la bande d'absorption du CO à 2.3um, couvert par le spectrographe SPIRou. Je présenterai les détails des observations de transit de WASP-127 obtenues avec SPIRou, un survol de la méthode d'analyse, ainsi que les résultats qui en découlent. Ceux-ci comprennent une reconfirmation des détections de l'eau, du CO2, du Na, et d'aérosols, ainsi qu'une détection potentielle de OH, qui est surprenant considérant la température trop faible de l'atmosphère. Une limite supérieure forte sur la présence du CO, à log10 CO ¡ -4, nous indique que le signal à 4.5um provient principalement du CO2, et mêne à une sous-abondance en CO et sur-abondance de CO2 par rapport à un scénario à l'équilibre. Je présenterai les scénarios de formation et d'évolution qui pourraient possiblement expliquer ces résultats surprenants.

Hope Boyce: "Searching for a supermassive black hole with molecular gas and ALMA"

> We present a measurement of the mass of the supermassive black hole (SMBH) in the lenticular Fornax-cluster galaxy NGC 1387. A lenticular galaxy in the Fornax cluster, NGC 1387 contains a nearly face-on molecular gas disk at its centre. We map this disk through the detection of the CO(2– 1) emission line with data taken with the Atacama Large Millimeter/sub-millimeter Array (ALMA). This measurement marks the 6th SMBH mass measurement from the mm-Wave Interferometric Survey of Dark Object Masses (WISDOM), and demonstrates the power of this method to estimate central BH mass even when emission is missing from most of the central region containing the sphere of influence.

Margaret Bruna: "Combining Astrometry and Photometry to Improve Orbit Retrieval of Directly Imaged Exoplanets"

> Future missions like Roman, HabEx and LUVOIR will directly image exoplanets in reflected light. While current near infrared direct imaging searches are only sensitive to young, self-luminous planets whose brightness is independent of their orbital phase, reflected light direct imaging will observe planets that change in brightness over the course of an orbit due to phase variations. One of the first objectives will be determining the planets orbit via astrometry, the projected position of the planet with respect to its host star in the sky plane. We show that the changing brightness of a planet throughout its orbit can significantly improve the accuracy and precision of numerical orbital retrieval with two and three direct images. This would speed up the classification of exoplanets and improve the efficiency of subsequent spectroscopic characterization of their atmosphere and surface. We develop a forward model to generate synthetic observations of the three observables produced by a direct image at a given epoch: the two dimensional position of the planet with respect to its host star on the sky plane, and the planet/star flux ratio. Synthetic data are fitted with Keplerian orbits and Lambertian or non-Lambertian phase variations to retrieve orbital parameters, the size of the planet, and its geometric albedo. Our analysis indicates that for astrometric uncertainties of 0.01 AU in projected separation and uncertainties at 1012 in the flux ratio, using photometry in orbit retrieval improves the precision of semi-major axis by 40% for two epochs and 73% for three epochs if the phase curves are presumed to be Lambertian. In the more realistic scenario that the phase curve is non-Lambertian, photometry still improves retrieval accuracy by 16% for two epochs and 50% for three epochs.

Ève Campeau-Poirier: "A neural ratio estimator to infer the Hubble constant from strong gravitational lenses"

> The latest measurements of the Hubble constant, H0, by local probes like supernova and early Universe probes like the Cosmic Microwave Background are still at a $\sim 5\sigma$ tension with each other. Time delay cosmography with strong gravitational lensing is one of the alternative independent methods that could shed light on this tension. The upcoming Legacy Survey of Space and Time should observe around 3000 lensed quasars with well-measured time delays. However, analyzing this many systems with the traditional method is not feasible due to computational costs. Fortunately, machine learning methods provide an opportunity to accelerate this procedure.Here, we discuss our ongoing work in estimating H0 in a simulation-based inference framework using neural ratio estimators. This allows implicite marginalization over large sets of nuisance parameters, while providing an efficient way to estimate this low-dimensional variable. We discuss our simulation pipeline, the inference structure, show preliminary results on simulated data, and point to future directions and the challenges of applying the method to real data.

David Chemaly: "Heavy Lifting: Leveraging Machine Learning to Measure the Masses of Supermassive Black Holes"

> Despite recent advances in the study of supermassive black holes (SMBH), most notably those by the Event Horizon Telescope (EHT) team, a fast and effective methodology to determine the masses of these leviathans at high redshifts continues to elude the astronomical community. Nowadays, the best method to conduct such calculations is to resolve the kinematic of the molecular gas in the region where the SMBH's gravitational potential dominates over the galaxy's potential. Considering how negligible the mass of a SMBH ($\sim 10^8 M\odot$) is compared to a host galaxy ($\sim 10^{12} M\odot$), a high spatial resolution is required to resolve such regions which are of the order of a few tens of parsecs. This need for high-resolution data prevents us from adequately measuring masses at further distances. Here, we present a new machine learning-based method to lens observations and to resolve the surrounding gas

at redshifts that go far beyond what is currently achievable. Our initial findings show that using gravitational lensing on realistic simulations provided by MassiveFIRE leads to a spatially magnified image of the targeted region. By training our new neural network on these simulated datasets, we obtained an algorithm capable of rapidly and accurately deconvolving a lensed galaxy harboring a SMBH and measuring its mass. Additionally, we treated the simulated galaxies as if they were directly observed with ALMA to enable an easy use of our model on real data. We will also discuss the implications of such a tool and showcase the surprising extent to which this new methodology can enrich our knowledge on the primary state of our universe.

Carolina Cruz-Vinaccia + Julie Hlavacek-Larrondo: "Recent EDI Activities at CRAQ Member Institutions: Outcomes Lessons Learned"

Fostering and sustaining an equitable and inclusive environment —one which recognizes the diversity of backgrounds, identities, and expectations— strengthens our community and our research. Professional societies such as CRAQ play an important role in shaping the culture of scientific disciplines, and as such are in an optimal position to lead the way by showing that equity and inclusion are valued. In this talk, we will highlight some of the EDI activities that CRAQ members have undertaken at their institutions in the past two years. We will provide summaries of the work currently being done by the EDI committees at iREx and MSI to identify address areas of underrepresentation, build EDI into our activities, and create spaces for discussion of EDI and workplace climate issues. We will also provide an introduction to the activities of Parité Sciences, a provincial campaign supported by CRAQ that works with colleges to increase the enrolment rate of women in bachelor's degrees of science programs. Throughout this talk, we will emphasize both outcomes and the lessons learned along the way. In doing so, we hope to provide insight that CRAQ's newly formed EDI committee can then draw on when developing CRAQ's EDI strategy.

Alice Curtin: "Searching for FRB-like Counterparts from GRBs using the First CHIME/FRB Catalog"

Fast Radio Bursts (FRBs) are a class of highly energetic transient events, lasting for a few milliseconds and originating from extragalactic distances. While over 750 FRBs have so far been published, very little is known about their origins. Some theories for extragalactic FRBs predict accompanying high energy emission, but none has so far been detected. In this work, we use the Canadian Hydrogen Intensity Mapping Experiment (CHIME) Fast Radio Burst (CHIME/FRB) Project to explore whether any FRB-like emission is associated with 69 gamma-ray bursts (GRBs) detected between 29th August 2018 and 2nd July 2019. We do this by searching for any GRBs that are temporally and spatially coincident with FRBs from the first CHIME/FRB catalog. We also search for GRB-FRB pairs within the time frame of the first CHIME/FRB catalog that are solely spatially coincident and find two such pairs, although the chance probability of this occurring is high for our given sample. Lastly, we use CHIME/FRB to constrain FRB-like radio emission before, during, and after the high energy emission for 33 GRBs. Our most constraining radio limits for short gamma-ray bursts (SGRBs) are < 20 Jy at 19 ks pre-high-energy emission, and < 5 Jy at 28 and 38 ks post-high-energy emission. We use these limits to constrain certain models for radio emission from SGRBs. We also place limits as small as 1 Jy for long gamma-ray bursts (LGRBs), although radio emission associated with LGRBs has not been as strongly predicted.

Antoine Darveau-Bernier: "ATOCA: An Algorithm to Treat Order ContAmination applied to the SOSS mode of NIRISS, the Canadian contribution to the James Webb Space Telescope"

The unprecedented sensitivity of JWST due to its 25 square meters collecting area will open a new window to characterize the atmosphere of exoplanets. More specifically, the NIRISS instrument features a Single Object Slitless Spectroscopy (SOSS) mode which is designed precisely for the purpose of transit and eclipse spectroscopy around bright stars. Its wavelength coverage from 0.6 to 2.8 microns will give access to many molecular absorption features relevant to the determination of the chemical composition of exoplanets. This will play a key role for understanding their formation processes and the physical mechanisms occurring in their atmosphere. However, the first cross-dispersed diffraction order suffers contamination from the second order in the red end of its wavelength domain. This overlaping prevents the direct application of standard spectral extraction techniques. To circumvent this problem, we propose the ATOCA, an Algorithm to Treat Order ContAmination. I will present the basics of the algorithm and its performance in the context of exoplanet atmosphere characterization.

Ariane Deslieres: "GL229 : Le système aux multiples planètes fantômes"

Gliese 229 est le célèbre système stellaire contenant la première naine brune (NB) confirmée, GL229B. L'étoile fut observée avec HARPS, un spectrographe à vitesse radiale, dévoilant une exoplanète avec une période orbitale d'environ 471 jours et une masse d'environ 32 masses terrestres (Tuomi 2014). En 2020, une deuxième exoplanète avec une période orbitale d'environ 122 jours et une masse d'environ 7 masses terrestres fut rapportée (Feng 2020). Avec sa NB et ses deux exoplanètes, GL229 est considéré comme l'un des systèmes les plus diversifiés et suscite des discussions sur les différents mécanismes de formation qui pourraient avoir eu lieu autour de cette étoile. Ce travail présente une nouvelle analyse des données HARPS de GL229 accessibles publiquement réduites en vitesse radiale avec un algorithme, le line-by-line (LBL), moins affecté par les effets systématiques tels que : le décalage résultant du changement de fibre optique dans l'instrument HARPS et la tendance induite par GL229B. L'activité stellaire fut modélisée avec un processus gaussien (GP) informé par l'indicateur d'activité fourni par le LBL révélant un signal fort avec une période d'environ 30 jours. Nous démontrons que les signaux d'exoplanètes signalés précédemment étaient causés par des erreurs systématiques et de l'activité stellaire. Le système GL229 ne contiendrait alors que son étoile hôte et une naine brune.

Laurent Drissen: "Des nouvelles de SITELLE"

Je présenterai quelques-uns des faits saillants des deux dernières années d'observation avec SITELLE au télescope CFH, dans des domaines aussi divers que les restes de supernovae, les galaxies proches et les amas de galaxies.

Salvador Duarte Puertas: "Kinematics of supernova remnants in two SIGNALS galaxies - NGC 6822 and M33"

There are currently ~ 1500 known supernova remnants (SNRs) spread across a dozen galaxies where most of them have been identified optically. These objects chemically enrich their host and influence future generations of stars. Distinguishing SNRs from HII regions is not straightforward. Most authors consider an emission lines ratio [SII]/H$\alpha > 0.4$ for this. Recently it has been proposed to study the velocity structure to differentiate them as well, since SNRs show a larger velocity broadening than HII regions. In this work we combine these two prescriptions, i.e. the [SII]/Hα value and the velocity structure, for a sample of SNRs in two galaxies of the Local Group, NGC6822 and M33. Both galaxies have been observed with the imaging Fourier transform spectrometer SITELLE, developed in Québec (U. Laval and ABB) and installed at the Canada-France-Hawaii Telescope, as part of the SIGNALS survey. Our observations offer a minimum spectral resolution R = 3000. Bearing in mind also the large field of view (11'×11'), high spatial resolution (0.32"/pixel, seeing limited), and the spectral ranges of SITELLE, this work have allowed us to perform a spatially resolved study of all SNR candidates in these two galaxies taking into account these criteria for the first time. From our study we discard some published SNR candidates in NGC6822 and M33. This is the first work in a series dedicated to the detection of all SNRs in the SIGNALS sample.

George Dufresne: "On the evolution of intermediate-period hot sub dwarfs"

Hot subwarfs are essentially the stripped helium cores of more massive progenitors. The hot subdwarfs found in binaries can have orbital periods ranging from less than a day to thousands of days. The ultra-short period ones are the result of common envelope evolution, while the very long period ones were created due to extreme mass loss as the progenitor was evolving close to the tip of the red giant branch. We show that it is possible to explain the existence of intermediate period binaries containing sdB or sdO stars as the result of the evolution of intermediate mass stars that undergo highly non-conservative mass transfer. These binaries have orbital periods on the order of tens of days to hundreds of days. We believe EPIC 225300403 is an example of a progenitor binary that will evolve to form an sdB in a 72 day period binary.

Cyril Dumontier: "Étude à haute résolution spatiale par spectromètre à transformée de Fourier de la bulle Wolf-Rayet NGC 2359"

L'instrument SITELLE installé au CFHT nous a permis de détecter une partie du spectre visible de l'ensemble de la nébuleuse NGC 2359, connue sous le nom de casque de Thor, avec une très haute résolution spatiale. L'analyse des raies spectrales du gaz du complexe permet de dresser le profil cinématique et morphologique de l'ensemble du complexe. On y trouve une distinction flagrante entre

deux grandes structures, un arc fort probablement à plus faible température et plus basse dispersion de vitesse et une bulle filamenteuse de plus haute température et de plus haute dispersion de vitesse. Les rapports du flux de ces raies permettent de décrire les caractéristiques physiques du gaz à chaque pixel de l'image.

Jakob Faber: "Compelling Morphologies of Fast Radio Bursts with CHIME/FRB Baseband Data"

Fast Radio Bursts (FRBs) are a class of highly luminous extragalactic radio transients that occur on micro-to-millisecond timescales. While the majority of FRB sources appear to emit only once, an increasing number of sources have been discovered to emit repeatedly. Investigations into the underlying progenitors and emission mechanisms of FRBs, the likes of which remain a mystery, have largely been limited by the availability of data at sufficiently high time and frequency resolutions with full-polarization information. The Canadian Hydrogen Intensity Mapping Experiment (CHIME) has detected thousands of repeating and non-repeating FRBs, hundreds of which we now have the capability to study morphologically and polarimetrically at a high time resolution of 2.56 us using baseband (raw voltage) data. From this rich sample of high-resolution data, we have selected sixteen one-off FRBs and two bursts from repeating sources that exhibit morphologies of compelling complexity. These events were chosen based on their brightness and suggestive consistency (or lack thereof) with models of FRBs that have been put forward in the field thus far. Motivated by this diverse gallery of events, I show how we can draw new insights into emission mechanism and progenitor models of FRBs, paying particular attention to relativistic shock and magnetospheric scenarios. I also discuss the extent to which their morphologies and polarization properties can be explained by propagation through intervening media.

Luca Fabiani: "Caractérisation de structures à grandes échelles dans le vent de l'étoile WR6 par l'analyse d'observations spectro-polarimétriques linéaires"

L'Étude des signatures polarimetriques linéaires Q et U de l'étoile WR6 révéle l'évolution des sructures à grande échelle dans son vent en fonction du temps. Le vent très puissant des étoiles Wolf-Rayet cache la surface de l'étoile mais il est stratifié en degrée d'ionisation, rendant possible de contraindre sa géometrie via les variations temporelles de la polarisation dans les raies d'emission de son spectre.

Nicole Ford: "CFHT Gravitational Wave Follow-up Pipeline Development"

The LIGO/Virgo gravitational wave observatories' Observing Run 4 is scheduled to start in December 2022, and is expected to detect gravitational wave signals from ∼10 new NS-NS and NS-BH mergers. Rapid telescope follow-up of these mergers will obtain light curves and spectra of the first sample of kilonovae. We plan to use CFHT's MegaCam and WIRCam to search for these kilonova counterparts; to prepare for this search, I have incorporated several improvements to our follow-up image reduction software pipeline. I will discuss several of these improvements, including the generation of tiling maps and ranked galaxy target lists customized for CFHT and optimized to cover the gravitational wave localization map.

Samuel Gagnon-Hartman: "Un-Biasing Standard Siren Inference of the Hubble Constant"

The Hubble tension between early-time and late-time measurements of the expansion rate of the universe now stands at a 5-sigma disparity. Another method of measuring the Hubble constant that is independent of the two current methods is needed to determine if new physics are necessary to explain the discrepancy. One promising approach is to use gravitational wave standard sirens, in which a binary neutron star (BNS) merger's redshift is inferred through its electromagnetic (EM) emission while its luminosity distance is measured from its gravitational wave (GW) emission, enabling an inference on the Hubble constant via Hubble's law. However, this approach suffers from systematic biases arising from the geometry of the BNS mergers themselves. In rough terms, there are two biases: that arising from the anisotropy of the GW emission, and that arising from the anisotropy of the EM emission. In each bias, an event viewed on the angular momentum axis is more likely to be detected than an oblique event, pushing the inferred luminosity distance nearer to the observer, and thus inflating the inferred Hubble constant. Furthermore, there are two classes of BNS merger: those with detected EM counterparts (standard sirens), and those without. Previous attempts at bias removal have considered only one of the biases independently of the other and have only considered data from a suite of standard sirens. We present a novel method of simulation-based inference which leverages data from both event classes to correct for both biases at once.

Frédéric Genest: “Influence de l’activité stellaire sur la spectroscopie de transit à basse résolution et possibilités de mitigation à haute résolution”

> L’activité stellaire (taches, facules) peut affecter la caractérisation de l’atmosphère d’exoplanètes par spectroscopie de transit en biaisant la mesure du rayon planétaire, en introduisant une pente dans le spectre et en produisant des signatures d’absorption atomiques et moléculaires. Ce problème peut devenir particulièrement important dans le cas d’étoiles froides (naines M), où les signatures de contamination imitent par exemple l’absorption d’eau par la planète. Je présenterai les résultats de simulations de surfaces stellaires et de transits à basse et haute résolution spectrale pour des modèles de trois systèmes différents. À basse résolution, il est difficile, voire impossible, de distinguer l’origine des signatures spectrales. En revanche, à haute résolution, une variation suffisante de la vitesse radiale de la planète pendant le transit permet de séparer plus clairement l’origine d’une détection.

Simon Guichandut: “New models of photospheric radius expansion bursts”

> Of the more than 7000 Type I X-ray bursts that have been observed, about a fifth of them exhibit photospheric radius expansion (PRE) as a result of near to super-Eddington luminosities being produced at the surface of the accreting neutron star (NS). PRE bursts are a key tool for high energy astrophysics as they contain a wealth of information about neutron star physics. We present recent and undergoing work on models of PRE bursts that go beyond previous simplifying approximations. We focus on a new study of the two regimes of PRE: sub-Eddington, where the atmosphere expands but remains in hydrostatic equilibrium, and super-Eddington, where a radiatively-driven wind expels accreted material and nuclear burning ashes from the star. We show that the existence of the former, apparent only once general relativistic effects are taken into account, may cause NS radius measurements from PRE to be over-estimated. For the latter, we discuss how our models can help infer the NS mass from gravitationally redshifted absorption lines of heavy elements ejected in the wind. These two aspects are relevant in the efforts to constrain the NS equation of state, upon which interpretations of other observations, such as multi-wavelength and gravitational wave observations of NS mergers, rely. Our models can also be coupled with time-dependent simulations of the NS burning layer to predict the light curve of these bursts in X-rays, especially relevant now with the advent of the NICER telescope, which is able to fully track the soft spectrum of PRE bursts. Finally, we demonstrate how the stellar evolution code MESA can be used to study PRE bursts that occur after the ignition of a stratified H/He envelope, a likely common scenario with a poorly understood observational signature, recently captured by NICER.

François Hardy: “Analyse spectrophotométrique des étoiles naines blanches magnétiques riches en hydrogène”

> Environ 10 à 15% des étoiles naines blanches sont catégorisées magnétiques (MWD). Bien que les données spectroscopiques, photométriques et astrométriques se soient multipliées au cours de la dernière décennie, aucune analyse homogène de ces étoiles n’a été effectuée depuis l’étude de Külebi (2009). Je présenterai ici, à partir de modèles dernier cri, les résultats de l’analyse de toutes les MWD riches en hydrogène trouvé dans le Montreal White Dwarf Database. Les propriétés de l’échantillon, ainsi que la structure et l’évolution du champ magnétique de ces étoiles, seront également discutées.

Raphaël Hardy: “Oscillations torsionnelles magnétohydrodynamiques dans les Jupiters chaudes”

> Les Jupiters chaudes possèdent des températures au-delà de 1000K et des écoulements équatoriaux de l’ordre du km/s. Les simulations hydrodynamiques, ainsi que la majorité des observations montrent que ces écoulements se font d’ouest en est. Cependant, les observations de CoRoT-2b et HAT-P-7b ne se conforment pas à cette prescription. Une explication de cette anomalie est que les champs magnétiques de ces planètes, en interaction avec leurs atmosphères partiellement ionisées, peuvent renverser la direction des écoulements si les champs sont assez puissants. Ces atmosphères sont partiellement ionisées à ces températures, car elles contiennent des métaux alcalins qui s’ionisent thermiquement à ses températures. La conductivité électrique possède donc une très forte dépendance sur la température. De plus, il a déjà été montré avec un modèle stationnaire qu’il existe un régime dans les Jupiters chaudes où une instabilité thermique peut se développer en présence de dissipation ohmique dans le régime de faible traînée magnétique et de vents forts. Je vais présenter les résultats de deux modèles magnétohydrodynamiques adimensionnels possédant une conductivité électrique variant selon la température locale. Le modèle local permet d’obtenir des critères d’instabilité, tandis que le

modèle 1D permet une meilleure représentation du problème physique dans les Jupiters chaudes. Dans les deux cas, les modèles démontrent qu'une conductivité électrique dépendante de la température conduit à des solutions intrinsèquement dépendantes du temps.

Mahesh Herath: "The magnetic fields of terrestrial Exoplanets"

The ability to generate a sustainable magnetic field is an important aspect of planetary habitability. In this work, we outline the deployment of a planetary interior structure model to determine the optimal conditions that could potentially generate magnetic fields in terrestrial Exoplanets. An assumption was made that the magnetic field is created in a manner similar to that of the Earth's, where convection from the release of light elements during the formation of a solid Iron inner core inside a liquid Iron outer core leads to the emergence of a geodynamo. The models were tested on planet masses ranging from 1 Mearth to 6 Mearth, with their core mass fractions (CMF's) varied from 16 percent to 70 percent. The simulations predict that planets between 1 Mearth and 3 Mearth generate their strongest and longest lasting fields at CMF's between 30 percent and 50 percent while the field gets damped at CMF's above 50 percent. Planets with masses between 4 Mearth and 6 Mearth have their strongest fields for CMF's between 16 percent and 50 percent. Planet masses between 2 Mearth and 4 Mearth, with CMF's between 30 percent and 50 percent showed the most stable magnetic fields over all the simulations. It was also noted that while CMF's above 50 percent would damp any emerging geodynamos, a slight increase in the thermal conductivity of the core-mantle-boundary layer would solve that problem and generate sustainable magnetic field over several billion years. This showed overall that planetary masses, CMF's and the thermal conductivity of the deep interior layers are important aspects in the evaluation of a rocky planet's ability to have a magnetic field.

Prime Karera: "Analyse spectroscopique du gaz ionisé des galaxies Arp 143"

Je présenterai les données observationnelles du duo de galaxies Arp 143 obtenues avec le spectromètre imageur à transformée de Fourier, SITELLE, dans les bandes SN1, SN2 et SN3. La paire comprend une des rares galaxies à anneau, NGC 2445, recensées dans le catalogue Arp, en interaction avec la galaxie lenticulaire NGC 2444. Les données permettent une analyse de la cinématique à haute précision couplée à une étude de la métallicité du gaz ionisé de NGC 2445. Les régions de formation stellaire détectées se retrouvent presque exclusivement dans l'anneau en expansion. Je présenterai aussi un modèle numérique reproduisant certaines des propriétés du sytème de galaxies en utilisant le code GCD+ qui inclue la gravité, l'hydrodynamique, la formation stellaire, l'enrichissement chimique, la rétroaction et le refroidissement radiatif. La simulation numérique montre que le système se serait formé à partir de la collision entre une galaxie spirale riche en gaz et une galaxie lenticulaire.

Ophélie Légaré: Système optique embarqué sur un ballon stratosphérique pour analyse des turbulences atmosphériques

Le projet HiCIBaS (High Contrast Imaging Balloon System) a pour but de récolter des données pour des futures missions d'imagerie haut contraste pour l'observation directe d'exoplanètes. L'imagerie haut contraste exigeant la meilleure qualité d'image possible, il est nécessaire d'offrir une correction sur le front d'onde en temps réel pour les turbulences atmosphériques, les vibrations, les variations optiques dû au changement thermique, etc. Ma contribution à cette phase du projet est de développer une charge utile (vol en septembre 2023) pour mesurer les turbulences atmosphériques à 40 km d'altitude.

Ronan Legin: "Simulation-Based Inference of Strong Gravitational Lensing Parameters"

In the coming years, a new generation of sky surveys, in particular, Euclid Space Telescope, and the Rubin Observatory's Legacy Survey of Space and Time (LSST) will discover more than 200,000 new strong gravitational lenses, an increase of more than two orders of magnitude compared to currently known samples. Accurate and fast analysis of such large volumes of data within a clear statistical framework is crucial for all sciences enabled by strong lensing. In this talk, I will discuss the critical role of simulation-based inference (SBI) in the context of strong gravitational lensing analysis for these surveys. I will present our results related to obtaining the posteriors of the macro-parameters of individual strong lenses using machine learning models and share our ongoing work in inferring population-level statistics using hierarchical models.

Olivia Lim: "Transits de TRAPPIST-1b observés avec SPIRou: Historique de formation et atmosphère"

TRAPPIST-1 est un système composé de sept exoplanètes rocheuses tempérées de tailles terrestres en orbite autour d'une naine rouge dans le voisinage solaire. C'est un système compact et ses planètes sont en résonance orbitale, ce qui le rend d'autant plus intrigant en termes d'historique de formation. On peut en apprendre davantage sur la formation d'un système par sa configuration géométrique, en particulier en mesurant le (dés)alignement entre l'axe de rotation de l'étoile et l'axe orbital des planètes. Cette mesure peut se faire grâce à l'effet Rossiter-McLaughlin (RM), une technique dans laquelle on mesure la vitesse radiale de l'étoile durant un transit planétaire. Avec 8 transits de TRAPPIST-1b observés avec SPIRou, notre objectif était de détecter l'effet RM et de mesurer l'angle de spin-orbite entre l'étoile hôte et l'orbite de TRAPPIST-1b. Nous avons détecté la signature RM et elle indique une orbite prograde alignée avec la rotation stellaire à moins de 54 degrés. En combinant les données SPIRou à des données publiées de Subaru IRD (Hirano et al. 2020), on trouve un alignement cohérent avec la littérature et pointant vers un historique de formation calme sans perturbation gravitationnelle majeure qui aurait pu désaligner l'orbite planétaire.Nous avons également tenté de détecter une atmosphère sur TRAPPIST-1b en corrélant les spectres de transits à divers modèles d'atmosphères. Nous avons une possible détection d'une atmosphère riche en eau, mais le défi est maintenant de distinguer un signal produit par une atmosphère autour de la planète d'un signal résiduel ou contaminant de l'étoile.

Hector Linares Arroyo: "Astronomical site characterization with the Illumina light model"

Illumina is one of the most precise and reliable light pollution models at the time of this writing. For the last decade it has been used for assessing the quality of the night sky, for pointing out main sources of light pollution and for comparing different lighting systems before the actual installation.This model, however, has hardly been used outside the developing team. There are two main reasons. The first reason is that it takes weeks (for a light pollution expert) to learn how to handle all the variables and files that the model requires. And second, because it is designed to be run in a CPU cluster, a kind of facility not available for many.Illumina Light aims to solve those problems. It is a simplified version of Illumina designed to be run in a domestic laptop. It is managed from a user friendly visual interface that in its first version allows the user to estimate V band sky brightness for the zenith direction in any location desired in less than ten minutes (8 CPU laptop).The astronomical community is encouraged to use it when trying to compare the quality of the night sky over different locations, for instance when looking for the best place to install astronomical instrumentation.

Derek Lizotte: "Exoplanet Atmospheric Refraction Effects in the Kepler Sample"

We present a detailed analysis regarding the viability of detection of refraction effects in exoplanet atmospheres in the Kepler/CKS sample using binning techniques for the Kepler light curves and comparing them with simulated refraction effects. We split the Kepler/CKS planet into sub-populations according to the Period-Radius valley, applying the feasibility of detection of refraction effects towards measuring their sensitivity with regards to planetary and atmospheric properties. Specifically, we test whether planets above the Period-Radius valley have H/He atmospheres, which would then be possibly evaporated by high radiation from stellar activity, leaving rocky cores (below the valley). It is shown that optically thin, H/He dominated atmospheres are not common in the observed planetary population, very likely owing to their small orbital period. This would cause the planets to have hotter atmospheres susceptible to strong opacity sources, effectively removing or reducing any potential refraction effects.

Anan Lu: "Star Formation Efficiency in the Bulge of the AGN-host Galaxy NGC 3169 with SITELLE and ALMA"

The star formation efficiency (SFE) has been shown to vary across different environments, particularly within galactic starbursts and deep within the bulges of galaxies. Various quenching mechanisms may be responsible, ranging from galactic dynamics to feedback from active galactic nuclei (AGN). Here, we use observations of warm ionised-gas emission lines (e.g. Hβ, [OIII]$\lambda\lambda$4959,5007, [NII]λ6548,6583, Hλ, [SII]λ6716,6731) from the imaging Fourier transform spectrograph SITELLE at the Canada-France-Hawaii Telescope (CFHT) and cold molecular gas (CO(2-1)) from the Atacama Large Millimeter/sub-millimeter Array (ALMA) to study the SFE in the bulge of the AGN-host galaxy NGC

3169. After distinguishing star-forming regions from AGN-ionised regions using emission-line ratio diagnostics, we measure spatially-resolved molecular gas depletion times ($\tau_{dep} \equiv 1/SFE$) with a spatial resolution of ≈ 100 pc within a galactocentric radius of 1.8 kpc. We identify a star-forming ring located at radii 1.25 ± 0.6 kpc with an average τ_{dep} of 0.3 Gyr. At radii < 0.9 kpc, however, the molecular gas surface densities and depletion times increase with decreasing radius, the latter reaching approximately 2.3 Gyr at a radius ≈ 500 pc. Based on analyses of the gas kinematics and comparisons with simulations, we identify AGN feedback, bulge morphology and dynamics as the possible causes of the radial variations of SFE observed in the central region of NGC 3169.

Matthew Lundy: "Studies of Rapid Transients using VERITAS"

Probing rapid astrophysical variability (sub-second) allows us to investigate some of the most energetic and understudied systems in astrophysics. In recent years there has been a rapid rise in interesting radio transients that occupy this parameter space but investigating other wavelength bands has proven challenging. The VERITAS array has the capability of constraining both rapid optical (0.4 ms sampling in the B band) and gamma-ray emission (200 GeV $\rightarrow$10 Tev) for a variety of known transients and is also capable of studying new transients. I will discuss various ongoing rapid optical and gamma-ray work performed at VERITAS, including FRBs and measurements of stellar diameters. I will also discuss future VERITAS upgrades and what this means for the next generation of imaging atmospheric Cherenkov telescopes that are being developed.

Christopher Mann: "NEOSSat's value for hard-to-observe transits"

NEOSSat is a small Canadian space telescope that began its general observing program in recent years. Though designed to observe near-Earth objects, its on-board photometer and new fine-pointing mode make it well-suited for exoplanet transit observations. For the last few years I have been using NEOSSat to follow up hard-to-observe TESS targets, particularly those with long transits or unknown periods. Being a space-based instrument, NEOSSat lends itself to these types of observations and has produced some exciting results.

Étienne Massé: "The lopsided spiral galaxy NGC1637 with SITELLE"

Using the imaging spectrograph SITELLE at the CFHT, a thorough analysis of the isolated lopsided spiral galaxy NGC 1637 was performed with the goal to find new clues about the origin of its asymmetry. Four filters have been used (SN1 which includes [OII]3727, SN2 with Hb and [OIII]4959, 5007, C3 with Mgb and Fe absorption lines between x and y A, and SN3 with Ha, [NII]6... and [SII]6717,6731). Maps of the strong emission lines have been obtained revealing more than 700 HII regions. Spectra of the old stellar populations underneath these emission regions have been modeled using the code PpXF. An analysis of the contribution of C3 to the fit was performed. Corrected emission line ratios are used to study the HII regions properties over the whole galaxy and to obtain a catalogue of HII regions. A dynamic analysis revealed that the kinematic and luminosity centers are separated by close to 200 pc.

Michael Matesic: "Bayesian Assessment of Kepler's Candidate Exoplanets with Gaussian Processes and Nested Sampling"

The Kepler exoplanet catalogue has only been extensively analyzed under the assumption of white noise (equal intensity on all observed timescales), which breaks down on timescales longer than a day due to coloured noise (point-to-point correlation) from stellar variability or instrumental effects. Statistical validation of candidate transit events contaminated by this form of noise becomes increasingly difficult in lower signal-to-noise regimes, including those where Earth and Venus-analogues are expected to exist. To diagnose these cases, we assess candidate exoplanets by modelling Kepler's photometric data as noise, treated as a Gaussian process, with and without the inclusion of a transit model. Nested sampling algorithms from UltraNest recover the maximum likelihood estimator parameter combinations and associated evidences of each model, allowing for true Bayesian comparison. To substantiate this methodology, results are verified against baselines established using MCMC techniques and candidates that scored highly in favour of real transits will serve as priority targets for follow-up observations from Hubble or James Webb space telescopes.

Marcus Merryfield: "A Synthetic Pulse Injection System for the CHIME/FRB Experiment"

> The detection pipeline in the Canadian Hydrogen Intensity Mapping Experiment Fast Radio Burst project (CHIME/FRB), like all FRB detection pipelines, is subject to selection effects. To correct for these, a synthetic pulse injection system was developed. The system injected a sample population comprised of ∼85,000 synthetic pulses with ∼25,000 corresponding detections for the First CHIME/FRB Catalog, and is now being modified to inject an order of magnitude larger sample. Such an increase in sample size will improve our understanding of CHIME/FRB's biases, and the true FRB population as a result. We present in detail the architecture of the injection system, and the methods with which it was operated for the First CHIME/FRB Catalog. We share some examples of the injection dataset's utility in understanding and correcting biases in the First CHIME/FRB Catalog, and discuss what further insights can be made with a larger injection sample. Finally, we discuss the utility of the injection system in improving CHIME/FRB's sensitivity.

Stefan Pelletier: "Titanium cold-trapping, numerous metals and ions, and the first ever unambiguous detection of vanadium oxide revealed on a ultra-hot giant exoplanet"

> Orbiting extremely close to their host stars and blasted by enormous amounts of radiation, ultra-hot Jupiters are giant gas planets that are home to some of the most extreme known atmospheric conditions. With orbital periods of a few days at most, these exoplanet are tidally-locked (like the moon around the Earth), causing a permanent hot dayside facing towards, and a cooler nightside facing away from their host star. This makes ultra-hot Jupiters unique astrophysical laboratories that present a tremendous diagnostic tool to probe the chemical contrasts governing their opposing, potentially drastically different hemispheres. The ultra-hot Jupiter WASP-76b took the exoplanet community by storm at the turn of the decade with evidence of iron condensation occurring from its hot dayside to its colder nightside (literally iron raining down). This landmark discovery was inferred from a distinct asymmetry in the absorption signal of gaseous iron evolving throughout the transit and introduced a new realm of opportunities for studying the day-to-night dichotomy of exoplanet atmospheres. I will present the results of follow-up transit observations of this fascinating planet using the new ultra-stable high-resolution MAROON-X spectrograph operating on Gemini-North. Our analysis of this data shows a plethora of gaseous metals and ions detected in WASP-76b's transmission spectrum, a multitude of which also show similarly distinct asymmetric absorption signals throughout the transits. We also report the first ever unambiguous detection of vanadium oxide (VO) on an exoplanet (confirmed with 2 different instruments). VO is a strong UV light absorber that has long been thought to be a driver for thermal inversions in ultra-hot Jupiter atmospheres, but has historically been notoriously difficult to detect. We will also present an unprecedentedly thorough analysis of WASP-76b's composition, precisely constraining the relative abundance of 15+ species in its atmosphere using a Bayesian high-resolution retrieval framework. We find that, while most elements are in agreement with equilibrium chemistry and a solar-like composition, a few species show clear deviations from model predictions. In particular, we measure V + VO abundances perfectly in line with expectations, but Ti + TiO abundances that are depleted by more than a factor of 100. This is a clear indication that titanium is missing from WASP-76b's upper atmosphere, likely because it is cold-trapped on the nightside due to its lower condensation temperature relative to vanadium.

Laurence Perreault Levasseur: "Modeling assembly bias with machine learning and symbolic regression: application to cosmic neutral hydrogen"

> Upcoming 21-cm surveys will map the spatial distribution of cosmic neutral hydrogen (HI) over unprecedented volumes. Mock catalogs are needed to fully exploit the potential of these surveys. Many standard techniques used to create these catalogs, such as the halo occupation distribution (HOD) model, rely on the assumption that the baryonic properties of dark matter halos depend on only their masses. From the hydrodynamic simulation IllustrisTNG we can show, to the contrary, that the HI content of halos strongly depends on their local environment. In this talk, I'll show how this effect can be modeled by machine learning algorithms and parametrized in the form of new analytic equations. From these, we can provide physical explanations for the environmental effect and show that ignoring it leads to ∼10% bias in the real-space 21-cm power spectrum, which is larger than the expected precision from upcoming surveys.

Caroline Piaulet: "Not all super-Earths are rocky planets: evidence for a warm-temperate volatile-rich water world"

The population of planets smaller than approximately 1.7 Rearth is widely interpreted as consisting of rocky worlds. This picture is largely corroborated by radial-velocity (RV) mass measurements for close-in super-Earths, but lacks constraints at lower instellations. Here we present the results of a detailed study of the Kepler-138 system using 13 Hubble and Spitzer transit observations of the warm-temperate 1.51 Rearth planet Kepler-138d combined with Keck/HIRES RV measurements of its host star. We find evidence for a volatile-rich "water world" nature of Kepler-138d, independently supported by transit timing variations, RV observations, as well as the flat optical/IR transmission spectrum. The bulk composition of Kepler-138d resembles those of the icy moons rather than the terrestrial planets in the solar system. Our photodynamical analysis provides important revisions of the parameters of the three known small planets in the system and we infer the presence of Kepler-138e, a likely non-transiting planet at the inner edge of the habitable zone.

Myriam Prasow-Émond: "Searching for Exoplanets orbiting X-ray Binaries via Direct Imaging"

X-ray binaries, composed of a compact object (stellar-mass black hole, neutron star, or white dwarf) accreting material from a donor star, are fantastic laboratories for studying astronomical objects and phenomena under extreme conditions. Although the study of these systems has led to major breakthroughs in high-energy astrophysics, their circumbinary environment at ∼100-5000 astronomical units (AU) scales is yet to be studied in detail. In fact, it remains unclear how the accretion onto the compact objects or the explosions giving rise to the compact objects interact with their immediate surroundings. In this project, we conducted a new and explorative, yet innovative, study by applying direct and high-contrast imaging techniques on a sample of a dozen X-ray binaries using the vortex coronagraph on Keck/NIRC2. This allowed us, for the very first time, to seek exoplanets, or even brown dwarfs, companion stars, and protoplanetary disks, in these extreme environments. In this talk, we present the key results from this campaign: the discovery of several candidate companions ranging from planetary to stellar masses. In addition to extending our comprehension of how companions can form and survive in such systems, this project could allow us to completely redefine our understanding of X-ray binaries.

Nayyer Raza: "Reconstructing gravitational waves from core-collapse supernovae with Advanced LIGO-Virgo"

Our current understanding of the core-collapse supernova explosion mechanism is incomplete, with multiple viable models for how the initial shock wave might be energized enough to lead to a successful explosion. Detection of a gravitational-wave signal emitted in the initial few seconds after stellar core-collapse would provide unique and crucial insight into this process. With the Advanced LIGO and Advanced Virgo detectors expected to approach their design sensitivities soon, we could potentially detect this signal from a supernova within our galaxy. In anticipation of such a scenario, we study how well the BayesWave algorithm can recover the gravitational-wave signal from core-collapse supernova models in simulated advanced detector noise, and optimize its ability to accurately reconstruct the signal waveforms. We find that BayesWave can confidently reconstruct the signal from a range of supernova explosion models in Advanced LIGO-Virgo for network signal-to-noise ratios > 30, reaching maximum reconstruction accuracies of $\sim 90\%$ at SNR 100. For low SNR signals that are not confidently recovered, our optimization efforts result in gains in reconstruction accuracy of up to 20-40%, with typical gains of $\sim 10\%$.

Jocelyn Read: "Neutron stars observed with gravitational-wave astronomy"

Discoveries by LIGO, Virgo and KAGRA are informing our understanding of dense matter and stellar evolution. We have used the gravitational-wave data of GW170817 - the first and nearest signal from merging neutron stars - to constrain the equation of state of dense matter in neutron stars. More distant sources tell us about the distribution of masses in compact binary mergers, which will be a key observable in the coming years of gravitational-wave astronomy. The heavy neutron-star merger GW190425 and the neutron-star/black-hole mergers GW200105 and GW200115 have already have revealed that our source population includes binary systems unlike those previously observed in our Galaxy. In this talk, I will discuss methods being developed to explore matter and mass properties for LIGO/Virgo neutron stars. I will discuss how current results fit with other neutron-star observations, outline prospects of learning about neutron stars in the current Advanced-detector era, and extrapolate to the potential of next-generation gravitational-wave observatories like Cosmic Explorer.

Carter Rhea: "LUCI: A General Purpose Line Fitting Algorithm Tailored to SITELLE"

> High-resolution optical integral field units (IFUs) are rapidly expanding our knowledge of extragalactic emission nebulae in galaxies and galaxy clusters. By studying the spectra of these objects – which include classic HII regions, supernova remnants, planetary nebulae, and cluster filaments – we are able to constrain their kinematics (velocity and velocity dispersion). In conjunction with additional tools, such as the BPT diagram (e.g. Baldwin et al. 1981; Kewley et al. 2006), we can further classify emission regions based on strong emission-line flux ratios. LUCI is a simple-to-use python module intended to facilitate the rapid analysis of IFU spectra. LUCI does this by integrating well-developed pre-existing python tools such as astropy and scipy with new machine learning tools for spectral analysis (Rhea et al. 2020). Furthermore, LUCI provides several easy-to-use tools to access and fit SITELLE data cubes.

Maxime Royer: "Analyse des paramètres thermodynamiques de la région HII Sh2-158 via SITELLE et simulations Monte-Carlo."

> Nous avons acquis trois cubes de la région HII Sh2-158 à l'aide de SITELLE. SITELLE est un spectro-imageur à transformée de Fourier avec 11'x11' de champ de vue, installé au TCFH. Nous disposons de 3 cubes spectraux, SN2(480-520 nm), C2(562-625 nm) et SN3(651-685 nm), permettant de déterminer des paramètres thermodynamiques tel que la température et densité électronique de Sh2-158. La densité et la température doivent être déterminer de manière itérative à cause de l'interdépendance des paramètres. Ceux-ci sont importants dans la détermination des abondances. Afin d'obtenir une bonne détermination des incertitudes associées à la température et la densité, nous avons implémenté des simulations Monte-Carlo dans le calcul de ceux-ci. Ainsi, nous avons obtenues une carte de la densité à l'aide du doublet de [SII] 6731/6716 et une carte de la température avec [NII] 5755/(6548+6583). Avec ces deux cartes, il fut possible d'observer les variations et les fluctuations des paramètres et de discuter de l'impact de celle-ci sur le comportement du gaz dans la région HII.

Marianne Ruest: "Caractérisation a large bande spectrale de la bulle Wolf-Rayet NGC6888 avec des données SITELLE"

> NGC 6888, aussi appelée la nébuleuse du croissant, est depuis longtemps la muse de recherches tant amateures que scientifiques. Les données récentes acquises par SITELLE, un spectro-imageur à transformée de Fourier à large champ de vue en place au télescope Canada-France-Hawaii, permettent toutefois de nouvelles analyses et conclusions. On dispose de 5 cubes spectraux, chacun couvrant une bande spectrale stratégique dans le visible décrivant un champ de vue aussi large que 11 arcminutes carrées. Il est ainsi possible de faire une description des abondances chimiques de 23 raies clés avec une résolution jusqu'à 3000. Le décalage Doppler permet également des fits à deux composantes de vitesse qui décrit les différentes couches de la bulle en expansion. Le doublet de soufre permet de décrire les densités électroniques en plus des autres raies (incluant [NII]5755, [OIII]4363 et NeIII]3868), qui sont essentielles pour déterminer les températures et les abondances. Toute cette étude permet de décrire de façon plus complète NGC6888 et son étoile centrale WR136.

Ketan Sand: "A periodically repeating Fast Radio Burst."

> Fast Radio Bursts (FRBs) are millisecond duration radio pulses of extragalactic origin ubiquitous over the sky. Earlier thought to be one-off events, additional bursts were detected from some of these sources now known as repeaters. The CHIME/FRB project is responsible for detecting 20 out of 24 of these repeaters, the most unique of which is FRB 20180916B. This source is active every 16.3 days with an activity window lasting about 5 days. This unique periodicity and its relative proximity (150 Mpc) have made it an excellent source to understand the mysterious origins of FRBs. I will present here the synopsis of research so far on the source. This involves an extensive study using numerous radio facilities mainly CHIME/FRB as well as optical and other high energy estimates. I will discuss the consequences of these studies on possible progenitor scenarios and how multiwavelength observations are helping us to unveil the origins of this source and FRBs in general.

Gabriel Savard: "The epic adventures of detecting HII regions wtih SITELLE data"

> The study of the ionized gas in galaxies is crucial to understand how stars are formed within their environment. With the help of the imaging spectrograph SITELLE at the CFHT, we undertook an

investigation of the emission regions over the whole spiral galaxy NGC 7479 (at 36 Mpc). SITELLE's large field of view (11'×11') allows the study of the whole galaxy while its high spatial resolution (0.32"/pixel) enables the individual identification of HII regions. Using SITELLE filters (SN1:364-385nm, SN2:484-512nm, SN3:648-686nm), we cover the main emission lines needed for the extraction of the gas physical properties (kinematics, metallicity...). For this work, and for the ongoing systematic study of more than 40 nearby galaxies with SITELLE, as part as the SIGNALS survey, a new detection code for the emission regions has been developed. It identifies emission peaks (based on the Hα Laplacian map and the noise map), the physical domain surrounding each peak (fitting 2D Gaussian profiles), and their background emission. Taking into account the stellar populations underneath the emission lines, we can separate diffuse emission regions from HII regions and draw an accurate Hα luminosity function. We present here the basic functionalities of the detection code and the results obtained for NGC 7479. Hundreds of HII regions are found and their properties are being compared taking into account their location in the galaxy's strong bar, asymmetric arms and extended disk.

Alexandre Simoneau: "Processus d'étalonnage d'appareils photo numériques en astronomie"

L'usage d'appareils photographiques en astronomie est extrêmement répandu, car ceux-ci permettent d'obtenir des images d'objets dont la luminosité est trop faible pour être visible à l'œil nu. Cependant, les images capturées ne peuvent servir à une analyse scientifique sans que l'appareil ait d'abord été étalonné en fonction de leur utilisation prévue, et les méthodes d'étalonnage traditionnelles peuvent représenter un investissement de plusieurs milliers de dollars. Le présent travail détaille des méthodes d'étalonnage d'appareils photo numériques commerciaux exigeant un minimum de ressources et de l'équipement facilement accessible. Les méthodes proposées visent à mesurer la position relative et la radiance des sources lumineuses observées.

Mohammad-Hadi Sotoudeh: " Posterior Sampling with Hierarchical Probabilistic U-Net"

Deep generative models have proved to be powerful tools for likelihood-free inference, providing a promising avenue to address the problem of doing inference in very high-dimensional parameter space, particularly in the context of the upcoming generation of sky surveys. In this talk, I will present our ongoing exploration of the Hierarchical Probabilistic U-Net (HPU-Net) for generating high-dimensional posterior samples. I will summarize the experiments we conducted with HPU-Net and the methods we employ to assess the quality of its generated samples. We will also present the results of training this model in an adversarial setup and how it affects the quality of samples. We hope to apply this tool to the problem of reconstructing the initial conditions of the Universe, among others.

Chia Min Tan: "The CHIME Slow Pulsar Search Project"

The Canadian Hydrogen Intensity Mapping Experiment (CHIME) Fast Radio Burst project produces a continuous high time resolution radio data stream that can be exploited to search for pulsars. The CHIME Slow Pulsar Search (CHIME/SPS) project is poised to do exactly this; combining daily quality-controlled data to create a sensitive survey of the northern sky with the primary goal of searching for new low-luminosity pulsars. In addition, the daily data processing will make CHIME/SPS sensitive to pulsars with sporadic or intermittent emission properties. Here, we will discuss the scientific motivations of CHIME/SPS, the novel setup of the search process, and the various challenges in enabling a continuous processing pipeline.

Simon Thibault: "25 ans de conception optique pour l'astronomie"

Il y a 25 ans, un astrophysicien (Jean-René Roy) m'a dit que l'astronomie avait besoin de concepteur optique, car l'instrumentation devenait de plus en plus complexe. Cet exposé décrira à travers le temps les différentes leçons tirées durant le design de dizaine d'instruments. De WIRCAM aux aventures en ballon et à la fabrication des slicers d'image, nous pourrons apprécier comment l'astronomie pousse la technologie vers le haut.

Christian Thibeault: "Modélisation dynamique de la dynamo solaire avec rétroaction magnétique sur les écoulements aux grandes échelles"

La vitesse angulaire locale du Soleil varie de l'ordre de quelques pourcents avec le cycle magnétique de 22 ans. Dans le cadre de mon projet de doctorat, l'action de la force de Lorentz sur l'écoulement du

plasma solaire est ajoutée à un modèle de dynamo numérique, originalement à écoulement fixe. Je présenterai des résultats préliminaires de cet ajout, ainsi que sa comparaison avec les observations du Soleil.

Patrick Tremblay: "Amélioration de la simulation des profils de raie d'hélium élargis par l'effet Stark pour les Naines Blanches DB"

Au cours des 25 dernières années, nous avons considéré l'effet Stark pour les raies d'hélium neutres dans les naines blanches DB en utilisant la théorie d'élargissement standard de Stark à la fois dans le régime d'impact (au centre des raies) et dans le régime quasi-statique (dans les ailes) pour les électrons, en négligeant l'effet de la dynamique des ions. Bien qu'il s'agisse probablement d'une bonne approximation basée sur des travaux théoriques antérieurs, la transition entre les deux régimes pour les électrons et la contribution des ions très proches du cœur pourrait être mal représentée. Pour mieux tenir compte ces particularités, nous rapportons les résultats d'une nouvelle série de simulations qui traitent de la dynamique locale et des interactions des électrons et des ions autour d'un atome d'hélium neutre. A partir de ces simulations, nous produisons de nouveaux profils de raies améliorés, que nous comparons avec nos résultats analytiques antérieurs.

Thomas Vandal: "Imagerie interférométrique infrarouge d'exoplanètes sous la limite de diffraction avec JWST/NIRISS"

La détection d'exoplanètes par imagerie directe nous informe non seulement de la présence d'une planète, mais permet aussi de caractériser son orbite, de déterminer sa masse (si l'âge est connu) et d'étudier son atmosphère. Lorsque combinée à des mesures de masse dynamique, elle représente également une avenue privilégiée pour contraindre les mécanismes régissant la formation des planètes. Or, malgré les quelques dizaines de planètes directement imagées, la majorité des exoplanètes restent inaccessibles via cette méthode. Le télescope spatial James Webb (JWST) ouvrira la porte à l'imagerie directe de planètes de la masse de Saturne, jusqu'alors indétectables. L'utilisation de coronographes permettra d'atteindre des contrastes inférieurs à 10, mais limitera la détection à des séparations plus grandes que $\sim$400 mas, soit plusieurs fois (4-6) la limite de diffraction (λ/D). Une approche alternative à la coronographie est l'interférométrie à masque non-redondant (AMI), qui permet d'extraire des observables interférométriques robustes face aux erreurs instrumentales en plaçant un masque à la pupille du télescope. Le mode AMI du Near Infrared Imager and Slitless Spectrograph (NIRISS) atteindra des contrastes aussi bas que 10 à des séparations de allant jusqu'à 70 mas, sous la limite de diffraction. Je présenterai brièvement le mode AMI de NIRISS ainsi que sa généralisation à une pupille pleine, soit l'interférométrie par noyaux de phases (kernel phase). J'aborderai ensuite des programmes scientifiques visant à détecter des planètes géantes à courte séparation avec JWST, tant autour d'étoiles brillantes (via AMI) qu'autour de naines brunes de type Y (via les noyaux de phase).

Sebastien Vicens: "Emission line objects in NGC 4214 observed with SITELLE"

My presentation will focus on HII regions, supernova remnants and planetary nebulae in NGC4214 observed with SITELLE. I will present how HII regions were used to determine star-formation and metallicity in galaxy's studies. I will present how we separated supernova remnants from HII regions using lines ratio and kinematic. I will also present how we used the planetary nebulae newly found to determine the distance to NGC4214 using the planetary nebulae luminosity function.

Nicholas Vieira: "Spectroscopic r-Process Abundance Retrieval for Kilonovae (SPARK): Abundances and Features in the Early, Blue Ejecta of GW170817"

Freshly-synthesized r-process elements in kilonovae ejecta imprint billions of absorption lines on optical spectra, as observed in the GW170817 binary neutron star merger. These spectral features encode insights on the physical conditions of the r-process and the origins of the ejecta material, but identifying specific lines and inferring the abundance pattern is computationally challenging. We introduce Spectroscopic r-Process Abundance Retrieval for Kilonovae (SPARK), a framework to perform Bayesian inference on kilonova spectra with the goals of (1) inferring elemental abundance patterns, and (2) identifying individual absorption features in early-time, optically-thick spectra. SPARK inputs an atomic line list and abundances from nuclear network calculations into the TARDIS Monte Carlo radiative transfer code, and performs fast Bayesian inference on observed kilonova spectra by training a Gaussian process surrogate model for the approximate posteriors of key kilonova

ejecta parameters. We use the spectrum of GW170817 at 1.5 days post-merger to perform the first inference on a kilonova spectrum. We recover the previous identification of Strontium lines and also identify absorption by Yttrium at ∼3500 Å. Our inference shows that the early blue ejecta had a relatively high electron fraction, hot entropy pattern, and considerable velocity, resulting in an abundance pattern with no lanthanide elements. Our approach will enable computationally-tractable inference using spectra of the large number of kilonovae expected to be discovered through multi-messenger gravitational wave observations over the next few years.

Benjamin Vigneron: "Révéler la nature et la cinématique de la nébuleuse filamentaire de NGC 1275 avec des observations à haute résolution spectrale"

L'amas de Persée abrite une galaxie centrale massive et brillante, NGC 1275, qui possède une nébuleuse filamentaire extrêmement étendue. Les précédentes observations à basse résolution de ces filaments gazeux avec l'instrument SITELLE ont révélé une structure en vitesse chaotique. Or, ces observations n'avaient pas le pouvoir de résolution requis pour distinguer les multiples composantes de vitesse ainsi que les faibles raies d'émission telles que le doublet du S[II]. Nous avons ainsi obtenu de nouvelles observations à très haute résolution spectrale de ces filaments avec SITELLE. Néanmoins, une résolution aussi élevée nécessite une analyse minutieuse pour démêler correctement les caractéristiques spectrales appartenant aux différentes raies d'émission, mais aussi pour prendre en compte la variabilité de l'émission du ciel. En utilisant le nouveau logiciel d'analyse appelé LUCI, nous avons obtenu de nouvelles cartes de vitesse, d'élargissement et de flux de la nébuleuse filamentaire, qui nous permettront de mieux comprendre la cinématique et l'évolution de cette structure. De plus, en considérant le rapport des raies d'émission spécifiques, nous étudierons également la source d'ionisation ainsi que la densité électronique du gaz. Cela nous permettra d'étudier davantage les corrélations entre les émissions optiques et rayons X de l'environnement entourant NGC 1275.

Koichi Watanabe-Brouillette: "Détection des débris spatiaux à partir d'un ballon stratosphérique"

Le réseau de surveillance spatiale des États-Unis suit en continu environ 23 000 objets spatiaux en orbite (RSO). La détection des RSO diminue grandement avec la taille de l'objet et la réflectivité de celui-ci. Ces projectiles spatiaux à grande vitesse peuvent causer de graves dommages aux satellites et aux engins spatiaux ainsi que la croissance exponentielle des débris spatiaux. Ce projet de recherche se concentre sur la possibilité d'observation de cette population de débris, en utilisant une caméra EMCCD de l'entreprise montréalaise Nüvü Caméras avec une fréquence d'images rapide, dans le domaine du visible à partir du ballon stratosphérique HiCIBaS-II.

Charles Wilson: "Accelerating dark matter halo lensing with generative neural networks"

Strong gravitational lensing has proven to be an invaluable probe of the abundance of low mass dark matter halos, a crucial component for resolving the current "Standard Model" of cosmology's missing satellites problem. Novel approaches for the detection of the extremely faint lensing signal of such halo populations require a large number of simulations of line-of-sight halos, which become unfeasible to produce at scale. I will discuss ways in which machine learning can accelerate such simulations to make them practical. In particular, I will present the results of training generative neural networks to efficiently synthesize deflection angles of line-of-sight halos.