Evelyne Alecian: **The magnetic field of the Class I variable protostar V347 Aur**

Class I objects probe a very early phase of star formation during which the strongly accreting protostar is still embedded into a dense envelope. Little is known about the magnetic fields in these objects. Yet the powerful jets and outflows, as well has intense X-ray emission suggest the presence of strong magnetic fields, as well as magnetic star-disk interaction. V347 Aur is a particularly interesting object as (i) a magnetic field has been previously reported using Zeeman broadening of near-IR individual lines, and (ii) it shows regular large photometric brightening events with a period of about 6 months. We have monitored V347 Aur within the SLS SPIRou in order to map its large-scale magnetic field at different phases during the brightening cycles, and attempt to understand the role the magnetic field can play in this peculiar class I variable.

Mike Alexandersen: **Searching for Pluto's Neighbors - the Large Inclination Distant Objects (LiDO) survey**

Beyond Neptune the trans-Neptunian objects (TNOs) in the Kuiper Belt comprises a large belt of dwarf planets and smaller objects. To date, about 4100 TNOs are known, but most dedicated TNO discovery surveys have observed near the ecliptic plane, where the overall density of TNOs is highest, creating a substantial bias in the sample with low-inclination objects being over-represented. The Kozai Plutinos occupy a resonance within a resonance, which has the critical effect that these objects are brightest when they are farthest from the ecliptic. This makes Kozai Plutinos particularly scarce in traditional surveys. However, their orbital and surface characteristics provide valuable constraints on the history of the Solar System and the migration of the giant planets, especially Neptune.

We have conducted a TNO discovery survey, in a similar manner to earlier TNO discovery surveys using CFHT's MegaCam, focusing on detecting Kozai Plutinos and other previously underrepresented high inclination TNOs. Our Large Inclination Distant Objects (LiDO) survey targeted 40 sq.deg. around 15 degrees off the ecliptic plane, where the density of Kozai Plutinos is predicted to be highest. The LiDO survey has discovered about 140 TNOs, of which 22 appear to be Plutinos. Ongoing tracking observations will reduce the orbit uncertainty until we are able to determine the resonant behavior of each object, including whether they experience Kozai resonance. This poster will present a progress report and preliminary findings of the LiDO survey.

Anke Arentsen: **Highlights from the Pristine Inner Galaxy Survey (PIGS)**

Old, metal-poor stars are unique probes of the First Stars and the early formation and evolution of galaxies in the Local Group. They are typically searched for in the Galactic halo and the dwarf galaxies surrounding the Milky Way. A prediction of simulations is that the fraction of metal-poor stars that are very old is highest towards the centers of galaxies: in their bulges. But searching for metal-poor stars in the dusty, crowded inner Milky Way faces many challenges, hence much is unknown about the properties of the metal-poor inner Galaxy. I will present the Pristine Inner Galaxy Survey (PIGS), which has reached unprecedented efficiency in finding very metal-poor stars in the bulge region thanks to the use of metallicity-sensitive CFHT/MegaCam CaHK photometry. We have

obtained thousands of follow-up spectra for metal-poor candidates, leading to a unique metal-poor inner Galaxy sample. I will present several PIGS science highlights from the past few years, and discuss what we can learn about the ancient inner Milky Way from the chemistry and kinematics of metal-poor inner Galaxy stars.

Luc Arnold: **The Earth as a transiting planet: First results from a lunar eclipse observed with SPIRou**

A lunar eclipse is a proxy for observing the Earth during its transit in front of the Sun. An observer located on the Moon in the Penumbra sees the Sun partially occulted by the Earth. A fraction of the light reaching Penumbra contains the absorption signature of the atmosphere above Earth's limb. This is similar to the transit of an exoplanet, where a fraction of the stellar light is absorbed by the atmosphere of the exoplanet. We present first results of Penumbra spectroscopy done with SPIRou during the Nov. 2021 partial lunar eclipse. We show that Oxygen is detected and we calculate an effective thickness of the atmosphere of about 30 km. It means that Earth's radius at Oxygen absorption wavelengths looks 30 km larger than at continuum wavelengths between 1250 and 1280nm.

Bronson Bolo: **Confirming the Variability of SS433**

We investigate spectral data of SS433 to see how the brightness of the system in H-alpha changes over time. SS433 is a microquasar: a black hole with a precessing jet and accretion disk, and a nearby companion star from which it accretes material. We used the ESPaDOnS spectrograph to gather data within the spectral range of ~400 - 1050nm and displayed the spectra using a custom web app. We used the web app to measure the average intensity at the peak of the H-alpha line. Our results show how the brightness changed over the course of six months in 2017. We found significant variabilities that confirm the findings of previous work. We want to keep progressing with this project because we want to see if the brightness of SS433 continues to change. We hope to do this by taking more data and measurements at different dates using our ESPaDOnS viewer web app.

James Barron: **Finding magnetic north: an extraordinary magnetic field detection in Polaris and first results of a magnetic survey of classical Cepheids**

Classical Cepheid variables are essential tools in studying stellar evolution and cosmology due to their radial pulsations and period-luminosity relation (Leavitt Law). Cepheids exhibit a number of poorly understood phenomena, including cycle-to-cycle line variability, infrared excess and phase-dependent UV/X-ray `flashes'. While Cepheids have been studied for over a century, we know surprisingly little about their magnetic properties and what role magnetic fields may play in their evolution and these observed phenomena. We report recent ESPaDOnS and HARPSpol observations from our ongoing magnetic survey of the brightest ~20 Galactic Cepheids. Magnetic Stokes V signatures are detected in eight targets, about half the sample observed to date. Most notably, we detect a magnetic signature in Polaris for the first time. The detected Stokes V signatures show a diversity of morphologies with weak associated longitudinal field measurements of order 1 G. Many Stokes V profiles are difficult to interpret in the context of the normal Zeeman effect. They consist of approximately unipolar single/double lobe(s) of positive or negative circular polarization,

similar to those seen in some weakly magnetic Am stars. We tentatively attribute these unusual signatures to the presence of atmospheric velocity and magnetic gradients.

Paul Cristofari: **Accurate characterization of M dwarfs from SPIRou spectra**

M dwarfs are the most numerous stars in the solar vicinity. They constitute privileged targets in the search for planetary systems in the habitable zone and their characterization. Several instruments were designed specifically to study M dwarfs, such as SPIRou, the high resolution spectro-polarimeter installed at CFHT. Deriving the fundamental parameters of these stars is essential to the characterization of the companions, but remains a challenging task. In this talk, we discuss a method relying on the comparison to synthetic spectra to derive the effective temperature (Teff), the surface gravity ($\log{g}$) and metallicity ([M/H]) of M dwarfs from SPIRou observations. We demonstrate our ability to retrieve parameters in good agreement with the literature, with internal error bars of about 30 K in Teff, 0.05 dex in log g and 0.1 dex in [M/H] for a dozen of inactive M dwarfs with temperatures ranging from 3000 to 4000 K. Using both PHOENIX-ACES and MARCS synthetic spectra, we also show how the choice of model may lead to systematics of up to 50 K in Teff and 0.4 dex in log g and [M/H]. We further extend our study to allow for the determination of alpha elements enhancement, alpha/Fe], discuss the impact of this parameter on the results, and extend our analysis to tens of SPIRou targets in order to provide the community with a reference database of accurate stellar parameters.

Laurent Drissen: **Wolf-Rayet ring nebulae in the Local Group: a view from SITELLE**

Massive stars are characterized by powerful winds which can in principle shed more than half of their original mass into their surroundings before their explosion as supernovae. These winds and their interaction with the interstellar medium at different stages of their evolution (main sequence, supergiants, LBV and Wolf-Rayet) create cavities with diverse morphologies and ionization structure, with which the supernova shock wave eventually interacts.

I will highlight some results from our study of ring nebulae surrounding Wolf-Rayet stars in Local Group galaxies with SITELLE: M1-67, NGC 2359 and NGC 6888 in the Milky Way and, using data acquired for the SIGNALS survey, a comprehensive study of WR ring nebulae in M33, M31 and IC 1613. While our data cubes of the nearby targets reveal astonishing kinematical and chemical details of the nebulae, the unprecedented statistics provided by dozens of WR nebulae in nearby galaxies provide a new, innovative, tool to study the evolution of the most massive stars.

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]/Hα > 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.

Trent Dupuy: **CFHT Infrared Parallax Program**

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 more recently 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 ground-based 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, and establishing the properties of low-mass stars hosting Kepler exoplanets. Finally, I will discuss the vital role that CFHT astrometry can continue to play in the era of Gaia and JWST based on our unique record of long-term (10+ year) astrometry.

Raphaël Errani: **C-19: Tidal debris of a dark matter-dominated globular cluster?**

The recently discovered C-19 stellar stream is a collection of kinematically associated metal-poor stars in the halo of the Milky Way lacking an obvious progenitor. The stream spans an arc of ~15 degrees on the sky, and orbit-fitting suggests an apocentric distance of ~20 kpc and a pericentre of ~10 kpc. The narrow metallicity dispersion of stars with available spectra, together with light element abundance variations, suggest a globular cluster (GC) origin. The observed metallicity ([Fe/H] ~ -3.4), however, is much lower than that of any known GC. In addition, the width and velocity dispersion of the stream are similar to those expected from disrupting dwarf galaxies, and substantially larger than the tidal debris of GCs able to disrupt on C-19's orbit. We propose here an unconventional model where the C-19 progenitor is a dark matter-dominated stellar system with GC-like abundance patterns. We use N-body simulations to show that the tidal disruption of a ~100 pc King-model stellar component embedded in a ~20 km/s cuspy cold dark matter halo yields debris consistent with C-19's observed width and velocity dispersion. The stellar component of the progenitor is fully disrupted, and is spread over two distinct streams; one corresponding to C-19 and another possibly hiding behind the Galactic plane. If such companion stream were found, it would suggest that dark matter-dominated dwarfs may also develop GC-like enrichment patterns, a finding that would inform our theoretical understanding of the formation of multiple populations in GCs and dwarf galaxies alike.

Benjamin Finociety: **Reconstruction of evolving magnetic topologies**

During the last two decades, Zeeman-Doppler Imaging (ZDI) has been used to characterize, and better understand, the stellar activity, magnetic fields and the underlying dynamo processes occurring in the convective zone of the stellar interior. Many studies involving ZDI were made possible thanks to high-resolution spectropolarimeters such as ESPaDOnS, and more recently SPRIou, both mounted on the Canada-France-Hawaii Telescope. However, ZDI is based on the assumption of a static configuration of the stellar magnetic field, which could not be true for observations of very active spanned over several months. This presentation aims at presenting a new method being inspired by sparse approximations, ZDI and gaussian processes to model the time dependency of the stellar magnetic topologies. We will in particular show simulations revealing that our method is able to recover an evolving magnetic topology from circularly polarized spectra as obtained by SPIRou and discuss its application to actual SPIRou data.

Heather Flewelling: **CFHT data analysis in a web browser - webtools for the Mauna Kea Scholars program**

The Mauna Kea Scholars program (https://maunakeascholars.com/), started in 2015, provides research opportunities for high school students in Hawai'i to use the telescopes on Mauna Kea. These students work with astronomy mentors (mostly graduate students, but also astronomers working with the observatories), to write proposals for telescope time. Over 100 students have received telescope time since the start of the program.

It is a steep learning curve to learn how to analyze astronomical data, often requiring specialized software and a background in programming. These skills are often needed even for very basic tasks such as opening a fits file or viewing a spectra, and can act as a barrier to high school students who have an interest in science but do not yet have the computer background. Another barrier is that many of the students have chromebooks, which makes it impossible to run typical astronomy software. We have created a couple of webtools to make CFHT's data more accessible to high school students. These tools are written in html5 and javascript, and can be easily viewed on chromebooks and mobile devices.

For images, we have a 'colorizer' that allows one to create color images using a preset collection of different fields observed in different filters, for a set of publicly available Pan-STARRS images and CFHT MegaCam images. The mentor can clone the github page and change the images to use the student's telescope images, making this a very simplified way to view FITS files. The student can pan and zoom the images, choose the filters to view, and adjust the intensity, and also create color images. For students interested in exploring CFHT ESPaDOnS spectra, we have a javascript webtool that allows one to load up to 2 spectra, and to examine (pan, zoom, scale) the spectra. The student can find the min, max for a set range, and overlay known spectral lines for Hydrogen and other elements. Both of these webtools are written in html5 and javascript, and can be used with any modern browser. These tools work on mobile devices as well as on chromebooks. They are hosted on github to make it easy to clone/modify, and have a GPL3 license. They can be found at https://www.cfht.hawaii.edu/~heather/

Viktor Khalack: **Study of abundance stratification in magnetic chemically peculiar stars with ESPaDOnS**

The abundance variation with optical depth of certain chemical species in chemically peculiar (CP) stars is a well-known fact that can be explained in terms of atomic diffusion. Over several years of observations with ESPaDOnS we have accumulated high resolution and high SNR polarimetric spectra of CP stars, that show rotational modulation and/or stellar pulsations in TESS data, to study the manifestation of atomic diffusion in their stellar atmospheres. We have estimated their Teff, log(g) and metallicity from analysis of Balmer line profiles. The aim is to extend our database of CP stars with detected vertical stratification of chemical elements from the rapidly rotating magnetic CP stars to the domain of very slowly rotating stars with a magnetic field.

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]λλ4959,5007, [NII]λ6548,6583, Hα, [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/submillimeter 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.

Nadine Manset: **Maunakea Scholars - Cultivating Student Scientists**

Maunakea Scholars is an innovative program designed to bring Hawaii's aspiring young astronomers into the observatory community, competitively allocating observing time on world-class telescopes, including the Maunakea Observatories, to local high school students. This lasting partnership between the Hawai‘i Department Of Education, the University of Hawai‘i, and the Maunakea Observatories (MKO), introduced in 2017, is the first program of its kind internationally, leveraging the most powerful collection of telescopes in the world for the direct educational advancement of Hawaii's public high school students.

Chow-choong Ngeow: **WIRCam Observations of RR Lyrae variables in Globular Cluster M3 and M53 and their Period-Luminosity Relations**

The population II RR Lyrae variables are well-known distance indicators and exhibit a well-defined period-luminosity (PL) relation in the near-infrared (NIR) JHKs bands. In May 2019, we obtained on average 20 epochs of time-series JHKs observations of M3 and M53 using the WIRCam at CFHT. NIR light curves of a large number of RR Lyrae in M3 and M53 allowed us to investigate their pulsation properties including the light curves, color-magnitude diagrams, period-amplitude diagrams in Oosterhoff I and II type cluster, respectively. We used template-fitting to obtain accurate mean magnitudes and derive the JHKs band PL relations for RR Lyrae in M3 and M53. Combining with the literature data for RR Lyrae in other clusters, we investigated the metallicity-dependence on NIR PL relations and obtained accurate and precise distances to globular clusters. Our results were published in Bhardwaj et al (2020, 2021) for both globular clusters, respectively. Our work clearly illustrates that the WIRCam is a very valuable and important instrument for such studies, which motivated us to continue our ongoing ""WIRCam Globular Clusters Program"" to include more targets spanning a wide range in metallicity.

Merwan Ould-elhkim: **A method to correct micro-tellurics for precise radial velocity measurement**

We present a new method for the optimization of data reduction of near infrared (nIR) radial velocity (RV) measurements. Our work used data from the Spectro-Polarim`etre Infra Rouge (SPIRou) on the Canada-France-Hawaii Telescope (CFHT). Numerous telluric absorption lines are present in the nIR which creates an important challenge in high-precision RV measurements, as the barycentric velocity of the star varies through the year so do the telluric lines which leads to systematic RV offsets. By taking advantage of the line-by-line (LBL) algorithm (Artigau et al., submitted), a recent tool for precision velocimetry, we were able to estimate the impact of micro-tellurics on the RV precision through Monte-Carlo simulations: the LBL enabled us to compute a RV timeseries for each lines and quantify how sensitive its RMS is to the addition of tellurics. The lines that we consider too sensitive are consequently removed, we typically keep ~ 75 – 80% of the total spectral domain and even most of the lines deep in the tellurics bands are conserved. The main results are the removal of spurious yearly signals that we had in our data and a better final RV accuracy for our targets, decreasing their RMS from 0.5 to 1 m/s which is a non-negligible gain in order to detect small amplitude exoplanets.

Lise-marie Seillé: **Reconstructing the evolution of the galaxy N4321 using HII regions**

Halpha is a reliable estimator of very recent star formation (~10 Myrs) making it the ideal candidate to reconstruct the evolution of galaxies. We measure fluxes for thousands of regions selected from the Halpha band image from the VESTIGE survey (Boselli et al. 2018). We use the same apertures to obtain fluxes in several photometric bands (from UV to IR). We estimate the amount of contamination from the galaxy as well as the blending affecting the regions. This process is replicated for each band to allow for an efficient spectral energy distribution reconstruction of the galaxy.

Svetla Tsvetkova: **The surface magnetic field topologies of both M-dwarf components from the double-line spectroscopic binary FK Aqr**

We present the double-line spectroscopic binary FK Aqr (GJ 867A) as a part of the BinaMIcS project. The system consists of two dM1-dwarfs with masses of 0.55 and 0.44 solar masses. Based on spectropolarimetric observations with ESPaDOnS@CFHT, we were able to reconstruct the large-scale magnetic field topology on the surface of both components of the system and also to measure their radial velocities. Radial velocities of both components were measured from the mean Stokes I profiles. Then, we used them along with interferometric observation to refine the orbital parameters with Phoebe software. Stokes V signatures were detected from all observations. Zeeman Doppler imaging method was employed to reconstruct the maps, which show that both M-dwarfs have strong poloidal components of about 91% for the primary and 99% for the secondary. The magnetic analysis shows that both stars possess slightly stronger magnetic fields compared to single M-dwarfs with similar masses and spectral class. Even though, their magnetic characteristics follow the general tendency for M-dwarfs.

Cam Wipper: **Goodbye Northstar, Hello Kealahou K1! A New Observing Proposal Submission & Review Application for CFHT**

For over ten years, prospective users of CFHT have submitted their observing proposals through Northstar. This application, while satisfactory in its day, has since become outdated and unreliable from a user perspective, and maintenance-intensive from a technical perspective. The time has come for a modern, adaptable, and secure replacement to serve the user community well into the next decade. Enter K1: the Kealahou Phase 1 Tool, an integrated module of CFHT's Kealahou Queued Service Observing software. Kealahou is the complete redesign and reconstruction of the entire QSO computing backbone, replacing the decades-old legacy systems with a modern architecture. Proposal submission and review is a critical component to the QSO process, and starting for the 2023A semester, observing proposals will be accepted through the new K1 application. This will result in a significantly improved user experience. Initially, SPIRou and ESPaDOnS users will have access to the totally unified Kealahou Phase 1 and Phase 2 applications. SITELLE, MegaCam, and WIRCam users will use the new K1 application for proposal submission only until these instruments are transitioned to the Kealahou QSO software. In addition, Kealahou will have a full suite of self-serve account and program management functionalities, with everything combined in an intuitive web application.