Canada-France-Hawaii Telescope
12th Users' Meeting
Montréal, Canada
19 - 22 May 2019
This meeting has been made possible thanks to:

Merci!
CFHT’s triennial Users’ Meetings are important opportunities for our community to share recent discoveries and perspectives that help guide CFHT’s future. The range of possible futures for CFHT has perhaps never been more diverse as we explore opportunities that will substantially define CFHT’s legacy in 21st century astronomy. Near term, CFHT’s future remains rooted in innovative operations enabling world-class surveys and PI research. Longer term, with the rapid advancement of the Maunakea Spectroscopic Explorer (MSE), CFHT is poised to make a quantum leap in its mission, becoming a truly pivotal research facility in modern astronomy. Balancing these options as we develop a strategy forward remains one of today’s challenges and will be an important topic of discussion at the Users’ Meeting. All of these possibilities are ultimately grounded in the research capabilities CFHT’s community has developed to date. These include a suite of 5 instruments that collectively enable wide field imaging and high resolution spectroscopy and spectropolarimetry at optical and infrared wavelengths, and spectro-imaging from UV to ~1 µm. Large Programs are now the focus of >50% of the observing time at CFHT and annual publication rates have never been higher, exceeding 200 papers per year. Thanks to all of these efforts, CFHT’s science impact remains among the highest of any ground based telescope in the world, year after year. Combined with its location at a premier site like Maunakea, CFHT will celebrate its 40th anniversary in 2019 in a strong position to contribute to astronomy for many years to come.

Chris Willott, Chair, CFHT Scientific Advisory Council  
Chair, UM2019 Scientific Organizing Committee

Doug Simons, CFHT Executive Director  
UM2019 Scientific Organizing Committee
## PROGRAM AT A GLANCE

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<td>8:30</td>
<td><strong>Session 1: CFHT</strong>&lt;br&gt;(Chair: Chris Willot)&lt;br&gt;Speakers: D. Simons, A. Sheinis, G. Barrick, C. Moutou</td>
<td><strong>Session 5: MSE</strong>&lt;br&gt;(Chair: Nicolas Martin)&lt;br&gt;Speakers: A. McConnachie, D. Huber, D. Haggard, M. Balogh, W. Percival</td>
<td><strong>Session 9: Maunakea Observatories</strong>&lt;br&gt;(Chair: Laura Ferrae)Speakers: R. McLaren, H. Lewis, M. Yoshida, D. Simons</td>
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<td>Time</td>
<td>Session 3: TESS / Stellar Activity (Chair: Sylvie Cabrit)</td>
<td>Discussion (Chair: Emanuele Daddi)</td>
<td>Session 11: The Milky Way and Brown Dwarfs (Chair: Anthony Boccaletti)</td>
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<td>Session 4: VESTIGE and galaxy clusters (Chair: Stéphane Courteau)</td>
<td>Session 8: Solar System and Extragalactic Astronomy (Chair: Eugene Magnier)</td>
<td>Session 12: CFHT Outreach, Publications and Output and Discussion (Chair: Jérôme Bouvier)</td>
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User Mtg. Dinner
Inspiration Room
LUNCH AND DINNER OPTIONS

Participants are free in their selection for lunch locations. On the main level of the Double-Tree by Hilton there is a food court that is perfect for lunch. The website is the following: Complexe Desjardins.

Other suggested restaurants nearby for lunch or dinner are:

- **Grinder** for lunch & dinner Mon to Fri, dinner only Sat & Sun -- 10min by car
  1708, rue Notre-Dame Ouest

- **Les Enfants Terribles** for lunch and dinner, 7 days a week -- about a 10min walk
  1, Place Ville Marie, 44th floor

- **Mercuri** lunch Mon to Fri, dinner Tue to Sat, closed on Sun -- about 10min by car
  645, rue Wellington

- **Bouillon Bilk** for lunch Mon to Fri, and dinner Mon to Sun -- about a 10min walk
  1595 Boul. St-Laurent

- **Pullman** for dinner only, 7 days a week -- 10min walk
  3424 du Parc Avenue

- **Taverne F** for lunch and dinner Tue to Fri, dinner only Sat, closed on Sun & Mon -- 4min walk
  1485 rue Jeanne Mance

- **Brasserie T** for lunch and dinner, 7 days a week -- less than a 5min walk
  1425 Jeanne-Mance st.

- **Baton Rouge Steakhouse** Mon to Fri 8h30-12h30, and 13h-17h -- less than a 5min walk
  Complexe Desjardins 180 rue Ste-Catherine Ouest

- **Sesame** for lunch and dinner, 7 days a week -- less than a 5min walk
  288, Ste-Catherine West

WIRELESS NETWORK

Wireless network: DoubleTree by Hilton Honors Meetings
Password: cfht2019
FLOOR PLAN OF THE HOTEL

<table>
<thead>
<tr>
<th>Reception and registration</th>
<th>Creation Room (6th floor)</th>
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<tr>
<td>Conference</td>
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<td>Poster room</td>
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<td>Banquet</td>
<td>Inspiration Room (6th floor)</td>
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LEVEL 6
- Creation
- Imagination
- Terrace Six
- Business Centre Concierges
- Six Resto Lounge
- Pavilion
- Inspiration
- Bar à Vin / Wine Bar
- Reception
- Terrasse des Festivals

LEVEL 5
- Symphonie 1
- Symphonie 2
- Symphonie 3
- Symphonie 4
- Symphonie 5
- Symphonie 6
- Symphonie 7
- Symphonie 8
- Petit Salon A
- Petit Salon B
- Maestro
- Foyer
- Offices
- Ovation
- Petit Soprano
- Grand Salon Opera A, B, C

LEVEL 4
- Soprano A
- Soprano B
- Soprano C
- Foyer
- Petit Soprano A

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SUNDAY MAY 19TH 2019

Starting at 4pm, participants are invited to register in the Creation Room, on the 6th floor of the hotel. A reception will be held from 4pm to 6pm for participants who have indicated their attendance to this social event.
MONDAY MAY 20TH 2019  
SOPRANO ROOM

8:30 – 8:40  
Welcome and Logistics

Chris Willott

SESSION 1: CFHT  
CHAIR: CHRIS WILLOTT

8:40 – 9:10

CFHT and MSE

Doug Simons (CFHT)

After a brief retrospective stemming from 40 years of CFHT operations is summarized, and a status report on current capabilities provided, the future of CFHT in the form of MSE will be described. Various challenges and opportunities for 21st century astronomy in Hawaii will also be presented.

9:10 – 9:30

CFHT Technical Update

Andy Sheinis (CFHT)

I will present an update to the current status and performance of the CFH telescope, instruments and associated subsystems. Included in the presentation, will be current and historical performance and engineering challenges associated with Megacam, WIRCAM, ESPaDOnS, Sitelle and SPIRou.

9:30 – 9:50

Installation and Integration of SPIRou at CFHT

Greg Barrick (CFHT)

After the acceptance review for SPIRou in Toulouse in December 2017, SPIRou was shipped to CFHT. Thanks to the tremendous efforts by the teams from L’Institut de Recherche en Astrophysique et Planétologie (IRAP - Toulouse), L’Observatoire de Haute-Provence (OHP), the National Research Council (NRC - Victoria), l’Université de Montréal (UdeM), and CFHT, the instrument has successfully progressed from delivery, to installation, to integration, and finally to functioning on-sky. The work involved in making this a reality will be presented.
Science Performances of SPIRou

Claire Moutou (CFHT)

SPIRou was received at CFHT in January 2018, and open to the community usage in February 2019. In between, the SPIRou and CFHT teams have had a long journey of remounting, aligning, testing, fine tuning, and testing again - days and nights. In this talk, we will not focus on the journey, but rather on the final result from laboratory tests and commissioning runs: the present science performances in near-infrared spectroscopy, spectropolarimetry, and high-precision velocimetry of the new most-demanded CFHT instrument, current limitations, and prospects.

The SPIRou Legacy Survey: Discovering and Exploring New Worlds with SPIRou

Jean-François Donati (IRAP / CNRS)

With 300 CFHT nights allocated over the next 8 semesters (2019a to 2022b), the SPIRou Legacy Survey (SLS), gathering a consortium of over 140 scientists worldwide, aims at achieving a breakthrough on two forefront topics using SPIRou, the nIR spectropolarimeter / high-precision velocimeter recently installed at CFHT. The SLS first aims at detecting and characterizing planetary systems around nearby M dwarfs, focusing especially on Earth-like planets located in the habitable zones of their host stars as well as on transiting planet candidates identified through photometric surveys with facilities such as K2 or TESS. Investigating the early stages in the life of stars and their planets, and in particular the impact of magnetic fields on this genesis, is the other main objective of the SLS, which comes as a logical addition to the exploration of nearby planetary systems for understanding how worlds like (and unlike) our Solar System are born. In my talk i will outline the main discoveries expected from the SLS, detail its practical implementation and give an account of the first few observations collected so far.

Know Your SPIRou Data

Etienne Artigau (Université de Montréal)

SPIRou has been offered to the CFHT community since 2019A, and PIs have started to receive their long-awaited data. The SPIRou data presents a number of peculiarities that need to be understood by users and may not be immediately obvious. I will review the SPIRou data products and explain some of the key underlying assumptions of the DRS. In particular, I will describe the telluric subtraction procedure. It is very efficient at removing telluric absorption features and
provides telluric-free spectra within the YJHK photometric band and significant portions of the inter-band domain. Nonetheless, users need to be aware of its limitations and, depending on the science goal of their observations, interpret the data accordingly.

11:30 – 11:50

Exploring the Magnetic Activity of M Dwarfs at nIR Wavelengths with SPIRou

Julien Morin (Université de Montpellier)

The new high resolution echelle spectropolarimeter at CFHT, SPIRou, is the ideal instrument to study the magnetic activity of cool stars and search for their planetary companions. Based on commissioning and early science data, we present a first overview of SPIRou capabilities for M dwarf magnetometry and discuss the potential for future improvement -- in particular with the inclusion of molecular lines in our approach. We also report on the study of chromospheric activity in the near-infrared spectral range, a largely unexplored topic so far -- especially in the K-band. Finally, we discuss the connexion between large-scale magnetic field, chromospheric activity, flares and apparent radial velocity variations in the near-infrared for active stars.

11:50 – 12:10

Simulations of SPIRou Radial Velocity Follow-ups of Transiting Exoplanets

Baptiste Klein (IRAP)

Transiting exoplanets are key targets to better understand the formation and evolution of planetary systems. On the one hand, one can estimate planetary radii using transit depths, while, on the other hand, the monitoring of the host star radial velocity (RV) with high-precision velocimeters allows to determine planetary masses. This allows for the estimation of planet bulk densities, yielding thus precious constraints on their inner compositions. However, precisely measuring the mass of earth-like planets is challenging given the low RV wobbles that they induce on the host star and the stellar magnetic activity whose RV signature frequently overwhelm the planetary signal. As a result, few planets with well-constrained bulk density populate the Mass-Radius diagram for Earth-analogs. The same goes for young close-in giants whose RV and photometric signatures are strongly inhibited by the intense magnetic activity exhibited by PMS stars. SPIRou is currently the best instrument worldwide to precisely determine the mass of transiting planetary systems around M dwarfs and PMS stars. Based on realistic simulations of RV follow-ups of TRAPPIST-1 and K2-33 planetary systems, we assess the ability of SPIRou to precisely retrieve the planet masses and show that the observational sampling plays a major role in the accuracy of the planet mass estimates for high-precision velocimeters like SPIRou.
Characterizing Hot Jupiter Atmospheres Through High Resolution Eclipse Spectroscopy

Melissa Marquette (McGill University)

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 new SPIRou spectopolimeter on CFHT, as well as our ultimate handling of the data to enable us to extract as much information as possible.

SESSION 3 - TESS / STELLAR ACTIVITY

2:00 – 2:30

Ground-based Follow-up for the Transiting Exoplanet Survey Satellite

Samuel Quinn (Center for Astrophysics, Harvard & Smithsonian)

NASA’s Transiting Exoplanet Survey Satellite (TESS) began science operations in July 2018. Over two years it will survey most of the sky in search of small planets transiting the nearest stars, the brightness of which enables studies of planetary compositions and atmospheric properties. The efficient deployment of state-of-the-art observing facilities in pursuit of such characterization, however, requires a community effort to vet planet candidates and coordinate observing resources. The TESS Follow-up Observing Program (TFOP) is a mission-organized, community-driven working group whose primary goal is to deliver such coordination. In this talk, I will describe the TESS mission and highlight science results from its first six months while I describe the role TFOP plays in planet discoveries and characterization.

2:30 – 2:50

Investigating the Magnetism and Activity of Epsilon Eridani

Pascal Petit (Observatoire Midi-Pyrénées)
We report on observations of the active K2 dwarf epsilon Eridani, obtained in 2018 in near simultaneity with SPIRou, NARVAL, and TESS. Near infrared spectropolarimetry with SPIRou was obtained over 4 nights in late September, while the visible NARVAL time series extends from 18 Sept to 07 Nov. The photometric monitoring with TESS was secured between 19 Oct and 15 Nov. We first recover the fundamental parameters of the target from both visible and nIR spectral models. The large-scale magnetic field geometry is then investigated from SPIRou and NARVAL polarimetric data, as well as its short term evolution under the effect of surface differential rotation. From unpolarized spectra, we also estimate the total magnetic flux through Zeeman broadening (using magnetically sensitive nIR lines) and the chromospheric emission (using nUV CaII line cores). We finally model the TESS light curve with pseudo-periodic Gaussian Process Regression. After detailing the outcome of this very diverse view of the photospheric and chromospheric activity of epsilon Eridani, we discuss the phase dependence of all magnetic measurements and activity proxies.

2:50 – 3:10

**Synergies Between CFHT and TESS**

Alexandre David-Uraz (University of Delaware)

In this presentation, I will discuss various possible synergies between CFHT facilities and ongoing space-based missions such as TESS. In particular, I will focus on the MOBSTER project (Magnetic OB[AR] Stars with TESS: probing their Evolutionary and Rotational properties), presenting early results and discussing a larger observational strategy that leverages the exquisite photometry obtained with TESS to extend prior magnetic surveys carried out with ESPaDOnS in a very cost-effective manner. Studies of magnetism in OBA stars, especially at the higher-mass end, are severely hampered by small-number statistics; our proposed approach will address that problem.

3:10 – 3:30

**Magnetic Fields Evolution During Stellar Formation at Intermediate-mass Stars**

Evelyne Alecian (IPAG - Université Grenoble Alpes)

Magnetic fields in main-sequence intermediate-mass stars are rare (less than 10%) and are most likely shaped during star formation. To better understand the origin of those fossil fields we aim at analysing the magnetic properties of the evolutionary precursor of those stars. I will present recent results on an ESPaDOnS survey of intermediate-mass T Tauri stars, as well as our current conclusions on magnetic field evolution during the pre-main-sequence phase. I will also discuss how SPIRou can help us to provide additional constraints on theories for the origin of magnetic fields in intermediate-mass stars.
Activity and Close-in Giant Planets of Weak-line T Tauri Stars

Louise Yu (IRAP)

Magnetic fields are believed to play a major role in the early life of sun-like stars and in the early evolution of their planetary systems. The MaTYSSE programme investigates the magnetic topologies of young sun-like stars and probes the presence of hot Jupiters around them through spectropolarimetric observations carried out among others with ESPaDOnS. We report the analysis, performed within the frame of MaTYSSE, of a 7-year spectropolarimetric monitoring of the ≤ 1 Ma weak-line T Tauri star (wTTS) V410 Tau. With Zeeman-Doppler Imaging (ZDI), we mapped the surface brightness distribution and magnetic topology and we constrained its differential rotation. We modeled the activity jitter in the radial velocity (RV) curve using ZDI and Gaussian Process Regression. Long-term trends appear in the magnetic properties of the star and the periodicity cycle in various activity proxies, potentially indicating the presence of a cycle over a several-year time scale. The bulk RV of V410 Tau also increases over the years, which could be the signature of its stellar companion. We will also present preliminary results for the 2017a spectropolarimetric data of the wTTS TAP 26, for which a young hot Jupiter was previously detected.

VESTIGE: A Virgo Environmental Survey Tracing Ionised Gas Emission

Alessandro Boselli (LAM Marseille)

I will introduce the VESTIGE survey, a blind, narrow-band Halpha imaging survey carried out with MegaCam at the CFHT (2017-2019 French-Canadian Large Program) to map the whole Virgo cluster region up to one virial radius. This survey has been designed to study at an unprecedented sensitivity (SHa ~ 2 x 10^{-18} erg sec^{-1} cm^{-2} arcsec^{-2}) and angular resolution (< 1 arcsec) the effects of the environment on cluster galaxies through the observation of the ionised gas component, ideal tracer of an ongoing perturbation. I will summarise the first results obtained after the first observing semesters based on the analysis of the core of the cluster and of some representative objects undergoing different kind of perturbations.

Synergies between surveys. The case of M87 and NGC 4424

Philippe Amram (LAM Marseille)

The Ha [NII] narrow band imaging survey of the Virgo cluster, VESTIGE, carried out at the CFHT, revealed the presence of extended tails of ionised gas associated to galaxies of different nature (ellipticals, spirals, starburst, tidally disrupted objects) undergoing an interaction with the
surrounding environment or with nearby companions. The observation of these extended structures with large field-of-view spectro-imagers like SITELLE@CFHT, GHASP@OHP, and MUSE@VLT allows a detailed analysis of the kinematical and physical properties of the gas, crucial for understanding the nature of the perturbing mechanism. I will describe the 2D spectroscopic observations of two representative galaxies with extended tails of ionised gas detected by VESTIGE: - the elliptical galaxy M87, which hosts a filament of ionised gas crossing the galaxy and extending over more than 20 kpc probably formed after a minor merging episode with a low mass, gas rich system; - the intermediate mass edge-on star forming spiral NGC 4330 currently falling into the core of the Virgo cluster, exhibiting a peculiar filamentary structure in addition to its 10 kpc low surface brightness tail and - the peculiar galaxy NGC 4424, where a filament of ionised gas is detected perpendicular to the galaxy disc in the direction opposite to the 110 kpc long tail of HI formed by a ram pressure stripping event. I will also briefly describe our strategy plan to apply to spectro-imagers such as SITELLE and other facilities for follow-up observations of interesting and representative galaxies detected by VESTIGE. We expect to complete the sample of cluster objects with the purpose of studying the effects of the environment on the kinematical properties of galaxies with different morphological type and stellar mass.

4:50 – 5:10

VESTIGE: A Unique Dataset to Study the Role of the Environment in the Production of Long Tails

Alessia Longobardi (LAM Marseille)

Structure evolution is now understood to be the products of a Hubble time's worth of merging, accretion, and interaction with the surrounding environment. This history is hidden, however, being quickly mixed into a smooth and apparently featureless distribution of baryons, or by being at surface brightness much fainter than the sky. Owing to its superior sensitivity VESTIGE (Virgo Environmental Survey Tracing Ionised Gas Emission) is a MegaCam@CFHT deep Hα narrow-band imaging survey of the Virgo cluster that offers a unique tool to investigate the regions in space hosting fossil records of structures evolution. The focus of this talk will be on the VESTIGE team effort of studying low surface brightness tails of stripped material through their ionised gas emission (Hα) that also present HI (neutral) and FIR (dust) emission. I will show the analysis for a sample of tens of Virgo galaxies, from the core to the less dense regions of the cluster, and the investigation of the physical conditions necessary for the long tails to be present in the two different gas phases (neutral, ionised) and to fuel star formation. Is there a preferred environments or are there peculiar requirements on the progenitors properties or encounter characteristics to trigger such a phenomenon? Thanks to its depth and extension (covering out to one virial radius) VESTIGE revealed for the first time long tails of ionised gas in several cluster galaxies. Moreover, capitalising on the wealth of multi-frequency data surveying Virgo at good/optimal resolution and sensitivity - e.g., VIVA Survey (VLA Imaging of Virgo in Atomic gas) and Herschel Virgo Cluster Survey (HeVICS) -, it provides the unique data-set to answer these questions.
Novel Observations of the Optical Nebulae in Brightest Cluster Galaxies

Julie Hlavacek-Larrondo (Université de Montréal)

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. Here, we present novel observations of the giant filamentary nebula surrounding NGC 1275, the brightest cluster galaxy in the Perseus cluster. Through SITELLE/CFHT observations, we produce for the first time a Ha 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 the heating and cooling mechanisms of the hot intracluster medium.
SESSION 5 – MSE

8:30 – 9:00

The Science and Status of the Maunakea Spectroscopic Explorer

Alan McConnachie (NRC Herzberg)

The Maunakea Spectroscopic Explorer will be the world’s only fully dedicated large aperture multi-object spectroscopic facility when it enters science operations at the end of the 2020s. It is now entering the Preliminary Design Phase after a very successful System Conceptual Design Review in 2018, which saw major design advances for the entire system across the international partnership. I will present an overview of the scientific, technical and partnership development of this ambitious reimagining of the iconic Canada-France-Hawaii Telescope.

9:00 – 9:15

Stellar Astrophysics and Exoplanet Science with the Maunakea Spectroscopic Explorer

Daniel Huber (University of Hawaii)

The Maunakea Spectroscopic Explorer (MSE) is a planned 11.25-m aperture facility with a 1.5 square degree field of view that will be fully dedicated to multi-object spectroscopy. A rebirth of the 3.6m Canada-France-Hawaii Telescope on Maunakea, MSE will use 4332 fibers operating at three different resolving powers (R ~ 2500, 6000, 40000) across a wavelength range of 0.36-1.8mum, with dynamical fiber positioning that allows fibers to match the exposure times of individual objects. MSE will enable spectroscopic surveys of stars with unprecedented scale and sensitivity by collecting millions of spectra per year down to limiting magnitudes of g ~ 20-24 mag, with a nominal velocity precision of ~100 m/s in high-resolution mode. In this talk I will describe science cases for stellar astrophysics and exoplanet science using MSE, including the discovery and atmospheric characterization of exoplanets and substellar objects, stellar physics with star clusters, asteroseismology of solar-like oscillators and opacity-driven pulsators, studies of stellar rotation, activity, and multiplicity, as well as the chemical characterization of AGB and extremely metal-poor stars.
9:15 – 9:30

Time Domain Science with MSE

Daryl Hagga (McGill University)

The multiplexing capability of MSE enables novel science not just in spatial coverage, but in the time domain as well. Time domain (synoptic) astronomy enables investigation of periodic (e.g., binaries/exoplanets, pulsation), evolutionary (e.g., post explosion supernovae) and bursting behaviour (e.g., flares, CV novae), solar system moving objects (e.g., main-belt and more distant asteroids, trans-Neptunian objects), as well as astrophysical transients (e.g., supernovae, kilonovae, neutron star mergers, gravitational wave electromagnetic counterparts, fast radio bursts), on time scales from minutes to years. I will outline the activities of the MSE’s Time Domain Science Working Group, briefly describe the important contribution MSE can make to these exciting, rapidly evolving research areas, and discuss the observing strategies needed to maximize science from this wide range of variable and transient astrophysical sources.

9:30 – 9:45

Galaxy Formation and Evolution with MSE

Michael Balogh (University of Waterloo)

The Maunakea Spectroscopic Explorer is perfectly designed to enable transformational advances in our understanding of galaxy formation and evolution. I will present highlights from the Detailed Science Case, including the potential for IGM tomographic mapping, halo occupation modeling, evolution within galaxy clusters and large scale structure, and a detailed look at galaxy properties ranging from dwarf galaxies to the rarest, most massive galaxies in the Universe.

9:45 – 10:00

The MSE high-z Cosmology Survey

Will Percival (University of Waterloo)

The Maunakea Spectroscopic Explorer (MSE) has the potential to perform a cosmologically focussed galaxy redshift survey over a large volume of the Universe (280 Gpc^3), with a galaxy density sufficient to measure the extremely-large-scale density fluctuations required to explore primordial non-Gaussianity and therefore inflation. We present the MSE High-z Cosmology Survey, which will provide a measurement of the level of non-Gaussianity as parameterized by the local parameter f_{nl} to a precision /-1.8. Combining the MSE High-z Cosmology Survey with data from a next generation CMB stage 4 experiment and existing DESI data will provide the first 5sigma confirmation of the neutrino mass hierarchy from astronomical observations. Only combining the data from the MSE High-z Cosmology Survey together with Planck provides a 4sigma neutrino mass measurement. In addition, the Baryonic Acoustic Oscillations (BAO) observed within the sample...
will provide measurements of the distance-redshift relationship in six different redshift bins between $z=1.6$ and 4.0, each with an accuracy of $\sim0.6\%$. These high-redshift measurements will provide a probe of the Dark Matter dominated era and test exotic models where Dark Energy properties vary at high redshift. The simultaneous measurements of Redshift Space Distortions (RSD) at redshifts where Dark Energy has not yet become important directly constrain the amplitude of the fluctuations parameterized by $\sigma_8$, at a level ranging from $1.9\%$ to $3.6\%$ for the same redshift bins.

10:00 – 10:10

Discussion

SESSION 6 – SITELLE

10:40 – 11:00

News from SITELLE

Laurent Drissen (Université Laval)

I will present a summary of SITELLE's recent science results and engineering activities.

11:00 – 11:30

The SIGNALS Legacy Survey: On the Birth of Stars in the Nearby Universe

Laurie Rousseau-Nepton (CFHT)

SIGNALS, the Star formation, Ionized Gas, and Nebular Abundances Legacy Survey, is based on a volume-limited sample of local extended galaxies ($D<10$ Mpc) that are actively forming massive stars. The project got awarded 54.7 nights of telescope time with SITELLE for the next four years to come. SITELLE is the most efficient instrument to conduct such a survey. It is currently and by far the biggest IFU in the world (i.e. largest FOV). Once completed, SIGNALS will provide the largest, most complete, and homogeneous database of spectroscopically and spatially resolved extragalactic HII regions ever assembled with over 50,000 resolved HII regions. By studying the spectra of spatially-resolved individual HII regions and their massive star content, SIGNALS aims for understanding how diverse local environments (nearby stellar population mass and age, gas density and chemical composition, dynamical structures, etc.) affect the star formation process. In this talk, I will present an overview of the survey.
Dancing Infrared-Bright Galaxies: Optical Imaging Fourier Transform Spectroscopy with SITELLE of the Galaxy Merger II Zw 96

Andreea Petric (CFHT)

Nearby Luminous Infrared Galaxies provide a window into the fate of galaxies at higher redshifts when gravitational interactions between gas-rich galaxies may have created today’s big ellipticals. II Zw 96 is Luminous Infrared system of merging galaxies, with global star-formation rates an order of magnitude larger than those of the well-studied merger system — the Antennae. Combined HST and Spitzer data suggested that 80% of the II Zw 096’s IR emission comes from a small (~1 kpc) off-center region (region D). SITELLE provides high-resolution 3D spectroscopic data which we use to measure the kinematics and morphology of the ionized hydrogen, measure extinction corrected star-formation rates, and suggest a solution for the mystery of region D.

A 3D view of the Crab Nebula with SITELLE

Thomas Martin (Université Laval)

The Crab Nebula (M1) has been observed with SITELLE as an engineering data cube to verify test SITELLE’s ability to reach a spectral resolution of R=10 000. We will show that it is indeed the case by presenting the first complete mapping of the [NII], Hα and [SII] lines (SN3 filter) of the Crab at such a resolution. A novel deconvolution technique, reaching sub-km/s uncertainty, reveals a complex filamentary structure surprisingly inhomogeneous in terms of physical conditions. Combining SITELLE’s kinematics with long-term HST imagery allows us to reveal the spectacular 3D shape of the Crab.

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.
SESSION 7 - MAGNETIC STARS/INSTRUMENTATION DISCUSSION

CHAIR: EMANUELE DADDI

1:50 – 2:20

**Magnetism in Hot Stars**

Coralie Neiner (LESIA - Paris Observatory)

will review our current knowledge of magnetism in hot stars, in particular the origin and occurrence of magnetic fields in these stars, as well as the impact of the magnetic fields on stellar structure, evolution, and circumstellar environment. A particular focus of this review will be on results obtained with ESPaDOnS in the last few years.

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2:20 – 2:35

**The Magnetospheres of the Early B-type Stars**

Matthew Shultz (University of Delaware)

Magnetic confinement of the radiative winds of hot stars leads to the formation of magnetospheres. Centrifugal support of the corotating plasma sculpts these magnetospheres into warped Centrifugal Magnetospheres (CMs), a phenomenon predominantly seen in early B-type stars. CMs bear a surprising resemblance to the magnetospheres of giant planets, and the large sample size as compared to solar system gas giants, and relative ease of observation of CMs as compared to exoplanetary magnetospheres, makes them excellent laboratories for plasma physics. ESPaDOnS has been the keystone instrument in observing and understanding CM host stars. In this talk, I discuss what we have learned about the magnetic, rotational, stellar, and evolutionary properties of CM host stars, how CMs are affected by binarity, and describe ongoing efforts to use CMs to probe plasma transport processes under extreme rotational and magnetic conditions.

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2:35 – 2:50

**Studying Weak Magnetic Fields in White Dwarf Stars with ESPaDOnS**

John Landstreet (University of Western Ontario)

Almost 50 years after the first discovery of a 300 MG magnetic field in a white dwarf (WD), little is known about fields weaker than about 1 MG. We have found that ESPaDOnS is a powerful tool for searching for and studying such fields in the brighter WDs (V < 15). We have set an upper limit of ~200 G for a possible surface field on the brightest isolated WD, 40 Eri B. We have surveyed several dozen WDs with uncertainties of a few kG or less in the longitudinal fields, and discovered weak fields in WD2047 372 and WD1105-340. We have used ESPaDOnS data to find rotation periods and to model the surface fields of WD2047 372 and WD2359-434, and have data for further
modelling. ESPaDOnS is able to compete effectively even with the FORS spectropolarimeter on an 8-m ESO telescope.

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2:50 – 3:50

**CFHT Instruments Usage and Discussion**

Daniel Devost & Andy Sheinis (CFHT)

With the arrival of SITELLE in 2016 and SPIRou two years later, CFHT is now operating five instrument in QSO mode. This is the highest number of instruments ever operated in this mode by the observatory. This bring more science capabilities to the observatory but also has its operating challenges. In this talk, I will first present each instrument science niche(s) and how they are used by each agency. In the second part of the talk, I will present the difficulties of operating five instruments in QSO mode. In particular, I will focus on the potential paradigm shift brought by SPIRou operations. The large amount of time constraints observations needed by exoplanet observations is hard to meet in single instrument mode given the large amount of resources needed and the risks associated with instrument exchanges.

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**SESSION 8 - SOLAR SYSTEM AND EXTRAGALACTIC ASTRONOMY**

**CHAIR: EUGENE MAGNIER**

4:10 – 4:40

**Outer Solar System through Characterized Surveys: Missing Small Members of the Haumea Family**

Rosemary Pike (ASIAA)

The Outer Solar Systems Origins Survey Ensemble includes OSSOS, the Alexandersen (2016) Survey, and CFEPS HiLat, four large surveys optimized for Trans-Neptunian objects (TNO) detection. Critically, the observational biases of the surveys were well documented, so the intrinsic populations of distant TNOs can be modeled. Three TNOs were discovered with orbital parameters consistent with the Haumea family, the only known collisional family in the Kuiper belt. These three objects have ejection velocities \( \Delta V < 160 \text{ m/s} \); the majority of TNOs discovered within this space are Haumea family members. 2013 UQ15 is conclusively a Haumea family member, with a \( \Delta V = 37 \text{ m/s} \) and solar colors, and is the largest of the three family member candidates. Although OSSOS is sensitive to Haumea family members to a limiting Hr absolute magnitude of 9.5, the smallest of these three objects is Hr = 7.9. If these objects share an absolute magnitude distribution with the other dynamically excited populations in the Kuiper belt, small Haumea family members Hr > 8 should account for ~50% of the detections. This requires that the Haumea family be characterized by a single shallow H-distribution slope; our preferred slope is \( \alpha = 0.3 \). Using the three OSSOS Ensemble detections and survey characteristics with this H-distribution and a model of the Haumea family orbital distribution, we determine that the stable non-resonant Haumea family has...
450 (-390 720) members with Hr<9.5 and ΔV<160 m/s. Assuming these objects have a density of water ice, albedos of 80%, and estimating the loss due to unstable or resonant family members, we estimate that the cumulative mass of the original Haumea family was about 3% of the present mass of Haumea.

4:40 – 5:00

The Role of CFHT in the Discovery and Early Characterization of `Oumuamua

Richard Wainscoat (University of Hawaii)

The first interstellar object, `Oumuamua, was discovered by the Pan-STARRS1 telescope on October 19, 2017. Followup observations obtained with CFHT immediately afterwards played a key role in establishing the orbit as hyperbolic, and clearly showed that the object had a point-like appearance. Subsequent photometric observations showed that the object had a dramatic light curve implying a shape unlike most objects in our solar system. Prospects for the discovery of additional interstellar objects will also be discussed.

5:00 – 5:15

The discovery of H3+ in the auroral regions of Jupiter

Jean-Pierre Maillard (IAP)

2019 marks the 30th anniversary of the publication in Nature of the unexpected discovery of the molecular ion H3 in Jupiter southern aurora, made possible thanks to the unique capabilities of high resolution and broad spectral coverage in the infrared of the FTS, part at that time of the CFH instrumentation. The identification of more than 30unknown lines, recognized after several months of work as belonging to the 2ν2 band of H3 at 2.3 μm, never observed before, even in lab, was the result of a broad and impromptu collaboration. It implies observers, laboratory spectroscopists, specialists of planetary atmospheres and molecular physicists, within the CFH community and beyond. The discovery of this active ion was at the origin of many following works in planetary astronomy with the FTS and on other ground-based IR telescopes as well as in space (Galileo, Cassini), which continue currently with Juno, and also on star formation as H3 plays a crucial role in the chemistry of the diffuse and dense interstellar clouds. This talk would aim at presenting an important page of CFHT history.
Quasar Reverberation Mapping with Photometry and Spectroscopy

Pat Hall (York University)

From 2014 to 2017, a photometric survey was conducted for 850 quasars as part of the SDSS Reverberation Mapping (SDSS-RM) project. While a spectroscopic survey was conducted at Apache Point Observatory to monitor emission line flux changes, continuum flux changes were monitored with a photometric survey conducted at CFHT during dark time and at the Steward Observatory Bok Telescope during bright time. The time delay between continuum and emission-line flux variations measures the size of the emission line region, which when combined with the velocity width of the line yields a black hole mass. This combined photometric and spectroscopic survey is the first of its kind for a large sample of quasars. I will discuss key results from the SDSS-RM project, which has been invaluable for studies of the structure and physics of broad-line regions of AGNs.

On the Environment- and Mass-driven Quenching of the Star Formation in Galaxies

Thibaud Moutard (SMU)

The fact that galaxies can be classified between “blue/star-forming” and “red/quiescent” populations is now well established and this bimodality, clearly observed to redshift z~4, is the statistical expression of a (rapid) phenomenon called “quenching”. The processes that are involved in the quenching of low-mass galaxies may, however, be quite different from what is involved in the quenching of massive galaxies after billion years of star formation on the main sequence. I will present a review of results we obtained regarding the connection between the regulation of the star formation histories of galaxies and large-scale structures on the basis of extensive use of $u$-to–$K_s$ imaging from the Canada-France-Hawaii Telescope (CFHT) over $\sim$27 deg$^2$, as part of the VIPERS Multi-Lambda Survey. In particular, I will discuss the different quenching channels that can be identified between star-forming and quiescent galaxies in the rest-frame $NUV-r$ vs. $r-K$ colour ($NUVrK$) diagram: 1) the slow quenching channel followed by evolved and massive galaxies, typically when their stellar masses reaches $M^*$ ($\sim 10^{10.6} M_\odot$), which is consistent with a critical dark-matter halo mass of $M_h$ ($\sim 10^{12} M_\odot$), and 2) the fast quenching channel affecting young low-mass ($\leq 10^{9.6} M_\odot$) quiescent galaxies and responsible for the low-mass upturn observed in the stellar mass function of quiescent galaxies. I will notably show how the quenching of low-mass galaxies is consistent with being driven by environment in addition to being fast, and I will discuss how the slow and mass-related quenching of $M^*$ galaxies may preferentially happen along cosmic filaments.
STARTING AT 6:30
MEETING DINNER IN THE INSPIRATION ROOM, ON THE 6TH FLOOR OF THE HOTEL
A CELEBRATION OF THE RENÉ RACINE’S CAREER
SESSION 9 - MAUNAKEA OBSERVATORIES

8:30 – 8:55

The University of Hawaii Perspective

Robert McLaren (University of Hawaii)

8:55 – 9:20

W. M. Keck Observatory Update

Hilton Lewis (WMKO)

The Director of the Keck Observatory will provide an update on current technological upgrades and new instrumentation under development at Keck. Hilton will speak about how Keck is addressing its scientific community’s needs in the area of time domain astronomy (both cadence observing and target of opportunity). Hilton will also talk about how the Keck Visiting Scholars Program, now in its third year, is helping both Keck and these early-career scientists succeed.

9:20 – 9:45

Updates from Subaru

Michitoshi Yoshida (Subaru)

9:45 – 10:10

Future of Maunakea Observatories

Doug Simons (CFHT)

After a brief retrospective stemming from 40 years of CFHT operations is summarized, and a status report on current capabilities provided, the future of CFHT in the form of MSE will be described. Various challenges and opportunities for 21st century astronomy in Hawaii will also be presented.
SESSION 10 – CFIS

10:50 – 11:20

**Status of the Canada-France Imaging Survey (UNIONS)**

Jean-Charles Cuillandre / Alan McConnachie (CEA Saclay / NRC Herzberg)

The Canada-France Imaging Survey (CFIS) is a legacy survey that aims at some of the most fundamental questions in astronomy: the properties of dark matter and dark energy, the growth of structure in the Universe from Galactic to cluster scales, and the assembly of the Milky Way. The CFIS community has now joined forces with University of Hawaii colleagues (Pan-STARRS) to create UNIONS, a collaboration to further enrich the scientific potential of this combined unprecedented deep imaging survey of the northern sky. This talk will present the observing status of the CFHT Large Program CFIS operating on MegaCam and an overview of its on-going scientific activities. Surveys composing UNIONS are motivated in part by the ESA Euclid space mission: this talk will in consequence present the big picture of the project and how UNIONS-CFIS articulates with the overall ground-based effort.

11:20 – 11:40

**Pan-STARRS Contributions to the UNIONS Collaboration**

Eugene Magnier (University of Hawaii)

The UNIONS Collaboration will combine deep imaging data from CFHT and the Pan-STARRS telescopes. The Canada-France Imaging Survey (CFIS) is obtaining deep u-band images of 10,000 square degrees of extragalactic sky in the northern hemisphere and deep r-band images of 5000 square on the northern Galactic cap. Pan-STARRS, while searching for potentially hazardous asteroids, is on track to accumulate deep imaging of more than 3/4 of the full sky in w- and i-band, with deep z-band imaging for the northern Galactic cap. In this talk I will discuss the current status and future roadmap for the Pan-STARRS portion of this collaborative survey.
11:40 – 12:00

Weak Lensing in the Canada-France Imaging Survey

Mike Hudson (University of Waterloo)

The Canada-France Imaging Survey, by virtue of its wide area coverage and overlap with SDSS spectroscopy enables unique science: weighing the masses of cosmic web filaments, the tidal stripping of dark matter halos, the emptiness of voids and tests of General Relativity. I will discuss these goals, our customized weak lensing analysis pipelines and present first weak lensing results from the survey.

12:00 – 12:20

Strong Lensing Events in the CFIS Survey and Weak Lensing Cluster Masses from Archival CFHT Imaging Data

Raphael Gavazzi (IAP)

I will present ongoing work on the CFIS imaging data in which we automatically search galaxy-scale strong lensing events as a probe of the small scale mass content of galaxies. On larger cluster of galaxies mass scales, I will present results on the systematic analysis of archival CFHT/Megacam (and Subaru/Suprimecam) images. Weak lensing masses for ~120 clusters are obtained hence allowing very accurate calibration of cluster mass proxies, like SZ or X-rays.

12:20 – 12:40

Structural Properties of Dwarf Galaxies in the MATLAS Low Density Fields

Melina Poulain (University of Innsbruck)

The MATLAS survey, aimed at studying the outer most regions and surroundings of a complete sample of nearby field early type galaxies, has produced deep multi-band optical images with limiting surface brightness down to nearly 29 mag/arcsec² in the g band. Such images obtained with MegaCam on the CFHT have optimal conditions (large scale of view, high sensitivity) for dwarf galaxies detection. We have made a systematic survey of the dwarf galaxy satellites located within 150 fields of one square degree each. Based on semi-automatic detection algorithms, the MATLAS dwarf catalog consists of 2210 dwarf galaxies situated in low density environments. Distances have been determined for 13.5% of our sample and confirm the dwarf nature of our candidates, as well as their association with the host galaxy. Assuming for all the dwarfs a distance corresponding to that of their host, we derive their basic properties - color, mass, Sersic index, effective radius, nucleation, morphology - and their variation with environment. We find in these low density fields a majority of dwarf ellipticals, and a significant fraction of nucleated ones, as well as ultra diffuse galaxies.
Reconstructing the Milky Way using its Stellar Graveyard

Nicholas Fantin (University of Victoria)

As the remnants of stars with initial masses less than ~8-10 M\(_\odot\), 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.

Mining and Mapping the First Generations of Stars with the Pristine CaH&K Survey at CFHT

Nicolas Martin (Observatoire Astronomique de Strasbourg)

I will present the ongoing Pristine survey, a Franco-Canadian photometric survey of the Milky Way halo performed with the new CaHK filter on CFHT’s MegaCam. Currently covering ~5,000 deg\(^2\), this survey leads to an efficient metallicity decomposition of the Milky Way halo. In particular, I will show how efficient Pristine is in selecting the metal-poor end of the metallicity distribution ([Fe/H]<-2.5) to hunt for the very rare extremely metal-poor stars (bearer of the chemical imprint of the first stars). Our spectroscopic follow-up campaign shows Pristine is very efficient at selecting very metal-poor stars from our photometry alone and we are building a large and unique sample of these stars. A dedicated part of the survey also focuses on the enigmatic very faint (and therefore metal-poor) Milky Way dwarf galaxies found over the last decade. I will show how efficient Pristine is at isolating likely member stars and how it opens a well-needed window onto the detailed study of these systems that are often used as near-field cosmological probes.
CFHT Infrared Parallax Program

Trent Dupuy (Gemini North)

Trigonometric parallaxes are critical for establishing the fundamental properties of astronomical objects. Since 2007, we have been using CFHT’s near-IR imager WIRCam to obtain high-precision parallaxes of low-mass stars, brown dwarfs, and planetary-mass objects. Our program is the longest continuously running infrared parallax program in the world, starting as an IfA/Hawaii observing program and continuing now as a CFHT Large Program. Thanks to Maunakea’s seeing, CFHT’s queue observing, and WIRCam’s stable high-quality imaging, we achieve astrometry comparable to the best long-term optical parallax programs, but observing in the infrared allows us to study objects of much cooler temperatures, lower luminosities, and lower masses. I will review the wide-ranging science results from our program: the discovery and characterization of the youngest and the coldest brown dwarfs, testing theoretical models using dynamical masses from substellar binaries, the first empirical determination of the stellar/substellar boundary, establishing the properties of low-mass stars hosting Kepler exoplanets, and potential new studies based on our unique record of long-term (10 year) astrometry. Finally, I will discuss the vital role that CFHT astrometry can continue to play in the era of Gaia and JWST.

Planetary-mass Objects in Taurus Found through a Water-band Imaging Survey

Loic Albert (Université de Montréal)

Are star formation processes able to form very-low mass stars down to the planetary regime mass? If the Local neighborhood (<20 pc) is any indication (Kirkpatrick et al. 2018) then star nurseries should abound with objects of a few to tens of Jupiter masses. When looking at the closest star-forming region (SFR), Taurus, the most sensitive surveys to date instead suggest a declining initial mass function towards low-mass objects. Some of this tension may be real, but some probably comes from observational completion limits being in the 20-40 Jupiter mass range (Luhman et al. 2017). Photometric surveys for red, low-mass, objects in SFRs yield IMFs that are very dependent on the adopted color cuts and extinction correction (Cook et al. 2017). We made use of a novel photometric technique with WIRCam at CFHT - it uses a custom made W filter (W for water) centered on the deep water vapor absorption band at 1.45 microns. Coupled with simultaneous J and H-band imaging to sample the pseudo-continuum, J-W and H-W colors become an extinction-free water-band measurement. We embarked on a 25 square degree survey of Taurus and, after spectroscopic follow-up with Gemini and IRTF, confirmed several tens of objects consistent with being as small as 4-5 Jupiter masses. This is more objects than were expected from a log-normal IMF and better fits an exponential IMF.
SESSION 12 - CFHT OUTREACH, PUBLICATIONS AND OUTPUT, AND DISCUSSION
CHAIR: JÉRÔME BOUVIER

4:00 – 4:30

**CFHT Outreach**

Mary Beth Laychak (CFHT)

The Canada-France-Hawaii Telescope serves a diverse audience of astronomers and the general public in five countries: Canada, France, Hawaii (US), Taiwan, and China. The observatory’s goals are ambitious; unlike other multi-national institutions pursuing a dynamic outreach presence, CFHT is a smaller facility with fewer staff fully devoted to public outreach. Through a combination of online engagement, innovative local outreach programming, and partnerships with users and stakeholders in constituent communities, CFHT maximizes its outreach impact. We will discuss our success, challenges, and lessons learned from our experiences coordinating activities and events in three diverse locations: Hawaii, Canada and France.

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4:30 – 4:45

**CFHT's Publication History: 40 Years of High Impact Science**

Dennis Crabtree (NRC Herzberg)

CFHT has an enviable bibliography of refereed papers. Data from the telescope has produced high impact papers over all of it’s 40 year history. CFHT has leveraged an excellent site, innovative and powerful instrumentation and a strong scientific vision to be one of the world’s leading telescopes. In this talk I will explore CFHT’s publication performance over (almost) 40 years and compare this performance to other telescopes.

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4:45 – 5:15

**Discussion and Wrap-up**
1 - MegaCam: Replacing the Controller Data Link System

Kevin Ho (CFHT)

MegaCam uses a proprietary optical fiber link interface, known as SLINK, to transmit pixel data from the CCD controller to the host computer. The interface specification was first described by CERN back in 1995 and the interface hardware currently installed in MegaCam was built soon after. The interface hardware is now over twenty years old and unfortunately has been failing over the past few years. The number of spare boards has dwindled below an acceptable level to support MegaCam. The boards, their upgrades and parts are obsolete and no longer attainable. We have embarked on a project to replace the SLINK interface with a GigE interface, the hardware of which is readily available on the market. The GigE interface will simplify the hardware on both the CCD controller and host computer ends, improve MegaCam’s reliability, and extend its operability beyond its life at CFHT. MegaCam performance should not be affected by the change.

2 - WIRCam Filter Wheel Failure

Greg Barrick (CFHT)

After over a decade of flawless operation, one of the filter wheels on WIRCam failed on 4 September 2017. The problem was traced to one or more of the sapphire ball bearings used in the filter wheel fracturing. The repair of this issue will be described.

3 - Lightning Strike and Recovery of ESPaDOnS and GRACES

Greg Barrick (CFHT)

On 19 August 2018 during the Venus observations, a lightning strike caused the failure of the majority of the motors on the ESPaDOnS/GRACES spectrograph. The efforts to continue observations in the short term and to fix all of the systems in the longer term will be described.
4 - Preparing SITELLE for Astronomy’s Roaring Decade

Marc Baril (CFHT)

The SITELLE imaging Fourier transform spectrograph continues to achieve impressive science results, standing in a class of its own in terms of simultaneously delivering a wide field of view (10.5’ square), and a well-matched mid-range resolving power (R=2000-4000, typical). This presentation will outline improvements made to the instrument since its arrival at CFHT in the summer of 2016. The emphasis will be on recent work to improve the image quality of the instrument, as well as plans to improve the stability of the metrology and servo system of the interferometer scanning mirror. We anticipate that the combination of an IQ that will take better advantage of the exceptional seeing on Mauna Kea, and a more stable metrology system that will both benefit operational stability and characterization of the science results, will allow SITELLE to fully achieve and even exceed the goals set out at its inception, securing its place in the next decade of astronomy.

6 - The SPIRou DRS

Neil Cook (Université de Montréal)

SPIRou is the first NIR instrument to reach a radial velocity precision of 2 m/s (targeting 1 m/s). This has meant many challenges in terms of the data pipeline. The SPIRou pipeline was based on the HARPS/SOPHIE pipeline but has undergone huge changes to be suitable for the NIR especially in terms of the H4RG detector, the optical design of SPIROU, the tellurics, and the wave solution. As well as this much effort has be put into making the pipeline more efficient, user friendly and adaptable.

7 - Successes and Challenges of Large Programs at CFHT

Daniel Devost (CFHT)

CFHT has been conducting projects that involve a significant amount of telescope time coming from multiple partners and spread over several years since the start of the Canada-France-Hawaii Legacy Survey in mid-2003. Since then, a total of 16 Large Programs that totaled more than 1400 Nights allocated. LPs are expected to have a high scientific return but are hard to complete because of the need for good image quality and dark skies. CFHT’s QSO mode allows for great flexibility for the scheduling of the programs and a high completion rate. It is however difficult to complete deep extragalactic surveys. These often require good weather conditions and dark time which are in high demand. I will present the scientific impact of our different LPs and describe the difficulties encountered during observations of these programs.
8 - MegaPipe 2.0: 10000 Square Degrees of CFHT MegaCam Imaging

Stephen Gwyn (CADC)

MegaPipe, the MegaCam data processing pipeline at the CADC, has been upgraded to version 2.0 and has processed over 10000 square degrees of the sky. MegaPipe has been operating since 2008 and has resulted in close to 200 publications. It was originally intended to increase the usage of archival MegaCam data by calibrating and stacking the images as they became public. That focus expanded to include processing data from the CFHT Large Programs such as the NGVS, OSSOS, VESTIGE and CFIS, as well as PI data. MegaPipe 2.0 represents several improvements. The advent of GAIA means that the astrometric calibration is considerably more accurate. The public release of Pan-STARRS allows photometric calibration of images even if they were taken under non-photometric conditions, by using the PS1 stars as in-field standards. Together this means that almost every MegaCam image can be astrometrically/photometrically calibrated to sufficient accuracy to allow stacking (30 mas and 0.01 magnitudes respectively). MegaPipe 2.0 also introduces an improvement to the stacking method. MegaPipe previously only stacked images that were centred on more or less the same part of the sky, which limited the number of images that could be stacked. MegaPipe 2.0 instead stacks on a grid of 10000x10000 pixel tiles, each half a degree square, evenly covering the whole sky. The result is that twice as much sky area can be stacked. There are now over 10000 square degrees of imaging in both the ugriz filters as well as the narrow band filters.

9 - Updates to QSO Software at CFHT

Kanoa Withington (CFHT)

CFHT is mid-way in a system-wide update of the software used for Queue Service Observing. Here we present the current state of those changes and highlight those that affect the CFHT user community. The changes are motivated by two goals: 1) upgrade infrastructure that has been frozen for so long it has become a risk 2) create a platform for deploying new features while minimizing the risk inherent to change. CFHT operates entirely in QSO mode and we depend on its uninterrupted reliability. The CFHT user community is also remarkably innovative and the theme of this work is to support that innovation while ensuring high availability.

10 - How to Provide Millions of High Quality Spectra? The Operations and Data Products for the Maunakea Spectroscopic Explorer

Kei Szeto (MSE)

Annually the Maunakea Spectroscopic Explorer (MSE) will obtain millions of spectra in the optical to near-infrared, at low ($R \sim 3000$) to high ($R \sim 40000$) spectral resolutions by observing >3000 spectra per pointing via a highly multiplexed fiber-fed system. This presentation focuses on the operations concept of MSE as a dedicated highly multiplexed fiber-fed facility. The operations concept details each phase of operations, from selecting proposals within the users community.
to distributing millions of science-ready spectra to this community. The operations concept describes the tools and observatory staff required to support the user community. It also highlights the specific challenges related to the complexity of MSE with millions of targets to observe, thousands of fibers to position, and different spectral resolutions to use. Finally, the operations concept shows how the science requirements on calibration and observing efficiency are met.

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11 - High Redshift Obscured Quasars and the Need for Optical to NIR, Massively Multiplexed, Spectroscopic Facilities

Andreea Petric (CFHT/UH)

Most bulge-dominated galaxies host black holes with masses that tightly correlate with the masses of their bulges. This may indicate that the black holes may regulate galaxy growth, or vice versa, or that they may grow in lock-step. The quest to understand how, when, and where those black-holes formed motivates much of extragalactic astronomy. In this presentation, I will focus on a population of galaxies with active black holes in their nuclei (active galactic nuclei or AGN), that are fully or partially hidden by dust and gas: the emission from the broad line region is either completely or partially obscured with a visual extinction of 1 or above. This limit, though not yet precise, appears to be the point at which the populations of AGN may evolve differently. We highlight the importance of finding and studying those dusty AGN at redshifts between 1 and 3, the epoch when the universe may have gone through its most dramatic changes. I will emphasize the need for MSE to perform dedicated surveys in the optical and NIR to pin down the demographics of such objects and study their reddening properties, star-formation histories, and excitation conditions. These key studies will shed light on the role of black holes in galaxy evolution during the epoch of peak growth.

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EXTRAGALACTIC ASTRONOMY

12 - Newly Discovered Dwarf Galaxies in the MATLAS Low Density Fields

Francine Marleau (University of Innsbruck)

Recent discoveries on dwarf galaxies, such as their planar rotation around the Milky Way and Andromeda galaxies, have challenged our understanding of galaxy formation and evolution. While these dwarf galaxies and others in the Local Group and in a few nearby clusters have been studied in considerable detail, relatively few observing programs have focused on the study of this population of galaxies in low density environments. Using the optical data obtained in the context of MATLAS, a deep imaging large program at CFHT, we have systematically assembled the largest sample of dwarf galaxies in low density environments. These dwarfs have magnitudes, surface brightnesses and sizes comparable to their Local Group and cluster counterparts. I will present results on their visual classification, 2D surface brightness profile fitting, local environment and clustering properties, and discuss how these new findings impact our current understanding of how these galaxies form and evolve.
13 - ShapePipe, a Shear Measurement Pipeline in the CFIS Context

Axel Guinot (CEA Paris-Saclay)

The Canada-France Imaging Survey (CFIS) is an ongoing wide-field imaging survey. It will cover around 5000 deg^2 in the u- and r-band on the Northern hemisphere with excellent image quality (median r-band seeing 0.65 arcsec). The recently formed collaboration with Pan-STARRS (UNIONS: Ultraviolet Near-Infrared Optical Northern Survey) is adding deep i- and z-band observations for photometric redshifts. These characteristics makes this survey extremely interesting for weak-lensing analyses. In this framework we are developing a new, modular galaxy shape measurement pipeline, ShapePipe, incorporating state-of-the-art techniques for object and blended galaxy detection, shape measurement, shear calibration, and validation diagnostics. I will present the first version of ShapePipe, and show preliminary weak-lensing results of CFIS analysis over the CFHTLenS W3 area. Our galaxy shear estimates analysis have been calibration with a recent method called metacalibration, which does not require image simulations but derives the shear calibration from the data themselves. Further, I will present a clustering-based redshift method as an alternative to photo-z. In light of limited color information but overlap with deep spectroscopic surveys such as BOSS and eBOSS, we plan to apply this method to CFIS/UNIONS to obtain redshift information for the lensed galaxies. I will show preliminary results of this method on simulations.

14 - Interacting Galaxies as Seen with SITELLE : the NGC 3227 Case

Prime Karera (Université Laval)

With the availability of large IFUs, large spectral surveys of nearby galaxies are now possible. This will allow to address questions related to the evolution of galaxies and how that evolution depends on other properties such as the environment (isolated vs. interacting galaxies). In this poster, we present spatially resolved kinematics and star formation of NGC 3227 in the interacting pair Arp 94 using data obtained with the imaging Fourier transform spectrometer SITELLE.

15 - NGC1637 with SITELLE

Carmelle Robert (Université Laval)

The nearby lopsided spiral galaxy NGC1637 has been observed with SITELLE. Emission lines and also a few absorption lines have been measured in order to study the galaxy dynamics and stellar populations. Maps of the velocity and velocity dispersion obtained from the stellar component and the ionized gas at large distance in the disk are presented here. Among others, this study confirms the already known shift of 9’’ between the galaxy dynamical center and light center. It also demonstrates SITELLE’s capability to provide valuable information as well from absorption lines.
16 - Gravitational Waves through the Binary Formation in Merging Galaxies

Rajesh Kumar Dubey (Lovely Professional University)

Gravitational waves: Violent events, such as the collision of two black holes, are thought to be able to create ripples in space-time known as gravitational waves. In 2016, the Laser Interferometer Gravitational-Wave Observatory (LIGO) announced that it found evidence of these tell-tale indicators. By the date, LIGO and LISA have observed 10 events of binary mergers along with the successful detection of Gravitational Waves in each case. With advanced interferometers coming in a row the detection rates will increase significantly and many unknown facts will be known. Apart from the traditional sources of Gravitational waves like binary black holes, neutron stars including pulsars etc., the possibilities of generation of gravitational waves from supermassive black holes sitting in the heart of galaxies is still considered to be high. As the mergers of SMBH during galaxy collisions is a potential candidate of gravitational waves it also has a big drawback that we need to wait for millions of years for these mergers to take place for direct observation by presently available technology. In this context here we propose the work done in the field of the simulations of mergers and the detection of GWs and its broad scope even apply for any forthcoming merging even to be observed in near future. GW & Galaxy Mergers: By the advancement of technology direct observations of many galaxy mergers events can be observed and related data from the highest resolution optical, X-ray and Gamma ray telescopes are available. These are being widely used for the simulation techniques for measuring other parameters along with production of GWs. This astrophysical event is important in the sense of merger of supermassive black holes as well. Thus, these are strong candidates of gravitational waves. I hereby present a detailed correlation between mathematical relativity principles involved in Galaxy mergers and the resulting possible gravitational waves. The study includes the theoretical approach in the mathematical domain of relativity related to heavy masses collisions along with situational techniques involved to predict the resulting gravitational waves in galaxy merger events.

STELLAR ASTRONOMY

17 - Deconstructing the Galaxy with the Canada-France Imaging Survey

Alan McConnachie (Dominion Astrophysical Observatory)

Gaia is revolutionizing our understanding of the Milky Way, especially in the relatively nearby Galaxy (<10kpc). At larger distances, however, the parallax uncertainties of Gaia start to become sufficiently large that it becomes important to combine insights from Gaia with deeper surveys. Here, CFIS has an important role to play. I will discuss how studies with CFIS have revealed strong interactions between our Galaxy and the Sagittarius dwarf spheroidal, as traced by the outer disk of the Milky Way. I will describe the structure of the halo at very large (>100kpc) as traced by blue horizontal branch stars. Finally, I will demonstrate how we can use CFIS Gaia SDSS as a pathfinder dataset for LSST Gaia future spectroscopy, to allow the determination of various stellar parameters from photometric datasets, where usually spectroscopic datasets are required.
18 - Magnetic Field and Prominences of the Young, Solar-like, Ultra-rapid Rotator AP 149

Tianqi Cang (IRAP)

Young solar analogues reaching the main sequence experience very strong magnetic activity, directly linked to their angular momentum loss through wind and mass ejections. We investigate here the ultra-rapid rotator (P ~ 0.32d) AP 149 in the young open cluster alpha Persei. With a time-series of ESPaDOnS spectropolarimetric observations gathered over 2 nights in 2006 and 4 nights in 2018, we are able to reconstruct the surface distribution of brightness and magnetic field using the Zeeman- Doppler-Imaging method. Simultaneously, we estimate the short- term brightness evolution through the latitudinal differential rotation. Using the same data set, we also map the spatial distribution of prominences through tomography of H-alpha emission and monitor short-term changes affecting the prominence system. This is the first example of a solar-type star to have its magnetic field and prominences mapped simultaneously, which will help to explore the respective role of wind and prominences in angular momentum evolution of the most active stars.

19 - Modeling the Topology of NGC1624-2.s Giant Magnetic Field

Rebecca Macinnis (University of Delaware)

NGC 1624-2 possesses the strongest magnetic field of any O-star (~20 kG). We present evidence from ESPaDOnS spectropolarimetric data that this star may also be the first O-star with a significant non-dipolar component to its magnetic field. We acquired 9 observations covering the full rotational period of NGC 1624-2. The maximal longitudinal field is 5.27±0.7 kG, which is in agreement with the initial measurements of 5.35±0.5 kG from the two discovery observations presented in Wade et al. (2012). Because of the strong magnetic field, Zeeman splitting is seen in the Stokes-I profiles, making the addition of new constraints to the magnetic field model possible. We used a simple polarized line profile model to simultaneously reproduce the Stokes-I and Stokes-V profiles. We are unable to accurately replicate the patterns observed from ESPaDOnS with any dipolar topology, leading us to conclude that NGC 1624-2 is the first O-star with a magnetic field more complicated than a simple dipole. These new constraints will be used to model the star's magnetospheric emission at optical (CFHT), X-ray (Chandra), and UV (HST) wavelengths.

20 - Surprising Activity of A-type Stars Revealed by Kepler: Are Magnetic Fields the Culprit?

James Sikora (Queen’s University)

A recent analysis of photometry obtained using the Kepler spacecraft has revealed the highly unexpected result that approximately 40% of main sequence A-type stars exhibit periodic variability that may be attributable to starspots. This is surprising in light of the fact that such activity is normally associated with the presence of magnetic fields, which are rare amongst stars much more massive than the Sun. Furthermore, a significant number of the Kepler A-type stars exhibit unusual signals in their periodograms, which have been speculatively attributed to a high frequency of hot Jupiters orbiting these stars. We have recently completed a spectroscopic survey
of a subsample of the stars found to be exhibiting both of these unexpected properties. This survey
is designed to test two specific hypotheses related to these discoveries including if spotted A-type
stars are substantially more common than previously believed. We will summarize our findings and
discuss our ongoing efforts to understand the origins of the discoveries.

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**21 - Magnetic Massive Stars with SPIRou**

Véronique Petit (University of Delaware)

In the past decade, an important breakthrough was provided by large survey programs that have
exploited spectropolaric instruments like ESPaDOnS to extend the characterization of stellar
magnetism to a growing subset of massive O and early-B stars. About 10% of massive stars host
strong, stable, and nearly dipolar surface fields similar to magnetic ApBp stars. However, the origin
of these magnetic fields is still unknown, and there is a need to determine the magnetic
characteristics of very young massive stars. Although massive stars are intrinsically very blue, the
infrared waveband can be an useful tool to study very young massive stars that are obscured by
their natal cocoon. We present first observations of known magnetic massive stars on the main
sequence by SPIRou, to assess the performance of this new instrument for performing
magnetometry of massive stars.

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**22 - AstroSat Observation of GX 5-1: Spectral and Timing Evolution**

Yashpal Bhulla (Pacific Academy of Higher Education and Research University Udaipur)

We report on the first analysis of AstroSat observation of the Z-source GX 5-1 on February 26-27,
2017. The hardness-intensity plot reveals that the source traced out the horizontal and normal
branches. The 0.7-20 keV spectra from simultaneous SXT and LAXPC data at different locations of
the hardness-intensity plot can be well described by a disk emission and a thermal Comptonized
component. The ratio of the disk flux to the total i.e. the disk flux fraction increases monotonically
along the horizontal to the Normal one. Thus, the difference between the Normal and Horizontal
branches is that in the normal branch, the disk dominates the flux while in the horizontal one it is
Comptonized component which dominates. The inner disk temperature radii changes
dramatically or that the disk is irradiated by the thermal component changing its hardness factor.
The power spectra reveal a Quasi periodic Oscillation whose frequency changes from ~ 30 Hz to
50 Hz. The frequency is found to correlate well with the disk fraction. In the 3-20 keV LAXPC band
the rms of the QPO increases with energy as a power-law, while the harder X-ray seems to lag the
soft ones with a time-delay of a milliseconds. The results suggest that both the temporal and
spectral properties of the source are determined by the geometry of the system which is
characterized by the disk flux fraction and that the QPO has its origin in the corona producing the
thermal Comptonized component.
EXOPLANETS

23 - Optical-nIR Synergy Between SPIRou and SOPHIE

Melissa Hobson (Laboratoire d’Astrophysique de Marseille)

As a high-precision nIR spectropolarimeter on a 3.6m telescope, SPIRou is the ideal instrument to search for exoplanets around M-dwarfs, and to further probe known planetary systems where the host stars’ faintness in the visible may have rendered detection of additional exoplanets impossible. Since 2011, an M dwarf survey has been carried out with the SOPHIE spectrograph at the Observatoire de Haute Provence, which has detected several planets and also various activity-induced signals. Several SOPHIE targets are in the SLS, and we have submitted an open-time proposal on a further three targets. Likewise, SLS targets will be observed with SOPHIE, in order to have visible spectra, and improve the sampling. In this contribution, we describe the SOPHIE results for these stars, and what we can expect SPIRou data to provide: the refinement of planetary parameters, the detection of additional planets, the confirmation of the stellar origin of activity signals.

24 - The SPIDI project: Star-Planets- Inner Disk Interactions

Jérôme Bouvier (IPAG)

The poster presents the “Star- Inner Disk-Planets Interactions” (SPIDI) project, whose long-term goal is to search for nascent inner planetary systems still embedded in the circumstellar disks of young stars. The challenge is to isolate a planetary signal buried in the large variability of young stars induced by the magnetic star-disk interaction. It will illustrate a few directions we might want to explore towards this goal. This project has received funding from the European Research Council (ERC) under the European Union’s Horizon 2020 research and innovation programme (grant agreement No 742095; SPIDI: Star-Planets- Inner Disk-Interactions)” http://spidi.eu.org/

25 - Transit Follow-up at the CFH Telescope in the Era of TESS : a Demonstration with TRAPPIST-1

François-René Lachapelle (Université de Montréal)

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.
# LIST OF PARTICIPANTS

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