A Quick Look into the first year of discoveries from TESS Full Frame Images: Chelsea Huang (MIT)

The Transiting Exoplanet Survey Satellite promises to discover small planets around the nearest and brightest stars. After the first year of observations, the TESS mission has recovered more than a thousand planetary candidates in the Full Frame Images around bright stars. In this talk, we present a quick look into the TESS Full Frame Image data and some of its exciting discoveries from it. Using these discoveries as examples, I will review the process of planetary candidate identification in TESS Full Frame Images using the MIT Quick Look Pipeline and discuss the potential of space-based wide-field transit survey.

Wide-field high-precision photometry with NGTS: Peter Wheatley (University of Warwick)

Ultra-High Precision Photometry with NGTS Multi-Telescopes :Ed Bryant (University of Warwick)

The Next Generation Transit Survey (NGTS) is an exoplanet hunting facility consisting of 12x20cm aperture robotic telescopes, situated at ESO's Paranal Observatory. I will present a new mode of observing in which we observe bright stars simultaneously with multiple NGTS telescopes/cameras. Using this observing method, we can obtain ultra-high precision light curves with precisions comparable to TESS. NGTS is able to monitor very bright stars (V < 9.5 mag), because the very wide field-of-view (8deg2) of NGTS provides us with the necessary number of comparison stars. Obtaining these bright star light curves is crucial for refining transit ephemerides and planetary radii for future atmospheric characterisation studies. With these ultra-high precision light curves, we can also achieve transit timing precisions on the order of 10s. This allows us to search measure transit timing variations due to perturbations between planets in multi-planet systems or tidal decay for ultra-short period systems.

Searching for TESS transits in stars from the Dispersed Matter Planet Project: M.H. Jones, C.A. Haswell, J.R. Barnes (Open University)

The Dispersed Matter Planet Project (DMPP, Haswell et al. 2019) aims to efficiently identify low mass rocky planets around nearby FGK main sequence stars. Target selection is based on anomalously low chromospheric emission, a feature that is attributed to absorption by circumstellar gas originating from a planet in the system that is in the process of being ablated. Since the absorbing gas is concentrated in the orbital planes of these planets (e.g. Debrecht et al, 2018), it is expected that such systems will have an increased probability of showing transits. TESS (Ricker et al., 2015) is currently providing short cadence photometry to an accuracy of ~100 ppm on about 200,000 of the brightest main-sequence dwarfs, and so can potentially identify transits from super-Earth type planets orbiting DMPP stars. We will present our work to-date in searching for transit signals in TESS lightcurves for some of the stars in the DMPP programme, and illustrate the challenges of detecting transits due to super-Earths in the presence of low amplitude stellar variability.

Hijacking Exoplanet Missions for the Stellar Cause: Helen Giles (AIP)

Exoplanet missions, like the Kepler mission, have produced reams of data which have led to over 3000 exoplanets to be confirmed from high-precision photometry. But this exoplanet data also has another use — to further our understanding of stellar activity.

Stellar surfaces are peppered with magnetically-active regions, or starspots. Starspots produce quasi-sinusoidal light curves. As active regions grow and decay over time, the phase and amplitude of these light curves change. Understanding the properties of these fascinating phenomena gives us an opportunity to further our knowledge of stellar structure and evolution (and are vital for determining precise and accurate masses of small, rocky planets).

In this talk I will briefly discuss the methods we used when analysing Kepler data and key points of interest that emerged from the results. I will also discuss how we can use new, current (e.g. TESS and NGTS) and future (e.g. CHEOPS and PLATO) high-precision photometry missions to aid us in learning more about stars. And perhaps the occasional exoplanet…

Nanoflares from NGTS: Chris Dillon (QUB)

Several studies have documented periodic and quasi-periodic signals from the time series of dMe flare stars and other stellar sources. Such periodic signals, observed within quiescent phases (i.e., devoid of larger-scale microflare or flare activity), range in period from 1-1000 seconds and hence have been tentatively linked to ubiquitous p-mode oscillations generated in the convective layers of the star. As such, most interpretations for the observed periodicities have been framed in terms of magneto-hydrodynamic wave behaviour. However, we propose that a series of continuous nanoflares, based upon a powerlaw distribution, can provide a similar periodic signal in the associated synthetic time series. Monte Carlo simulations, embodying the nanoflare signals and modelled noise profiles, produces a time series consistent with previous observations of dMe flare star lightcurves. Through an examination of nanoflare decay timescales and differing powerlaw indices, we provide evidence that periodic signals alongside characteristic power spectrum features found in stellar time series can be explained by low-energy nanoflares embedded within the noise envelope of a stellar lightcurve.

The NGTS is the ideal observational companion for these simulations, due to its high cadence, and months worth of data giving excellent frequency resolution. We have carried out promising feature mapping between our nanoflare simulations and M-type lightcurves. We also found a null result in a A-type lightcurve, as we would expect for a non flare-active star. This work holds the thrilling and novel capability of stellar nanoflaring diagnosis.

What asteroseismology can do for exoplanets in the era of Kepler, TESS, and PLATO:V Van Eylen (MSSL)

Almost everything we know about exoplanets to date has been inferred indirectly through their host stars, making it crucial to understand stellar properties if one hopes to learn anything at all about the architecture of planetary systems. Asteroseismology, the study of stellar oscillations, provides the current gold standard of stellar characterization. In this talk, I explain how we can use asteroseismology and other techniques can be used to make major leaps forward in our understanding of the formation of small close-in planets, the ones most commonly detected by TESS.

I show what we have learned about the basic properties of planetary systems from previous surveys like Kepler and K2, how these results inform TESS discoveries, and the first results from TESS discoveries. For example, I show what we have learned about orbital eccentricities for single- and multiple-transiting systems and link these findings to planet formation and evolution theories. I show how TESS planets which orbit brighter stars can be used to distinguish between different models.

Furthermore, I show how spectroscopy and asteroseismology have revealed the presence of a so-called "radius valley" in Keler data, i.e. a deficit of planets roughly twice the size of the Earth. I interpret this gap as the result of photo-evaporation, in which some planets lose their entire atmosphere under the influence of stellar irradiation. I finally show how small planets abudantly discovered by TESS can be used to test photo-evaporation models, and I show some of the first results constraining the composition of Earth-size planets with and without atmospheres, by pairing TESS transit observations with radial velocity measurements from the novel ESPRESSO instrument at the Very Large Telescope.

ULTRACAM and HiPERCAM - high-speed, multi-beam cameras for high-speed astrophysics: Vik Dhillon (University of Sheffield)

ULTRACAM and HiPERCAM are high-speed, multi-beam CCD cameras for high time-resolution astrophysics. ULTRACAM is permanently mounted on the 3.5m New Technology Telescope in Chile and can take hundreds of frames per second simultaneously in 3 optical bands. HiPERCAM is mounted on the 10.4m Gran Telescopio Canarias on La Palma and can take over a thousand frames per second simultaneously in 5 optical bands. In this talk, I will describe the design and performance of ULTRACAM and HiPERCAM, and the science that has been performed with these instruments to date.

A Correction of the Photometric Effect of Telluric Water Vapour on SPECULOOS-South : Peter Pihlmann Pedersen, Catriona Murray, Laetitia Delrez, Didier Queloz, SPECULOOS consortium (University of Cambridge)

The SPECULOOS (Search for Habitable Planets EClipsing ULtra-cOOl Stars) survey is a network of 1 m-class robotic telescopes, searching for transiting terrestrial planets around approximately 1200 of the nearest and brightest ultra-cool dwarfs (UCDs). Its main facility, the SPECULOOS-South Observatory (SSO), started full scientific operations in January 2019 at ESO's Paranal Observatory. UCDs are Jupiter-sized objects of spectral type M7 and later and effective temperatures less than 2700K. Due to their low luminosities and small sizes, the detection of a transit of a habitable Earth-sized planet, and of spectroscopic signatures in its atmosphere, is more favourable for UCDs than any other host star. SPECULOOS utilises NIR-optimised CCDs, with a custom-designed I+z' filter with a 0.7 – 1.1 μm bandpass. This wavelength window is heavily affected by 3 water absorption band features. We have developed a novel method of modelling and mitigating the photometric effects of rapidly changing water vapour on time-series photometric data, using accurate precipitable water vapour (PWV) values. The LHATPRO2 radiometer (with an accuracy of ± 0.1 mm), located on the VLT platform, provides us with high cadence, zenith PWV values which enables us to correct our nightly and global light curves . After correcting for this PWV effect, data from SSO is able of reaching ~0.28 mmag photometric precision at 28-minute binning.

Finding and characterising Exo-Earths with the PLATO mission: Suzanne Aigrain (University of Oxford)

PLATO, the 3rd M-class mission in ESA's Cosmic Visions program, will search for transits of small exoplanets around bright stars, and simultaneously perform asteroseismology on the same targets in order to obtain radius, mass and age estimates to better than 5, 10 and 10% respectively for the detected planets. It draws on the heritage of past transit surveys including CoRoT, Kepler and TESS, but uses multiple small telescopes pointing in the same direction to obtain simultaneously a very large field of view and significant collecting area. In my talk I will briefly outline the science goals, technical characteristics and status of the PLATO mission, and discuss the specific challenges we face when planning the PLATO Exoplanet Analysis System (EAS) in terms of systematics correction, light curve detrending and transit detection.

The High Cadence Photometry Capabilities of ARIEL: C.A. Haswell, G. Szabo, R. Szabo, K. Vida, G. Tinetti and the ARIEL Consortium

Abstract: ESA's ARIEL mission will perform infrared spectroscopy of a large sample of transiting exoplanets. It also has ground-breaking high cadence photometric capabilities. Alongside the time-resolved IR spectroscopy, ARIEL will perform simultaneous space-based photometry in three optical bands. The optical channels can be read out at 0.1 second time resolution. These capabilities lend themselves to exquisite determination of stellar limb darkening, planet orbital inclination (or equivalently impact parameter), and planet oblateness from the transit light curve. ARIEL photometry can also be used to determine transit timing and transit duration variations (TTVs and TDVs), to search for exomoons, Trojans and small planets, and to search for absorption from diffuse material surrounding the planets. It will be sensitive to stellar activity through detection and characterisation of flares and faculae, and through high frequency characterisation of granulation noise. ARIEL offers the potential to detect transient planetary events including lightening, impacts, and glint.