TASC7/KASC14

TESS/Kepler Asteroseismic Science Consortium Workshop

Conference Program

Honolulu, Hawai‘i
17-21 July 2023

UNIVERSITY of HAWAI‘I
MĀNOA

Contents

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Schedule

Sunday, 16 July 2023

16:00 – 18:00	**Reception & Registration: Institute for Astronomy**	

Monday, 17 July 2023

07:00 onwards	**Registration & Poster Setup**	
Session 1: Hawaii & TASC (Chair: Jen van Saders)		
08:30 – 08:45	**Welcome**	
08:45 – 09:15	**Leinani Lozi**	Astronomy in Native Hawaiian Culture (invited)
09:15 – 09:45	**Hans Kjeldsen**	History & Future of TASC (invited)
09:45 – 10:00	**George Ricker**	The Future of TESS (invited)
10:00 – 10:30	**Coffee Break**	
Session 2: Solar-like Oscillators (Chair: Dennis Stello)		
10:30 – 11:00	**Joel Ong**	Solar-like Oscillators (invited)
11:00 – 11:15	**Jérôme Ballot**	Seismic signatures of non-axisymmetric magnetic fields in red giant stars
11:15 – 11:30	**Nicholas Rui**	Gravity waves in strong magnetic fields
11:30 – 11:45	**Emily Hatt**	An Ensemble View of Magnetic Imprints on Mixed Modes at the Base of the RGB
11:45 – 12:00	**Joel Zinn**	Nonadiabatic corrections at low frequency: theoretical considerations and practical applications for luminous red giants
12:00 – 13:45	**Lunch Break**	
Session 3: AF Stars (Chair: Karen Pollard)		
13:45 – 14:15	**Daniel Holdsworth**	AF Stars (invited)
14:15 – 14:30	**Keyan Gootkin**	A correlation of Pulsator Fraction with Stellar Rotation Revealed through 100,000 TESS δ-Scuti Variable Candidates
14:30 – 14:45	**Tim Bedding**	New results on delta Scuti stars with TESS and Gaia
14:45 – 15:00	**Marion Galoy**	Coupling between the inertial modes of convective core and gravito-inertial modes of the radiative zone in gamma Doradus stars
15:00 – 15:15	**Simon Murphy**	800,000 pulsation models of young delta scuti stars
15:15 – 15:45	**Coffee Break**	
Session 4: Galactic Archaeology (Chair: Sukanya Chakrabarti)		
15:45 – 16:15	**Gail Zasowski**	Galactic Archaeology (invited)
16:15 – 16:30	**Sam Grunblatt**	Asteroseismology of Luminous Red Giants with TESS and WISE
16:30 – 16:45	**Daniel Hey**	The far side of the Galactic bar/bulge revealed through pulsating red giants
16:45 – 17:00	**Jessica Schonhut-Stasik**	The APO-K2 Catalog: Availability of Catalog Products and Ongoing Investigations
17:00 – 17:15	**Henrique Reggiani**	Precise Asteroseismic Ages for Metal-Poor Red Giants and their impact on Galactic Archaeology
18:00 onwards	**Young Astronomer's Mixer: Beer Lab HI**	

Tuesday, 18 July 2023

Session 5: Rotation & Activity (Chair: Marc Pinsonneault)		
08:30 – 09:00	**Zachary Claytor**	Rotation & Activity (invited)
09:00 – 09:15	**Luke Bouma**	The Empirical Limits of Gyrochronology
09:15 – 09:30	**Lucy Lu**	An abrupt change in the stellar spin-down law at the fully convective boundary
09:30 – 09:45	**Federica Chiti**	Gyrochronology Challenges at the Fully Convective Boundary: Insights from WD + MS Binary Systems
09:45 – 10:00	**Poster Sparklers**	
10:00 – 10:30	**Coffee Break**	
10:30 – 12:00	**Poster Session (Campus Center)**	
12:00 – 13:45	**Lunch Break**	
Session 6: Exoplanets (Chair: Ben Montet)		
13:45 – 14:15	**Nora Eisner**	Exoplanets (invited)
14:15 – 14:30	**Marc Hon**	The Great Escape of a Giant Planet from Planetary Engulfment
14:30 – 14:45	**Alexander Stephan**	A Rapidly-Rotating, Lithium-Enriched Red Giant in the TESS SCVZ: A Compelling Candidate for a Recent Planetary Engulfment Event
14:45 – 15:00	**Nicholas Saunders**	Evidence for Efficient Tidal Realignment of Giant Planets Orbiting Evolved Stars
15:00 – 15:15	**Jingwen Zhang**	The 3D Architecture of a Transiting Planet Orbiting an Oscillating Subgiant with an Outer Companion
15:15 – 15:45	**Coffee Break**	
Session 7: OB Stars (Chair: Rich Townsend)		
15:45 – 16:15	**Peter de Cat**	OB Stars (invited)
16:15 – 16:30	**Dominic Bowman**	Asteroseismology reveals a unique anchor point for calibrating interior rotation, mixing and angular momentum transport in massive stars
16:30 – 16:45	**Mathias Michielsen**	Observational probing of core masses and thermal structure with gravity modes
16:45 – 17:00	**Sarah Gebruers**	Uniting spectroscopy and asteroseismology for BAF-type stars
17:00 – 17:15	**Vincent Vanlaer**	Asteroseismic constraints on the internal magnetic field of the TESS beta Cepheid pulsator HD 192575

Wednesday, 19 July 2023

Session 8: Exoplanets, Solar-like Oscillators, & Clusters (Chair: Paul Beck)		
08:30 – 08:45	**Aldo Sepulveda**	TESS Characterization of Pulsating Stars Hosting Imaged Exoplanets
08:45 – 09:00	**Alexander Lyttle**	Hierarchically Modelling Many Stars to Improve Inference with Asteroseismology
09:00 – 09:15	**Yaguang Li**	Enhancing stellar properties through ensemble modeling techniques
09:15 – 09:30	**Madeline Howell**	Using Asteroseismology to Study Stellar Mass Loss and Multiple Populations in the Globular Cluster M80
09:30 – 09:45	**Claudia Reyes**	Asteroseismic modeling of the subgiants and redgiants in the open cluster M67 from three campaigns of K2 data
09:45 – 10:00	**Gang Li**	Asteroseismology in the young open cluster NGC2516 observed by the TESS mission
10:00 – 10:30	**Coffee Break**	
Session 9: Compact Stars (Chair: Stephane Charpinet)		
10:30 – 11:00	**Keaton Bell**	Compact Stars (invited)
11:00 – 11:15	**Zsófia Bognár**	Rotation of pulsating white dwarf stars as seen by TESS
11:15 – 11:30	**Wenchao Su**	A new hybrid sdB pulsator with significant differential radial rotation in short-period binary observed by TESS
11:30 – 11:45	**Agnes Kim**	The parameters that matter in white dwarf asteroseismic fitting: A systematic study
11:45 – 12:00	**JJ Hermes**	Outrigger modes in pulsating white dwarfs
12:00 – 13:45	**Coffee Break**	
13:45 – 18:00	**Free Afternoon**	
18:00 onwards	**Conference Dinner (Waikīkī Aquarium)**	

Thursday, 20 July 2023

Session 10: RR Lyrae & Cepheid Stars (Chair: Emese Plachy)		
08:30 – 09:00	**László Molnár**	RR Lyrae & Cepheids (invited)
09:00 – 09:15	**Csilla Kalup**	Seismic analysis of the upper giant branch and the horizontal branch of NGC5897 with K2
09:15 – 09:30	**Merieme Chadid**	First Detection of Gravity Modes in RR Lyrae Stars
09:30 – 09:45	**Emma Chickles**	A systematic search of short period variability using TESS Cycle 5 data
09:45 – 10:00	**Poster Sparklers**	
10:00 – 10:30	**Coffee Break**	
10:30 – 12:00	**Poster Session (Campus Center)**	
12:00 – 13:45	**Lunch Break**	
Session 11: Solar-like Oscillators (Chair: Martin Nielsen)		
13:45 – 14:00	**Tiago Campante**	Pushing the boundaries of cool-dwarf asteroseismology with ESPRESSO
14:00 – 14:15	**Christopher Lindsay**	Fossil Signatures of Main-sequence Convective Cores Observed Through Kepler Asteroseismology of Subgiant Stars
14:15 – 14:30	**Travis Metcalfe**	Probing Magnetic Stellar Evolution with Asteroseismology and Spectropolarimetry
14:30 – 14:45	**Yixiao Zhou**	Does the ν_{max} scaling relation depend on metallicity, Insights from 3D surface convection simulations
14:45 – 15:00	**Irina Kitiashvili**	3D Radiative Hydrodynamics Modeling of Acoustic and Gravity Modes Excitation in Main-Sequence Stars with Shallow Outer Convection Zones
15:00 – 15:15	**Alexander Kosovichev**	Physical Properties of Low-Frequency Oscillations of Rotating Stars
15:15 – 15:45	**Coffee Break**	
Session 12: OB & AF Stars (Chair: Vichi Antoci)		
15:45 – 16:00	**Mariel Lares Martiz**	Fine structure of combination frequencies to identify different non-linear behavior
16:00 – 16:15	**Joey Mombarg**	Testing the theory of angular momentum transport on the main sequence
16:15 – 16:30	**Gerald Handler**	Maia variables – fact or fiction?
16:30 – 16:45	**Amadeusz Miszuda**	Evolutionary and seismic modeling of delta Sct pulsators in eclipsing binary systems
16:45 – 17:00	**Alexandre David-Uraz**	Variability characteristics of OBA stars: how to find magnetic needles in a large data haystack
17:00 – 17:15	**Lester Fox-Machado**	The nature of KIC 2162283 from ground based spectroscopy and space photometry
18:00 onwards	**Public Talk: Katrien Kolenberg (TBC)**	

Friday, 21 July 2023

Session 13: Rotation & Activity (Chair: Jamie Tayar)		
08:30 – 08:45	**Charlotte Gehan**	Magnetic activity of red giants: impact of tidal interactions on magnetic fields
08:45 – 09:00	**Rafael Garcia**	Extracting reliable latitudinal differential rotation from photometric lightcurves
09:00 – 09:15	**Lyra Cao**	LEOPARD Starspots Catalog: Impact of Stellar Magnetism on Dwarfs and Giants
09:15 – 09:30	**Phil Van-Lane**	A data-driven inference model for stellar age estimation using gyrochronology
09:30 – 09:45	**Przemyslaw Walczak**	KIC 8264293 – detailed study of the differential rotation
09:45 – 10:00	**Janosz Dewberry**	Dynamical tides in rapidly rotating stars
10:00 – 10:30	**Coffee Break**	
Session 14: Methods (Chair: Mikkel Lund)		
10:30 – 10:45	**Christina Hedges**	Updates from the TESS Science Support Center at NASA GSFC
10:45 – 11:00	**Katrien Kolenberg**	AstroSounds: probing the power of sonification for asteroseismology
11:00 – 11:15	**May Gade Pedersen**	Identifying contaminating sources in TESS light curves
11:15 – 11:30	**Tobin Wainer**	Is Blending Even an Issue?: The First Catalog of Star Cluster Ensemble Light Curves
11:30 – 11:45	**Aarya Patil**	Improving Power Spectrum Estimation using Multi-tapering: Precise asteroseismic analyses for understanding stars, the Milky Way, and beyond
11:45 – 12:00	**Owen Scutt**	Discrete Grids to Continuous Functions: Neural Network Emulation for Stellar Parameter Inference
12:00 – 13:45	**Lunch Break**	
Session 15: Future & Surveys (Chair: Knicole Colon)		
13:45 – 14:00	**Christoph Baranec**	High-acuity imaging of TESS asteroseismic stars and Objects of Interest in the visible and near-infrared with Robo-AO-2
14:00 – 14:15	**Weikai Zong**	Spectroscopic surveys of Kepler/K2 targets with LAMOST: 1,000,000 visits with homogeneous parameters
14:15 – 14:30	**Tom Barclay**	Unleashing the Potential of NASA's Roman Space Telescope for Stellar Astrophysics
14:30 – 14:45	**Iair Arcavi**	Asteroseismology with ULTRASAT
14:45 – 15:00	**Jeroen Audenaert**	Updates on the status of the ESA PLATO mission: asteroseismology, exoplanet science, and so much more
15:00 – 15:15	**Savita Mathur**	HAYDN – High-precision AsteroseismologY of DeNse stellar fields
End of Conference		

Invited Speakers

Leinani Lozi (TMT & ʻOhana Kilo Hōkū), Astronomy in Native Hawaiian Culture

Hans Kjeldsen (Aarhus University), History & Future of TASC

George Ricker (MIT), The Future of TESS

Joel Ong (University of Hawaiʻi), Solar-like Oscillators

Daniel Holdsworth (University of Central Lancashire), AF Stars

Gail Zasowski (University of Utah), Galactic Archaeology

Zachary Claytor (University of Florida), Rotation & Activity

Nora Eisner (CCA/Flatiron Institute), Exoplanets

Peter de Cat (Royal Observatory Belgium), OB Stars

Keaton Bell (Queens College CUNY), Compact Stars

László Molnár (Konkoly Observatory), RR Lyrae & Cepheids

Contributed Talk Abstracts

Listed alphabetically by last name

Name	Institution	Abstract
Arcavi, Iair	Tel Aviv University	**Asteroseismology with ULTRASAT** ULTRASAT is 200 square-degree, ultraviolet space imager, to be launched in 2026. Most of its time will be dedicated to staring at one field with 5 minute cadence. The main science goals are transients (namely, supernovae and neutron star mergers), but such a mission could be extremely useful (and unique) for asteroseismology as well. The science working groups of ULTRASAT are currently being formed, and stellar science remains unrepresented. Now is a crucial time to discuss the possible stellar science that could be done with ULTRASAT while we can still influence its observing strategy and targets. I will present the mission, its main science goals and capabilities, and will invite input on the best way it could be used for asteroseismology and other stellar science.
Audenaert, Jeroen	KU Leuven, Institute of Astronomy	**Updates on the status of the ESA PLATO mission: asteroseismology, exoplanet science, and so much more** PLATO (PLAnetary Transits and Oscillations of stars) is an ESA space-based photometric mission whose primary focus is the detection and characterisation of Earth-like planets in the habitable zone around Sun-like stars. The payload of PLATO will carry 24 normal and 2 fast cameras, where the former will operate in white light and take images of the sky every 25 seconds while the latter will include colour information and operate at a sampling of 2.5 sec. PLATO will be launched towards the end of 2026 and will deliver observations of hundreds of thousands stars in several (nominal: two) long pointing fields of 2232 squared degrees for a total duration of minimally two years each. The required photometric precision of the PLATO instrument is 50 ppm in 1 hour for stars brighter than m_V = 11. In order to provide a high-precision characterisation of any detected planets, the core science program of PLATO has a component dedicated to high-precision asteroseismic studies of candidate exoplanet host stars. These studies will deliver masses, radii, and ages of asteroseismically active hosts with a precision better than 15%, 2%, and 10% (for a m_v = 10 G0V reference star), respectively. In addition to the core science, the PLATO mission will also have a rich complementary science program open to the worldwide community via Guest Observer calls, with the ultimate goal to maximise the scientific return of the mission. Research within the complementary science program covers a very broad range of topics, ranging from single-star pulsators, binary systems, activity phenomena in young stellar objects, to extragalactic research including variability of AGNs, of super-massive black hole binaries in distant galaxies, explosive phenomena in the Universe, etc. In this contribution, given on behalf of the PLATO Consortium, we will present the current status of the project covering aspects of the payload, as well as developments for the science preparation. We will highlight the details of the stellar content in the first long-pointing field of PLATO, which will have been announced in June, and will also present the development, implementation, and validation of the data reduction and analysis pipelines, and for the generation of realistic simulations of the PLATO photometric data.
Ballot, Jérôme	IRAP	**Seismic signatures of non-axisymmetric magnetic fields in red giant stars** Magnetic fields have been measured for the first time in the core of red giant stars thanks to a seismic analysis of Kepler data (Li et al 2022, Deheuvels et al. 2023). Observed mixed modes are mainly dipolar modes which appear as symmetric frequency triplets split by rotation. The presence of a magnetic field in the core shifts the mode frequencies and generates asymmetries triplets, which we have detected. These observations provide a measurement of the magnetic strength in the vicinity of the Hydrogen-burning shell in several red giants and give some informations on the magnetic field topology. We thus have made evident that all the observed fields have not a simple axisymmetric dipolar structure. The formalism we developed provide general analytical expressions of the frequency shifts induced by an arbitrary magnetic field. In this work we explore the impact of non-axisymmetric fields on dipolar modes. It is known (Gough & Thompson 1990) that non-axisymmetric fields may generate up to $(2\ell+1)^2$ rather than $2\ell+1$ components for each mode, it means that for dipolar modes, we may face multiplets with up to 9 components instead of triplets.

		Nevertheless, for weak fields, we showed that only 3 components are visible in dipolar modes, regardless of the magnetic geometry. However, when fields are strong enough, more complex patterns arise. In this talk we will present these results by showing to what extent non-axisymmetric terms may affect dipolar modes and by discussing the seismic signatures we expect to observe.
Baranec, Christoph	University of Hawaii, Institute for Astronomy	**High-acuity imaging of TESS asteroseismic stars and Objects of Interest in the visible and near-infrared with Robo-AO-2** We will soon use the the new Robo-AO-2 laser adaptive optics instrument at the 2.2-m telescope on Maunakea to fill in the gaps in follow-up high-acuity imaging of TESS objects of interest (TOIs). Approximately a third of the ~5000 TOI host stars have not been examined with high angular resolution imaging, and a further third have only been imaged once by these facilities. Robo-AO-2 can observe 200 targets in a clear night, so we can provide a uniform and systematic survey of all of these objects with just a modest amount of telescope time. Similarly, we used Robo-AO to survey Kepler asteroseismic stars to search for stellar blends that may affect oscillation signals, and we intend to partner with the TESS asterosiesmic community to observe scientifically important targets with Robo-AO-2.
Barclay, Thomas	NASA Goddard Space Flight Center	**Unleashing the Potential of NASA's Roman Space Telescope for Stellar Astrophysics** NASA's next flagship observatory, the Nancy Grace Roman Space Telescope, is slated for launch in late 2026. With a top objective to enable near-infrared sky surveys in imaging and spectroscopic modes, Roman holds immense promise for advancing our understanding of astrophysics and planetary science. A large field of view, high spatial resolution, and fast survey speed position it as a significant catalyst for scientific breakthroughs. Exquisite calibration ensures the reliability and accuracy of the data it will provide, paving the way for discovery. The mission of Roman encompasses three Core Community Surveys, comprising both high latitude surveys and exploration of the Galactic Bulge. Additionally, a minimum of 25% of observing time will be dedicated to General Astrophysics Surveys. To ensure broad involvement, the scientific community will actively participate in defining the surveys, contributing to crucial aspects such as field locations, observation cadence, and filter choices. The field of stellar astrophysics stands to benefit greatly from the data collected by Roman. In this presentation, we will provide an update on the current status of the Roman Space Telescope and discuss avenues for stellar astrophysicists to engage in this transformative mission. We invite you to join us on this captivating journey as we unlock the mysteries of the universe through the lens of the Roman Space Telescope.
Bedding, Tim	University of Sydney	**New results on delta Scuti stars with TESS and Gaia** The flood of data from TESS, which now covers most of the sky, is revealing many tens of thousands of delta Scutis. Even a single TESS sector is enough to reveal complex multimode pulsations, with light curves and power spectra better than anything that was possible from the ground. One useful approach is to study open clusters and moving groups, since each one samples a single age and chemical composition. In the Pleiades open cluster, which has 89 A- and F-type members, we detected delta Scuti pulsations in 36 stars (Bedding et al 2023). In the middle of the instability strip, the fraction that pulsate is unusually high (over 80%), and their range of effective temperatures agrees well with theoretical models. On the other hand, the characteristics of the pulsation spectra are varied and do not correlate with stellar temperature, calling into question the existence of a useful nu_max relation for delta Scutis, at least for young main-sequence stars. Our second approach is an all-sky survey with the TESS 10-minute full-frame images. This cadence is ideal for delta Scutis. We have started by selecting all Gaia stars out to 500 pc that lie within a narrow colour range (0.02 mag wide) in the centre of the instability strip (BP-RP = 0.3). This yields 2844 stars, for which TESS 10-min FFIs are available for 1708 stars (60%). note that only half these stars have 2-minute TESS light curves, and so our use of FFIs has allowed us to obtain a much fuller sample that is essentially complete down to G=12 (paper in prep.). We found that 51% of this sample are delta Scuti stars, including many new examples of the high-frequency pulsators with regular mode spacings that were discovered by TESS. Cross-matching with known associations and moving groups is underway, and the project shows the power of combining TESS and Gaia to study pulsating stars.

Bognár, Zsófia	Konkoly Observatory, CSFK	**Rotation of pulsating white dwarf stars as seen by TESS** In general, we can derive the projected equatorial velocity of a given star utilising the rotational broadening of spectral lines. However, we face difficulties applying this method for white dwarf stars. The strong pressure-broadening affects the line profiles of white dwarfs, masking the relatively small contribution of stellar rotation to the overall broadening. Fortunately, there is a way to gather reliable information on the stellar rotation periods for pulsators: through studying rotationally split oscillation frequencies. The separation of these frequency components highly depends on the rotational rate in the stellar layer probed by the given pulsation mode, which offers a unique opportunity to reveal their internal rotation. As we need long time-base and precise observations to resolve the often closely spaced and low-amplitude frequency components, space-based data are our best opportunity for such measurements. Thanks to the extended space-based and ground-based observations, it was possible to measure the rotation rates of a sample of white dwarfs as a function of mass (Hermes et al., 2017, ApJS, 232, 23). The authors found that 0.51–0.73 solar mass white dwarfs, which evolved from 1.7–3.0 solar mass ZAMS progenitors, have a mean rotation period of 35 hr with a standard deviation of 28 hr, with notable exceptions for higher-mass white dwarfs: it seems that there may be a trend that more massive white dwarfs rotate faster, but observations of additional massive white dwarfs are needed to confirm this finding. At any case, the white dwarf rotation rates as a function of mass can shed light on the unknown angular momentum transport mechanism in their progenitors, coupling red-giant cores to their envelopes. For this reason, using the TESS database, we primarily searched for rotationally split triplet frequencies, analysing the light curves of the selected star. We investigated the available TESS data on the stars listed in the ZZ Ceti database of Bognár & Sódor (2016, IBVS, id.6184) and by Romero et al. (2022, MNRAS, 511, 1574), looking for frequency multiplets in the data. We successfully identified triplet or doublet frequencies in 11 targets, and determined the rotation periods of these stars with the method presented by Hermes et al. (2017). We note that for all 11 stars, we performed period determinations independently of other authors, using only the TESS data sets. Out of the 11 stars, there are only 4 cases of overlap between the objects examined by us and by Hermes et al. (2017). Our results support the presumption of Hermes et al. (2017), that the most massive stars have the largest rotation periods in both samples. With this study, we came closer to learning more about the otherwise hidden rotation of pulsating white dwarf stars.
Bouma, Luke	Caltech	**The Empirical Limits of Gyrochronology** The promise of gyrochronology is that given a star's rotation period and mass, its age can be inferred. The reality of gyrochronology is complicated by effects other than ordinary magnetized braking that alter stellar rotation periods. I will present a new interpolation-based gyrochronology framework that reproduces the time- and mass-dependent spin-down rates implied by the latest open cluster data, while also matching the rate at which the dispersion in initial stellar rotation periods decreases as stars age (Bouma, Palumbo & Hillenbrand 2023, ApJL). I will discuss the validation of this method for stars with temperatures of 3800-6200 K and ages of 0.08-2.6 gigayears (Gyr), and will re-examine the empirical limits of gyrochronology. In line with previous work, we find that the uncertainty floor varies strongly with both stellar mass and age. For Sun-like stars (5800 K), the statistical age uncertainties improve monotonically from ±38% at 0.2 Gyr to ±12% at 2 Gyr, and are caused by the empirical scatter of the cluster rotation sequences combined with the rate of stellar spin-down. For low-mass K-dwarfs (4200 K), the posteriors are highly asymmetric due to stalled spin-down, and ±1σ age uncertainties vary non-monotonically between 10% and 50% over the first few gigayears. High-mass K-dwarfs (5000 K) older than 1.5 Gyr yield the most precise ages, with limiting uncertainties currently set by possible changes in the spin-down rate (12% systematic), the calibration of the absolute age scale (8% systematic), and the width of the slow sequence (4% statistical). An open-source implementation, called gyro-interp, is available online at github.com/lgbouma/gyro-interp
Bowman, Dominic	Institute of Astronomy, KU Leuven, Belgium	**Asteroseismology reveals a unique anchor point for calibrating interior rotation, mixing and angular momentum transport in massive stars** Massive stars are progenitors of neutron stars and black holes, and through their winds and supernova explosions dictate the chemical and energetic feedback of galaxies. During the hydrogen-core burning phase the convective cores of massive stars act as engines that drive

		stellar evolution, but inferences of core masses are subject to unconstrained boundary mixing processes. Moreover, uncalibrated chemical and angular momentum transport mechanisms can lead to unwieldy mixing and rotation profiles. Ascertaining the efficiency of these transport mechanisms is challenging because of a lack of observational constraints. However, thanks to the ongoing TESS mission and our development of modern asteroseismic modelling techniques for massive stars, we deduce a precise convective core mass and robustly demonstrate non-rigid radial rotation in a supernova progenitor. In this talk, we present the results of combining TESS photometry, high-resolution spectroscopy, and Gaia astrometry for a main-sequence massive star pulsator. We measure its mass, core mass, and age to better than 15% precision which is unprecedented. Using asteroseismic modelling of rotational multiplets, we also infer its core to be rotating five times faster than its envelope. This beta Cephei pulsator represents a truly unique anchor point for calibrating the interior rotation, mixing and angular momentum transport processes within massive stars. We conclude by demonstrating ongoing work to apply asteroseismology to hundreds of massive pulsators in the TESS mission data set, including those in binaries and those with strong magnetic fields detected at their surfaces.
Campante, Tiago	Instituto de Astrofísica e Ciências do Espaço	**Pushing the boundaries of cool-dwarf asteroseismology with ESPRESSO** Fueled by high-precision, space-based photometry, asteroseismology is vastly benefiting the study of cool main-sequence stars, which exhibit convection-driven, solar-like oscillations. Despite this success story, space-based asteroseismology faces a challenge concerning K and M dwarfs. Predicted oscillation amplitudes for these stars are extremely small (below the few ppm or, equivalently, 10 cm/s level) and thus hard to detect, even with multi-year photometry. To date, only a handful of dwarfs cooler than the Sun have detected solar-like oscillations, and none cooler than 5000 K. A viable alternative is offered by the lower stellar 'noise' over the oscillation timescales in Doppler observations, as demonstrated by a number of pre-Kepler era ground-based campaigns on cool dwarfs using HARPS and UVES. In this talk, I push a decade-old boundary by presenting the definite detection of solar-like oscillations in the mid-K dwarf (K5 V) eps Indi, based on observations collected with the state-of-the-art ESPRESSO spectrograph at the VLT. This makes eps Indi the coolest seismic dwarf ever observed. I expect this detection to restore the community's interest in the ground-based follow-up of cool dwarfs using next-generation spectrographs. The potential scientific gains abound, as one can start extending the mode amplitude scaling to the K-dwarf regime (with implications for PLATO), while shedding light on the elusive cool dwarf mass-radius relation.
Cao, Lyra	Vanderbilt University	**LEOPARD Starspots Catalog: Impact of Stellar Magnetism on Dwarfs and Giants** Surface magnetism in cool stars support dark starspot complexes, systematically inflating stars and changing their interior structure. Recently, two-temperature starspot models were applied to APOGEE high-resolution infrared spectra in open clusters, demonstrating 1) a precise mean spot-Rossby relation with a genuine field saturation at rapid rotation, 2) temperature/radius systematics in active stars present in spectroscopic pipelines due to a cool starspot component, and 3) a pattern of starspot evolution across age. Remarkably, such measurements also demonstrate systematic departures from the standard Rossby paradigm: starspot activity is strongly enhanced in stars undergoing stalled spin-down, which supports the hypothesis that stars with strong internal shears can drive anomalously strong surface fields. We present the LEOPARD dwarf starspots catalog (~135,000 stars) and explore the diagnostic power of ~8,000 RGB/RC stars in the preliminary LEOPARD-APOKASC giants sample with evolutionary state determinations. We discuss the potential synergies of joint asteroseismic and magnetic characterization and suggest tests of proposed activity paradigms in evolved stars. Finally, we anticipate the role of TESS in advancing models of stellar interiors and dynamo evolution in these populations.
Chadid, Merieme	University of Cote d'Azur	**First Detection of Gravity Modes in RR Lyrae Stars** I report the first detection of gravity modes in RR Lyrae stars. Despite great ground-based and space observations, the oscillation modes whose restoring force is gravitation have been actively searched for several decades. The detection of any gravity wave signal in the Sun, the most observed and best known star to human beings, is still a highly contentious issue today. Thanks to Photometer AntarctIca eXtinction (PAIX), the first Antarctic polar photometer. Unprecedented and uninterrupted UBVRI time-series photometric ground-based data are collected during 150 days from the highest plateau of Antarctica. PAIX light-curve analyses

		reveal an even richer power spectrum with mixed modes in RR Lyrae stars. Lower and higher frequencies and harmonics linearly interact with the dominant fundamental radial pressure mode and its second and third overtone pressure modes, and Half-integer frequencies as well. However, the most striking discovery is the direct detection of gravity waves. I discuss a possible mechanism for the excitation of gravity modes in RR Lyrae stars and I show that RR Lyrae stars are simultaneously p-mode and g-mode pulsators. This first detection makes RR Lyrae stars very challenging stellar objects, and provides their potential to undergo both p- and g- modes at the same time toward a breakthrough of the theory of stellar evolution and a better understanding of the universe.
Chickles, Emma	MIT	**A systematic search of short period variability using TESS Cycle 5 data** We give an update on our efforts to systematically search over a million white dwarfs in TESS Cycle 5 data for periodic signals under 3 hours using a GPU-implementation of the Box Least Squares algorithm. In Cycle 5 of TESS, the full frame image exposure time was decreased from 600 to just 200 seconds, which has sufficient temporal resolution to resolve the narrow eclipses of binaries involving a white dwarf and another small object. We use aperture photometry to extract light curves for 1.4 million Gaia eDR3 white dwarf candidates from TESS full frame images. We discuss the recovery of known cataclysmic variables (CVs) from our period search and implications for inferring a CV orbital period distribution from eclipsing CVs, which will be unbiased to the selection effects from identification by accretion signatures. We plan to conduct spectroscopic follow-up, with which we can characterize candidate CVs in our sample with orbital periods in the observed period gap from 2 to 3 hours and with orbital periods less than the observed CV period minimum of 80 minutes, which will allow us better understand the underlying physics giving rise to the period distribution.
Chiti, Federica	Institute for Astronomy, University of Hawai'i at Mānoa	**Gyrochronology Challenges at the Fully Convective Boundary: Insights from WD + MS Binary Systems** Determining stellar ages is crucial to understand star and exoplanet evolution, as well as the history of the Milky Way. Low-mass stars are the most abundant stars in the galaxy but they evolve slowly on the main sequence, making it difficult to infer their ages. Gyrochronology, which relies on the star's spin-down over time, is a promising method for determining ages in this mass regime, but requires proper calibration. Currently, there are no age-rotation calibrators for stars less massive than 0.8 $M_\odot$ and older than 4 Gyr. We propose using wide, coeval, white dwarf + main sequence (WD + MS) binaries, where the WD component enables an independent estimate of the system age and calibration of the period-age relationship. We construct a sample of 144 WD + MS binaries from Gaia, derive the total age of each WD, and use calibrated models of stellar angular momentum evolution to determine system ages based on the rotation of the MS companions. Both our data and models show the existence of a highly steep vertical feature in the temperature-period space at the fully convective boundary for ages up to 4 Gyr, where a slight shift in temperature corresponds to a much younger or older age of the star. Due to the current temperature uncertainty, there is no unique mapping between age and rotation period for stars along this feature, suggesting that gyrochronology may not be feasible for M dwarfs at the fully convective boundary.
David-Uraz, Alexandre	Howard University/NASA Goddard Space Flight Center	**Variability characteristics of OBA stars: how to find magnetic needles in a large data haystack** Among all stars with radiative envelopes, roughly 10% exhibit a strong surface magnetic field. Such a field bears important consequences on mass loss, atomic diffusion, and angular momentum transport and loss, ultimately affecting both its present-day "appearance" as well as its later evolution -- possibly leading to exotic late stages and remnants, such as magnetars, pair-instability supernovae, and highly-magnetized white dwarfs. Many observables across the electromagnetic spectrum may contain clues regarding a hot star's magnetic field, from the radio to the X-rays. However, not all of these observations are practical to obtain. In contrast, the wealth of observational data yielded by the Transiting Exoplanet Survey Satellite represents a truly transformative opportunity to gain more insight on the magnetic subpopulation of OBA stars. To fully leverage this resource, we are conducting a systematic population study aimed at identifying the general optical broadband variability characteristics of OBA stars and contrasting them to those of the known magnetic stars within that spectral type range. In this talk, I will review the latter and discuss strategies to disentangle rotational modulation from other periodic

		signals. I will also present our sample and some preliminary results from the larger population study. Ultimately, this study will help us better understand the properties of known magnetic stars, while further enabling us to identify hundreds to thousands of new magnetic candidates with more robust criteria. This will crucially improve existing statistics (especially for stars with higher masses), enabling us to tackle open questions regarding the origins of magnetic fields on OBA stars and their evolution.
Dewberry, Janosz	Canadian Institute for Theoretical Astrophysics	**Dynamical tides in rapidly rotating stars** Tidal interactions between compact objects, stars, planets and moons help to shape orbital dynamics in a wide variety of astrophysical systems, but quantitative predictions for tidal distortion and dissipation in rapidly rotating bodies remain contentious. I will describe direct numerical calculations of tidal dissipation in rapidly rotating, centrifugally flattened models of stars. I will introduce calculations for simple polytropic models rotating at up to the critical limit, as well as more realistic stars constructed with stellar evolution codes such as MESA. These numerical calculations facilitate the direct evaluation of sustained resonant tidal dissipation in rotating stars and stellar remnants, which may be important to an extensive range of tidal interactions in astrophysics.
Fox-Machado, Lester	Instituto de Astronomia - UNAM	**The nature of KIC 2162283 from ground based spectroscopy and space photometry** We present ground-based spectroscopy and space photometry of KIC 2162283, -a delta Sct / gamma Dor hybrid candidate star and suspected ellipoidal variable (ELL). Spectroscopic observations were secured at the San Pedro Martir observatory in Mexico between 2017 and 2019 years at 15 different epochs with the Echelle REOSC spectrograph attached to the 2.1m telescope. The atmospheric parameters of the star such as Teff, log g and v sin i were derived and are in good agreement with those reported in previous studies. The radial velocity analysis reveals that KIC 2162283 is a single-lined spectroscopic binary with an orbital period of 1.89 days, which is approximately twice the period of 0.902 days of the ellipsoidal variations seen in the Kepler and TESS light curves. We derived a systemic velocity $\gamma = 6 \pm 1$ Km s^{-1}, a semi-amplitude $K_1 = 10 \pm 2$ Km s^{-1} and an eccentricity value of 0.33. In order to search for pulsations a Fourier analysis of all available Kepler and TESS data has been performed, after extracting the effects of the binarity from the light curves. 30 frequency peaks are detected between 0 and 19 c/d, the frequency and period spacing are investigated. We conclude that KIC 2162283 is an ellipsoidal variable in a close SB1 system with a Delta Scuti component.
Galoy, Marion	IRAP	**Coupling between the inertial modes of convective core and gravito-inertial modes of the radiative zone in gamma Doradus stars** Gamma Dor stars have a convective core, a radiative envelope as well as a convective superficial envelope. Those stars are usually moderate to fast rotators and are known to oscillate according to gravito-inertial modes that are generally well described by the so-called traditional approximation of rotation (TAR). However, pure inertial modes may propagate in their convective core, which is not predicted by the TAR. Theoretical models predict that these inertial modes trapped within the core can couple with gravito-inertial modes in the radiative zone (Ouazzani et al 2020). These mixed modes create dips in the regular period spacings of series of modes with same degree and azimuthal order. Such dips have been already detected in some rapidly rotating Gamma Dor stars observed by Kepler (Ouazzani et al 2020, Saio et al. 2021). Our work aims to characterize this coupling, especially how these dips depend on various stellar properties, starting with the rotation rate Ω of the convective core. To completely take into account the effect of rotation on oscillations, we compute modes with the TOP code (Two-dimensional Oscillation Program). Oscillation spectra are dense in the considered frequency ranges making the numerical problem difficult: we first needed to develop tools to recover interesting series of modes among a dense forest of small-scale, or even unresolved, modes. We also carefully quantify the precision of frequencies we have reached. We extensively analyzed zonal and prograde l=2 modes and prograde l=1 modes. We find dips around the spin parameter ($s=2\Omega/\nu$) corresponding to inertial modes of the convective core alone, as expected in Ouazzani et al (2020). We show that those dips vary in depth and width with the rotation of the star. In particular, dips are more spread when the rotation rate increases. We then compared our computation to the theorical model proposed by Tokuno & Takata (2022). This study offers

		the opportunity to develop new seismic diagnosis to probe the rotation and the structure of the convective core of gamma Dor stars.
García, Rafael A.	Dap/CEA	**Extracting reliable latitudinal differential rotation from photometric lightcurves** One of the key physical processes responsible of the surface magnetic activity and magnetic cycles in solar-like stars is differential rotation. In the last 15 years, thanks to the advent of continuous ultra-high precision photometry from space-based instruments such as CoRoT, Kepler, and TESS, averaged surface rotation rates have been measured for many different teams for more than a hundred thousand stars. In the case of latitudinal differential rotation, only a few research groups have been able to report values deemed to be reliable. Moreover, in some cases, the community has not reached a consensus on the reliability of the methods used. In this work, we present a new methodology to extract reliable lower limits of latitudinal differential rotation. The method has been tested on simulated data providing very promising results. From a set of 1000 simulated stars with 61% of them containing differential rotation, only ~10% of them were retrieved. Although the recovered fraction is small, in some cases it could be justified by the low inclination angle and the small fraction of differential rotation simulated. Our methodology provides only 0.7% of false positives leading to a reliability of above 99% of the stars for which a differential rotation is reported. Moreover, a quick visual inspection of the light curves of the false positives is often enough to identify them as being polluted by instrumental. A preliminary result based on a test set of 5,200 Kepler stars show differential rotation reported for about 6% of the sample (~300 stars). By the time of the conference, we will report the results for the entire Kepler sample. We will then discuss how differential rotation is related with different stellar parameters.
Gebruers, Sarah	KU Leuven	**Uniting spectroscopy and asteroseismology for BAF-type stars** Our current knowledge about stars is encapsulated in the theory of stellar structure and evolution. Although our understanding of this subject has improved greatly over the last few decades, there are still uncertain physical processes at play. One way to constrain these unknown processes and to pin down the relevant mechanisms in the stellar interior is by studying the pulsations of stars. Via asteroseismic modelling of gravity mode pulsators it is possible to probe what is going on in their near core region. Another way to advance our understanding of the stellar structure is by studying surface characteristics of stars using spectroscopy, because mixing processes inside stars also influence their atmospheric characteristics. Both methodologies, asteroseismology and spectroscopy, essentially use light from the same star, however their results can turn out to be inconsistent. Therefore we developed a Bayesian framework that combines the two analyses. The spectroscopic component uses a machine learning method called zeta-Payne for the spectrum analysis which simultaneously fits the surface parameters and determines the best response function. The asteroseismic component consist of period spacing pattern fitting. We focus on main-sequence stars with BAF spectral type and the two classes of gravity mode pulsators among them: gamma Doradus stars and slowly pulsating B-type stars. Our combined methodology shows promising preliminary results for consistent analyses of these types of stars.
Gehan, Charlotte	Max Planck Institute for Solar System Research, Göttingen, Germany	**Magnetic activity of red giants : impact of tidal interactions on magnetic fields** According to dynamo theory, stars with convective envelopes efficiently generate surface magnetic fields, which manifest as magnetic activity in the form of starspots, faculae, flares, when their rotation period is shorter than their convective turnover time. Most red giants, having undergone significant spin down while expanding, have slow rotation, thus no spots. However, some red giants that belong to close binary systems display a photospheric activity measured from photometric time series produced by the NASA Kepler mission, which is about an order of magnitude larger than that of single red giants with similar rotation periods. In order to investigate whether binarity leads to larger magnetic fields when tides lock systems, or if a different spot distribution on single versus close binary red giants can explain this fact, we measured the chromospheric emission in the CaII H & K lines of LAMOST optical spectra. We find that red giants belonging to binary systems in a configuration of spin-orbit resonance

		display significantly larger chromospheric emission than single stars, suggesting that tidal interactions lead to larger magnetic fields. In other words, the large magnetic field of red giants in close binary systems is not only due to the faster rotation rate induced by tidal interactions. Somehow, our work resuscitates an old speculation about a special binary-induced dynamo activity.
Gootkin, Keyan	University of Hawai'i	**A correlation of Pulsator Fraction with Stellar Rotation Revealed through 100,000 TESS δ-Scuti Variable Candidates** δ-Scuti variables reside at the intersection of the classical instability strip and the main sequence on the Hertzsprung-Russell diagram. Despite our understanding of the underlying mechanisms driving pulsations in δ-Scuti stars, many stars within the instability strip do not pulsate. With space-based photometry providing millions of light-curves of A-F type stars, we can now probe the occurrence rate of δ-Scuti pulsations in detail. Using 30-min cadence light-curves from NASA's Transiting Exoplanet Survey Satellite's (TESS) first 26 sectors we identify variability in 118,739 stars within 5-24 cycles per day, which we identify as δ-Scuti candidates. With an all-sky coverage and magnitude completeness down to an apparent TESS magnitude of T=11.25, this represents the largest systematic search for such stars conducted to date. We derive an empirical instability strip using Gaia photometry and find that pulsator fraction peaks at just 50-70%. We discover a surprising correlation of pulsator fraction with spectral line broadening from Gaia RVS, suggesting that rotation has a role in exciting pulsations in A-F stars. Finally, we fit the period-luminosity relation for δ-Scuti stars in the Gaia G-band, allowing us to distinguish pulsators from contaminants for a subset of 38,385 stars. Out of this subset, over 17,000 follow the expected period-luminosity relation, representing 85% of targets within the instability strip. The remaining 15% of variables within the instability strip are likely hybrid or γ-Doradus pulsators.
Grunblatt, Samuel	Johns Hopkins University	**Asteroseismology of Luminous Red Giants with TESS and WISE** Measuring distances to luminous stars is essential for understanding the structure and formation of our Galaxy and the expansion rate of our Universe. In the last decade, increasingly large area time-domain surveys like Kepler and TESS have made it possible to identify oscillations in hundreds to thousands of these stars to distances more than 10 kpc away, transforming our knowledge of distant parts of our Galaxy and improving models of its formation. The NEOWISE survey, while not as precise or high-cadence as the Kepler and TESS surveys, captured infrared stellar variability in thousands of luminous red giant stars which are too faint for visible light oscillation detection with Kepler and TESS. These infrared oscillations observed by NEOWISE can be detected in luminous red giants all over our own Galaxy as well as dwarf satellite galaxies of the Milky Way. Here we present our new approach to performing asteroseismology with archival NEOWISE data, by demonstrating its agreement with TESS detections in bright stars and its potential to characterize populations of fainter stars unreachable by other current surveys. We use these oscillations to measure distances to thousands of individual stars in the Milky Way and the Magellanic Clouds from oscillations observed in NEOWISE, and compare the distribution of stars to galaxy models. We also use this study to predict yields for measurements of luminous red giant oscillations by upcoming surveys, such as the upcoming Roman and Rubin telescope surveys, and highlight the importance of these oscillation detections in strengthening and expanding the reach of an underutilized rung of the cosmological distance ladder.
Handler, Gerald	Nicolaus Copernicus Astronomical Center Warsaw	**Maia variables - fact or fiction?** For stars to exhibit pulsations, a mechanism driving the oscillations is required. Several such mechanisms are known and are associated to certain properties of the oscillating star. As a consequence, different groups of pulsating stars occur in specific regions in the HR Diagram: their instability strips. However, there have been reports of pulsating stars outside of the known instability strips. Perhaps the most (in)famous ones have been named the "Maia" variables, a group of late B to early A type stars that apparently show pressure mode oscillations, but are located between the instability strips of the Slowly Pulsating B and the Delta Scuti stars, a region where no currently known pulsational driving mechanism is at work. The existence of these variables has been controversial since the 1950s and it has meanwhile been demonstrated that Maia itself does not show detectable pulsations. Nevertheless, in recent years some reports of related objects have appeared in the literature, mostly based on highly accurate space

		photometry. To investigate the nature of these objects, we have obtained and analysed high resolution spectra of 31 of these objects as well as examined their TESS photometric data. According to our results, many of these stars are normal Beta Cephei and Delta Scuti pulsators, but some objects remain outside of any known instability strip. We have checked those for contamination in the large TESS pixels, possible binarity and rapid rotation. In this presentation, we discuss how many of those stars can indeed be considered to be pulsators "without a cause" (if any) and why. In any case, we propose that the designation "Maia variables" be abandoned.
Hatt, Emily	University of Birmingham	**An Ensemble View of Magnetic Imprints on Mixed Modes at the Base of the RGB** Mixed mode asteroseismology has to date provided observations of core magnetic fields in only a handful of red giants. The frequency and diversity of magnetic field structures in evolved solar-like stars has yet to be explored. Starting with stars at the base of the RGB we investigate the mixed mode properties of a large population of targets, inferring the prevalence of magnetic signatures. After fitting for the asymptotic g-mode parameters, we produce stretched period echelle diagrams directly from the power spectrum. These are then used to calculate joint estimates of the rotational and magnetic splitting for a sample of over 300 stars. Core magnetic fields on the RGB could be the remains of a field generated in the convective core on the main sequence. This would result in a strong correlation between observed magnetic splitting and mass. We use the sample to look for this relation, testing the hypothesis that the fields are the remains of a convective core dynamo on the main sequence.
Hedges, Christina	NASA GSFC	**Update from the TESS Science Support Center at NASA GSFC** The TESS Science Support Center (TSSC) helps the community in many ways, including providing Python tools to work with TESS data, writing tutorials and documentation, running the helpdesk, and running the TESS General Investigator (GI) proposal call. In this talk I will update the asteroseismology community on TSSC activities and will highlight i) GI funded work in the asteroseismology community ii) upcoming tools and enhancements specifically for asteroseismology iii) data products that the community can use and iv) funding opportunities.
Hermes, JJ	Boston University	**Outrigger modes in pulsating white dwarfs** Space-based observations of pulsating white dwarfs has opened a new window into the interiors of compact objects, given the newfound ability to detect low-amplitude pulsation modes unconfused by aliasing from gaps in observations. Dozens of pulsating white dwarfs now have reliable g-mode identifications thanks to the interpretation of frequency patterns caused by rotational splittings. However, there is at least one pulsating white dwarf discovered in the K2 mission that has a highly confusing set of frequency splittings that cannot be simply explained with usual rotation or even oblique magnetic models. Several modes in this star have splittings that are symmetric about a central component, but are unevenly spaced, appearing to be outriggers to a dominant rotational multiplet. I will discuss the detailed observations of this star (including three campaigns in K2, as well as ultraviolet observations from the Hubble Space Telescope), as well as possible interpretations of these outrigger modes.
Hey, Daniel	University of Hawaii	**The far side of the Galactic bar/bulge revealed through pulsating red giants** The Galactic bulge and bar are critical to our understanding of the Milky Way. However, due to the lack of reliable stellar distances, the structure and kinematics of the bulge/bar beyond the Galactic center are largely unexplored. Here, we present a new method to measure distances of pulsating M giants using a period-amplitude-luminosity relation anchored to the Large Magellanic Cloud, with random uncertainties of 10–15% and systematic errors below 1–2%. We apply this method to ground-based photometry to measure distances to over 200,000 stars in the Galactic bulge out to 20 kpc, and validate it with TESS photometry. Using this sample we measure a distance to the Galactic center of R0 = 8108 ± 106stat ± 93sys pc, consistent with astrometric monitoring of stars orbiting Sgr A*. Cross-matching the distances with Gaia we furthermore constrain the Milky Way's velocity field beyond the Galactic Center, showing for the first time that the bar is both bi-symmetric and aligned with the inner disk, and therefore dynamically settled along its full extent. The results demonstrate that pulsations of M giants are a powerful distance marker to probe stellar populations in our galaxy.

Hon, Marc	University of Hawaii	**The Great Escape of A Giant Planet from Planetary Engulfment** When main-sequence stars expand into red giants, they are expected to engulf close-in planets. The absence of planets with short orbital periods around red clump stars has been interpreted as evidence that close planets around Sun-like stars do not survive the red giant branch phase of their host stars. Here, I present the discovery that a known close-in exoplanet actually orbits a red clump star and therefore has a 'forbidden' existence. As an unlikely survivor to its previously expanding host star, the planet may have avoided engulfment through a stellar merger of its host star that drastically altered the star's evolution. This is the first confirmed close-in planet around a red clump star and it provides evidence for the role of non-canonical stellar evolution in the extended survival of late-stage exoplanetary systems.
Howell, Madeline	Monash University	**Using Asteroseismology to Study Stellar Mass Loss and Multiple Populations in the Globular Cluster M80** Asteroseismology provides a new avenue for accurately measuring the individual masses of evolved stars, with the detection of their solar-like oscillations. By measuring seismic masses of globular cluster (GC) stars, we are able to explore aspects of stellar evolution. Here we present the first detections of solar-like oscillations in 48 red giants in the globular cluster M80; a metal-poor GC, and only the second ever with seismic data. We investigate two major areas of stellar evolution and GC science; i) stellar mass loss, and ii) the multiple populations in GCs. Mass loss remains a major uncertainty in stellar modelling. This uncertainty propagates to studies that use these models as inputs. By taking the differences in the averaged measured masses in various phases of evolution, a total integrated mass loss can be quantified. Mass loss is thought to scale with metallicity, which we test by comparing our results to the seismic masses from a higher-metallicity GC, M4. From this comparison, we notice that there is a significant metallicity and temperature dependence in the mass loss on both the red giant branch and horizontal branch. We also investigate whether there are mass differences between the sub-populations in M80. We detect a distinct bimodality in the (early) asymptotic giant branch mass distribution. This could be a signature of sub-population membership. If confirmed with spectroscopy, it would be the first direct measurement of a mass difference between sub-populations. We also report strong evidence for mass loss differences between the sub-populations. Differing mass loss rates on the red giant branch has been proposed as the second parameter that could explain the horizontal branch morphology variations between GCs.
Kalup, Csilla	Konkoly Observatory	**Seismic analysis of the upper giant branch and the horizontal branch of NGC5897 with K2** Each globular cluster offers us a unique opportunity to trace the evolution of its individual stars and of the cluster as a whole. Different stages of stellar evolution can be probed by asteroseismology of variable stars. For this purpose, globular clusters provide a homogeneous sample of variables, because they contain stars with roughly the same physical properties such as distance, age and chemical composition. This also gives us a chance to study the pulsation properties as a function of the physical properties of the clusters. During the K2 mission of the Kepler space telescope, eight globular clusters were observed. Despite the large number of targets, only two have been studied so far, as these investigations require special procedures due to the high stellar density of globular clusters and their proximity to the bulge of the Milky Way. In my talk, I will focus on the red giant, RR Lyrae and SX Phoenicis stars of the metal-poor globular cluster, NGC5897. We present the first detailed seismic analysis of the RR Lyrae stars of the cluster, and compare them to other bulge, field and cluster RR Lyraes observed by OGLE, TESS and K2. We detected low-amplitude additional modes that were never seen before in this cluster. We also report newly discovered variables based on their position on the Hertzsprung-Russell diagram. We found that the distribution and abundance of the low-amplitude additional modes, as well as the frequency of modulated stars are considerably different from other samples, which can be caused by the very low metallicity of the cluster. Supplementing the K2 results with Gaia DR3 measurements, we created the most precise color-magnitude diagram of NGC5897, clearly showing the separation of the upper RGB and AGB stars. We tested various methods to obtain light curves, power spectra and oscillation signals of multiple RGB and AGB stars from the brightest part of the color-magnitude diagram.

		Asteroseismic detections in the cluster will help us to explore the properties of the cluster in even more detail.
Kim, Agnes	Penn State Scranton	**The parameters that matter in white dwarf asteroseismic fitting: A systematic study** To date, pulsational variability has been measured from nearly 50 DBVs and 500 DAVs, with only a fraction of these having been the subjects of asteroseismic analysis. Space missions such as Kepler, Kepler 2, and TESS have been major contributors to the wealth of data collected on pulsating white dwarfs. The White Dwarf Evolution Code (WDEC) has been used in the computation of models to perform asteroseismic fitting of these objects. It accepts as input parameters; mass, effective temperature, and parameters that describe the chemical profiles of the model. A pulssation spectrum is then obtained and compared with that of the star of interest. The goal of asteroseismic fitting is to find the set of parameters that produce a model that best matches the observed periods. The current version of the WDEC accepts a total of 15 parameters. It is not computationaly manageable (or necessary) to vary all for every object. We need to know which parameters matter the most and this is unfortunately star dependent. We engage in a systematic study, based on a sample of 15 DAVs chosen to be representative of the types of pulsation spectra we encounter in white dwarf asteroseismology. We find that there are patterns, some expected, some less expected. The results of this study can be used to help select the parameters that matter most, based upon what types of periods one finds in the spectrum to fit.
Kitiashvili, Irina	NASA Ames Research Center	**3D Radiative Hydrodynamics Modeling of Acoustic and Gravity Modes Excitation in Main-Sequence Stars with Shallow Outer Convection Zones** Realistic modeling of main-sequence stars with shallow convection zones opens an opportunity to investigate their turbulent dynamics in detail, particularly their oscillatory properties and mechanisms of excitation of the different modes, as well as the structure and dynamics of the ionization zones and the tachoclines. We perform high-resolution 3D radiative hydrodynamics simulations using the StellarBox code to model moderate-mass stars of different masses and metallicity. Each stellar model includes the upper radiative zone, the whole convection zone, and the lower atmosphere. This approach allows us to investigate how properties of the convection zone structure and dynamics depend on the global properties of stars, such as the stellar mass and metallicity. We also analyze the simulation results to study the coupling of rotation, convection, and stellar oscillations. In this presentation, we discuss mechanisms and properties of acoustic and internal gravity waves excited near the photosphere by turbulent high-speed downdrafts (~20km/s) and the convective overshoot layer at the bottom of the convection zone, as well as the effects of rotation. The results shed light on the mechanisms of excitation of acoustic and gravity modes and demonstrate the differences from the standard stellar models due to dynamical processes not included in the stellar evolution theory. This work is supported by the NASA Astrophysical Theory Program.
Kolenberg, Katrien	KU Leuven, University of Antwerp, VUB	**AstroSounds: probing the power of sonification for asteroseismology** AstroSounds is a citizen science project aimed at investigating to what extent the human ear is capable of distinguishing the timbre of different pulsating star types. At the same time, it is an educational project, inspired by the research field of asteroseismology, naturally linking different STEAM curriculum topics, such as physics, mathematics, biology, chemistry and music education. In the successful pilot project of AstroSounds, ran in Belgium from 2020 onwards and funded by the Flemish government, numerous Kepler/K2 and TESS light curves were used for sonification. In this short contribution, I will describe the work behind the scenes to set up our citizen science project, select light curve data, and sonify them. Subsequently, in an interactive Q&A, I would like to pick the asteroseismic experts' brains to plan our next steps in this sonification project.
Kosovichev, Alexander	New Jersey Institute of Technology	**Physical Properties of Low-Frequency Oscillations of Rotating Stars** The stellar rotation modifies the spectrum of g-modes and drives inertial oscillations, among which the quasi-toroidal Rossby (r) modes are most prominent. In the low-frequency range, the effect of stellar rotation cannot be described in terms of small variations resulting in the splitting of mode multiplets. We develop a general theory of linear non-radial oscillations of rotating

		stars, which is applied to relatively slow-rotating (thus, slightly deformed) solar-type stars. We show that in the stellar regions where the magnitude of the Brunt-Vaisala frequency is much greater than the frequency of rotation, the gravity and inertial modes are described by eigenfunctions of the Laplace tidal equation. In the rich gravity-inertia mode spectrum, this regime reveals fast prograde g-modes and slow retrograde r-modes. We calculate the surface and radial structure of low-degree r-modes for the standard solar model. We show that these modes can propagate in the radiative zone and the tachocline and be trapped in the sub-surface superadiabatic zone. We calculate the mode amplitude spectrum assuming that they are excited by the near-surface turbulent convection. In addition, we investigate the interaction of the r-modes with the latitudinal solar- and anti-solar differential rotation. We find that the solar-type differential rotation leads to the instability of low-order r-modes, which can play a significant role in stellar dynamics and magnetism.
Lares Martiz, Mariel	Institute of Astrophysics of Andalusia	**Fine structure of combination frequencies to identify different non-linear behavior.** One of the undisputed successes of the TESS and K2 missions is the possibility to study more deeply the non-linear behavior of a pulsating star by detecting many of its combinations of frequencies. Although these combinations add complexity when performing a proper asteroseismic analysis, they also can provide new information about the stellar structure from which they take their origin. There are several mechanisms present in pulsating stars that can generate linear combinations in their power spectra. Resonances, significant temperature changes in the stellar outer regions, and rotationally induced modulation or binarity are some of these mechanisms. Recently, we fully characterized a sample of HADS stars observed by the TESS satellite. In them, pulsation modes and their combinations follow strict phase and amplitude relationships identified with severe temperature changes in the outer regions of the star. Moreover, these observed patterns correlate directly with the star's surface gravity and effective temperature. Thus, the nonlinearities help to estimate the stellar fundamental parameters. Similarly, we will study the nonlinearities from the other mechanisms mentioned above. We will see if they follow patterns that identify them, as in the case of HADS stars. In this talk, I will present the software used to determine the non-linear part of a light curve, precisely the Best Parent Method, in its automatic version to massively obtain non-linear pulsations. On the other hand, I will show how the harmonics of the orbital period in binary systems are clearly distinguished from the nonlinearities resulting from resonances. Additionally, I will show if the phase and amplitude relationships in other pulsating stars, such as Cepheids and RR-Lyrae, can be characterized as they were for HADS stars. This study directly impacts the effort to unravel complex power spectra and the challenge of building data-driven non-linear models, in this way contributing to maximizing the exploitation of data from future missions such as PLATO.
Li, Gang	KU Leuven	**Asteroseismology in the young open cluster NGC2516 observed by the TESS mission** NGC2516, also known as the southern beehive, is a well-studied young open cluster in the southern hemisphere. Previous research of the cluster was mainly based on ground-based photometric and spectroscopic observations, which were not suitable for asteroseismology. Thanks to the 1-yr continuous photometric data by TESS, it is now a good time for asteroseismologists to reveal the oscillations of the cluster members. Performing simultaneous asteroseismic and isochrone modelling of pulsators in clusters promises to be much more powerful than just asteroseismic modelling of field stars because the stars in a cluster are equally old and were born with the same initial composition. These requirements will be of great help to break degeneracies that currently plague asteroseismology of field stars of intermediate mass. We successfully identified tens of variable stars, including gamma Doradus, delta Scuti stars, eclipsing binaries, and red giants. We identified period spacing patterns in some of the gamma Dor stars, including g modes and r modes, which allow us to measure their near-core rotation rates and asymptotic spacings. We also measured the surface rotation rates of tens of hot member stars (Teff>6000K). Our results will be combined with high-resolution spectra by the ESO FEROS spectrograph to provide input for joint seismic and cluster modelling as a road to improve the theory of stellar interiors.
Li, Yaguang	University of Hawai`i	**Enhancing stellar properties through ensemble modelling techniques** Addressing fundamental questions such as a star's age, luminosity, and mass can provide insights into a range of significant topics across the Galaxy, stellar, and exoplanetary studies. However,

		current techniques for determining stellar properties have yet to be fully optimized. A frequently underestimated, yet potent methodology is ensemble modelling analysis, which simultaneously models a group of stars. The strength of this approach lies in its ability to model underlying correlated parameters. In this presentation, I introduce two applications of ensemble modelling. The first application involves a prescription of the surface effect as a function of surface gravity, effective temperature, and metallicity. We can eliminate unrealistic surface corrections and improve parameter estimations. The result also provides us a correction for the $\Delta\nu$ scaling relation that, for the first time, incorporates the surface correction. In the second application, we model two stars in a binary system concurrently, leveraging the fact that these stars are coeval. This approach has the potential to yield accurate inferences on stellar ages and helium abundances. To conclude, ensemble modelling presents a promising path towards achieving unprecedented precision in determining stellar parameters.
Lindsay, Christopher	Yale University	**Fossil Signatures of Main-sequence Convective Cores Observed Through Kepler Asteroseismology of Subgiant Stars** Some physical processes that occur during a star's main-sequence evolution affect its post main-sequence evolution too. Stars with masses above approximately 1.2 solar masses host well mixed convective cores on the main-sequence, but the stellar structure in the neighborhood of the convective core regions is currently underconstrained. We use asteroseismology to study core properties, including convective boundary mixing, in such intermediate mass stars. These core regions are poorly constrained by the p-mode oscillations observed on the main sequence. We therefore seek fossil signatures of main sequence core properties during the subgiant phase of evolution. During the subgiant phase, modes of mixed character sample the deep interior, thereby imprinting such fossil signatures of the main sequence on the underlying frequencies. We model the radial and quadrupole p-mode frequencies, as well as the dipole mixed-mode frequencies, of more than 40 subgiants observed by the Kepler and K2 space missions. Using a grid spanning a wide range of initial parameters and evolutionary stages, we determine posterior distributions for the star's properties, including conditional distributions for the main-sequence core properties. We situate these results within the existing study of main-sequence convective core boundaries.
Lu, Lucy	Columbia University/AMNH	**An abrupt change in the stellar spin-down law at the fully convective boundary** The importance of the existence of a radiative core in generating a solar-like magnetic dynamo is still unclear. Analytic models and magnetohydrodynamic simulations of stars suggest the thin layer between a star's radiative core and its convective zone can produce shearing that reproduces key characteristics of a solar-like dynamo. However, recent studies suggest fully and partially convective stars exhibit very similar period-activity relations, hinting that dynamos generated by stars with and without radiative cores hold similar properties. Here, using kinematic ages, we discover an abrupt change in the stellar spin-down law across the fully convective boundary. We found that fully convective stars exhibit a higher angular momentum loss rate, corresponding to a torque that is ~2.25 times higher for a given angular velocity than partially convective stars around the fully convective boundary. This requires a dipole field strength that is larger by a factor of ~2.5, a mass loss rate that is ~4.2 times larger, or some combination of both of those factors. Since stellar-wind torques depend primarily on large-scale magnetic fields and mass loss rates, both of which derive from magnetic activity, the observed abrupt change in spin-down law suggests that the dynamos of partially and fully convective stars may be fundamentally different.
Lyttle, Alexander	University of Birmingham	**Hierarchically Modelling Many Stars to Improve Inference with Asteroseismology** Conventionally, we infer ages, masses, and radii with stellar evolutionary models on a star-by-star basis. However, by modelling many stars simultaneously, we can pool parameters together to learn from correlations between stars. We present a hierarchical Bayesian model which includes a statistical treatment of initial helium abundance (Y), mixing-length theory parameter (α), and other sources of uncertainty in stellar models. Parameterising distributions over Y and α in the population, we apply our model to a sample of dwarf and sub-giant solar-like oscillators observed by Kepler. We find pooling poorly constrained parameters reduces their uncertainty while characterising their distributions. Our method is fast and scalable, and provides

		uncertainty reduction which improves with more stars. We demonstrate how our method scales to tens of thousands of asteroseismic targets in the era of CoRoT, Kepler, and TESS, and in anticipation of PLATO and the Roman Space Telescope.
Mathur, Savita	Università di Bologna	**HAYDN - High-precision AsteroseismologY of DeNse stellar fields** HAYDN is a candidate ESA M7 mission aimed at radically improving our understanding of the building blocks of cosmic structures. HAYDN will gather high-precision, high-cadence, long photometric time series of large samples of coeval and initially-chemically-homogeneous stars in open and globular clusters, and will enable exquisite asteroseismic inference of stellar properties in dense stellar fields in the Milky Way. Such a mission will lead to breakthroughs in stellar astrophysics, especially in the metal-poor regime, will elucidate the evolution and formation of open and globular clusters, and aid our understanding of the assembly history and chemodynamics of the Milky Way's bulge and a few nearby dwarf galaxies. In this contribution we will review the mission payload, its science objectives and give an update on its status (the mission is currently in Phase-0).
Metcalfe, Travis	WDRC	**Probing Magnetic Stellar Evolution with Asteroseismology and Spectropolarimetry** During the first half of their main-sequence lifetimes, stars rapidly lose angular momentum to their magnetized winds, a process known as magnetic braking. Recent observations suggest a substantial decrease in the magnetic braking efficiency when stars reach a critical value of the Rossby number, the stellar rotation period normalized by the convective overturn timescale. Cooler stars have deeper convection zones with longer overturn times, reaching this critical Rossby number at slower rotation rates. Over the past several years, we have started to probe the nature and timing of the transition to weakened magnetic braking in stars across the HR diagram by combining asteroseismology from TESS with spectropolarimetry from the Large Binocular Telescope and other facilities. I will present an overview of what we have learned from these measurements, including new constraints on magnetic stellar evolution from subgiants, F-type stars, solar analogs, and cooler G-type stars. The results broadly support the weakened magnetic braking hypothesis, and elucidate the underlying causes of this unanticipated phenomenon.
Michielsen, Mathias	KU Leuven	**Observational probing of core masses and thermal structures with gravity modes** Internal mixing processes during the main sequence have a significant impact on the main sequence lifetime and core size of stars with convective cores. Indeed, one of the key quantities that determine a star's later stages of evolution is the mass of the helium core at the end of the main sequence. However, the properties of internal mixing remain relatively unconstrained by observations. Asteroseismology allows us to probe temperature gradients, mixing processes, and by implication the convective core mass due to the sensitivity of gravity modes to the physics of the near-core region. By modelling the gravity-mode period spacing pattern of rotating B stars observed by the Kepler space mission, we determine both the mixing profile and thermal structure in the near-core region for a carefully selected sample of SPB stars. We focus on a pristine example of a single SPB star and another in a close double-lined spectroscopic binary. A major advantage and novelty of our work is that we take the uncertainties for the theoretical predictions of the oscillation modes into account in the modelling procedure. Furthermore, we compare grids of models with different thermal structures, as well as varying the complexity of the mixing profiles using nested regression models in which we reward fit quality but penalise complexity. Our results include robust and unique constraints on the core masses and thermal structures allowing us to compare single and binary SPB stars, and demonstrate that the theoretical uncertainties are not to be neglected since they have a significant impact on the derived model parameters and the favoured degree of model complexity.
Miszuda, Amadeusz	Nicolaus Copernicus Astronomical Center of Polish Academy of Sciences	**Evolutionary and seismic modeling of delta Sct pulsators in eclipsing binary systems** Eclipsing binary systems are well-proven benchmarks in testing stellar evolution theory. Precise stellar parameters that can come from their analysis aid systems' age determination along with tracing back their evolution history. Eclipsing binaries that contain pulsating components are a special subclass of binaries that combine information coming from orbital and pulsational analyses. Whereas the single-star pulsators are rather well understood, the precise effect that binarity and possible mass transfer have on the pulsational characteristics of components has

		yet to be determined. In my talk, I will highlight some of the most important results from my studies of delta Scuti pulsators in binary systems. In particular I will discuss the effect that accumulation of He in outer layers of accretor caused by mass transfer has on excitation of the high radial-order g modes in models of delta Scuti stars and the evolution of radial mode frequencies during the main sequence evolutionary phase.
Mombarg, Joey	IRAP, Université Paul Sabatier, Toulouse, France	**Testing the theory of angular momentum transport on the main sequence** The theory behind the transport of angular momentum (AM), a key ingredient in stellar evolution, is currently a topic of large interest in stellar evolution theory, as asteroseismic measurements of stellar rotation rates from Kepler and TESS allow for observational calibration of the current theory. This talk compares the model-predicted AM transport with asteroseismic measurements of intermediate-mass and massive stars on the main sequence. For the intermediate-mass stars, I will present the comparison between 1-D state-of-the-art stellar evolution models with AM transport, and asteroseismic measurements of several gravity-mode pulsators close to the end of the main sequence. The AM transport is modelled by a viscosity computed from hydrodynamical and magnetic processes, assuming uniform rotation rate at the start of the main sequence that is a free parameter to be calibrated. I show that these models can in general explain the rotation profiles of intermediate-mass, although for some stars in the sample the predicted core-to-surface rotation ratio is larger than was has been observed. For the massive stars, I will present the predictions of the first 2-D stellar evolution models of rotating stars with the ESTER code. ESTER computes the rotation profile resulting from the baroclinic torque in a self-consistent manner, taking into account the centrifugal distortion of the star, something that is not possible with 1-D models. Switching from 1-D to 2-D stellar evolution models is crucial to model the evolution of stars with a significant rotation velocity more accurately. I show these models are in agreement with asteroseismically derived rotation profiles, and show predictions for the efficiency of chemical mixing induced by shear in the radiative envelope.
Murphy, Simon	University of Southern Queensland	**800,000 pulsation models of young delta scuti stars** The rapidly increasing number of delta Scuti stars with regular patterns among their pulsation frequencies necessitates modelling tools to better understand the observations. Further, with a dozen identified modes per star, there is potential to make meaningful inferences on stellar structure using these young delta Scuti stars. We describe our evolutionary and pulsation models of delta Scuti stars, spanning the early pre-main-sequence to roughly one-third of the main-sequence lifetime. We show how the asteroseismic parameters Dnu and epsilon change across the HR diagram and as a function of mass, age, and metal mass fraction. We show that the large frequency separation, Dnu, is insensitive to mass at the zero-age main sequence. We also show that in the frequency regime observed, the Dnu we measure (from modes with n=5--9) differs from the solar scaling relation by ~13%. We present our findings that the lowest radial order is often poorly modelled, and offer additional tools to aid in mode identification. Finally, we show that the pulsations of young delta Scuti stars can be exceptionally well-modelled, showcasing two pre-MS stars with 15+ identified modes and with random age uncertainties as small as 3%.
Patil, Aarya	University of Toronto	**Improving Power Spectrum Estimation using Multi-tapering: Precise asteroseismic analyses for understanding stars, the Milky Way, and beyond** Asteroseismic time-series data have imprints of stellar oscillation modes, whose detection and characterization through time-series analysis allows us to probe stellar interiors physics. Such analyses usually occur in the Fourier domain by computing the Lomb-Scargle (LS) periodogram, an estimator of the power spectrum underlying unevenly-sampled time-series data. However, the LS periodogram suffers from the statistical problems of (1) inconsistency (or noise) and (2) bias due to high spectral leakage. In this talk, I will present our novel multi-taper power spectrum estimator based on the Non-Uniform Fast Fourier Transform (mtNUFFT) that tackles the inconsistency and bias problems of the LS periodogram. mtNUFFT enables more accurate and precise frequency estimates of oscillation modes, and thereby ages of stars. I will demonstrate this using simulated and real light curves showing solar-like oscillations. For example, my method estimates the age of the Kepler-91 red giant with 36% better precision than APOKASC-2, which illustrates that mtNUFFT has promising implications for Galactic archaeology, in addition to stellar structure and evolution studies. I will then show how to combine mtNUFFT

		with the multitaper F-test to distinguish between different types of asteroseismic modes, and further improve their frequency estimation. Lastly, I will highlight that this new frequency analysis method generally applies to time-domain astronomy and is implemented in the public Python package tapify, available at https://github.com/aaryapatil/tapify.
Pedersen, May Gade	University of Sydney	**Identifying contaminating sources in TESS light curves** With its near full-sky photometric survey, the TESS space telescope has opened up exciting new opportunities for studying variable stars all across the HR diagram. However, with TESS' large pixel sizes the risk of nearby variable sources contaminating the studied TESS light curves is high, especially in crowded fields. When unaccounted for, such contamination bears the risk of associating the detected variability to the wrong target. Using the case of the newly identified Fast Yellow Pulsating Sugergiants (FYPS) as an example, we will demonstrate that studying the pixel data is crucial for identifying contaminating stars. We will do so by applying the openly available python tool TESS_localize to the TESS data, which allows us to localize the source of the identified variability in the pixel data. We will show that variable stars more than five magnitudes fainter than the intended target can introduce significant signals in the light curve not belonging to the target, and argue that studying the pixel data is an important step in analysing TESS data.
Reggiani, Henrique	The Carnegie Observatories	**Precise Asteroseismic Ages for Metal-Poor Red Giants and their impact on Galactic Archaeology** The complete 8D parameter-space galaxy's metal-poor stellar population (6D velocities, chemical pattern, and stellar age) can be used to investigate the earliest stages of its formation and chemical evolution. However, estimating individual stellar ages is one of the most difficult problems in stellar astrophysics. This scenario is now changing and is becoming possible to precisely obtain stellar ages by adding an additional data component: solar-like oscillations. By combining our extensive knowledge of the individual stars in our galaxy, photometric data spanning from the UV to the far infrared, stellar chemical content from high-resolution, high S/N, spectra, three dimensional galactic extinction, and astrometric information (parallax and proper motions) to the seismic data (solar-like oscillations), we can now precisely determine the relative ages of individual stars. However, most of the current developments in this area is focused on stars of metallicities higher than [Fe/H]~ -1.5. We have used the mid-infrared metal-poor star selection of \citet{schlaufman2014} and archival data to observe 9 K2 stars, including a star in the M4 Globular Cluster (with published asterosismic data) with high-resolution Magellan/MIKE spectroscopy. We have analyzed these nine red giants with the most current analysis technique, combining all photometric, astrometric, spectroscopic, and seismic data to infer the best possible relative ages of these metal-poor stars (-2.7 ≤ [Fe/H] ≤ -1.3). Our analysis correctly retrieves the metallicity and age of the M4 Gobular Cluster, and we can use our results to link the relative ages of the old metal-poor population with the chemo-dynamical history of the Milky Way.
Reyes, Claudia	University of New South Wales	**Asteroseimic modeling of the subgiants and redgiants in the open cluster M67 from three campaigns of K2 data** Sparked by the asteroseismic space revolution, ensemble studies have been used to produce empirical relations relating observed seismic properties and fundamental stellar properties. In this context, using cluster stars is particularly valuable because they have the same metallicity, distances, and age removing scatter and hence revealing smooth relations of stellar mass. We present the first seismic study of the open cluster M67 spanning the full range from subgiants to core Helium burning redgiants using all available K2 data. We are able to measure large and small frequency separations, the phase term epsilon, and the curvature term, as well as other features such as the occurrence of dipole mode suppression. From an eclipsing binary system, which enforces a strong constraint on stellar mass, we are able to provide an estimate of the accuracy of the relations we find. We have produced state-of-the-art 'boutique' isochrones tailored to M67's H-R diagram, which we compare to our seismic measurements, such as the C-D and epsilon-Dnu diagrams. We find a relation between overshooting and stellar mass reaffirming the need for better understanding of the factors that govern core overshooting. We perform peakbagging of l=0 and l=2 modes, allowing us to establish a precise surface term

		as function of numax. By detailed modelling of individual stars, we confirm the cluster age found via our isochrone fitting and provide an estimate of its uncertainty.
Rui, Nicholas	California Institute of Technology	**Gravity waves in strong magnetic fields** Observations of suppressed dipole modes in many red giants are expected to originate from strong core magnetic fields, although their effects on gravity waves have heretofore not been well-understood. We present a new non-perturbative formalism for deriving the eigenfunctions of magnetogravity waves (based on a "magnetic traditional approximation"), and derive their horizontal eigenfunctions for a dipole field in the general tesseral case. We demonstrate that, even in realistic field geometries, magnetogravity modes cannot remain radially propagating above a critical magnetic field, instead refracting to large radial wavenumbers where they are easily damped. Upward-propagating non-axisymmetric ($m\neq0$) modes develop sharp fluid displacement features at Alfvén-resonant critical latitudes. We consider the possibility that departures from the traditional approximations at these critical latitudes or the equator may allow some power to escape the stellar core. Finally, we discuss the simultaneous effect of strong magnetic fields and fast rotation rates, and their non-perturbative impacts on the period spacing.
Saunders, Nicholas	University of Hawaii Institute for Astronomy	**Evidence for Efficient Tidal Realignment of Giant Planets Orbiting Evolved Stars** The alignment between the stellar spin-axis and the orbital plane of planets (the obliquity) is a key diagnostic for planet formation. Hot Jupiters orbiting hot stars (>6200 K) display a wide range of obliquities, while similar planets orbiting cool stars are preferentially aligned. A leading theory to explain this trend is stellar tides, which are thought to damp initially high obliquities, and should be more efficient in stars with convective envelopes. Evolved stars provide a unique test for damping timescales, particularly stars which have crossed the Kraft break and gained deep convective envelopes. I will present the first systematic study of obliquities measured using newly obtained observations of the Rossiter-McLaughlin effect for hot Jupiters orbiting subgiants that recently developed convective envelopes. We find that hot Jupiters orbiting subgiants that crossed the Kraft break are aligned with the spin-axis of their host stars, indicating efficient tidal realignment after the emergence of a stellar convective envelope. I will compare our measured obliquities to theoretical predictions to test tidal evolution models and describe a pathway to the observed obliquity distribution, and comment on how asteroseismic measurements can be leveraged to examine the impacts of realignment on the stellar interior structure and characterize the evolution of the convective zone.
Schonhut-Stasik, Jessica	Vanderbilt University	**The APO-K2 Catalog: Availability of Catalog Products and Ongoing Investigations** Galactic archaeology is concerned with understanding the chemo-dynamical evolution of the Galaxy. Recently, a bevy of data from Kepler and K2 (providing stellar ages), Gaia (providing stellar velocities and distances), and extensive spectroscopic surveys like APOGEE (providing temperatures and abundance measurements) have revolutionized this field. We present a catalog of the stellar properties for a sample of ~8,000 evolved stars, with a well-understood selection function designed explicitly for Galactic archaeology. We determined stellar parameters from spectroscopic observations with the Apache Point Observatory Galactic Evolution Experience (APOGEE) survey and asteroseismic data from the K2 mission. The asteroseismic data allows for the calculation of stellar masses through well-established scaling relations, which can calculate ages when combined with spectroscopic metallicities and temperatures. Furthermore, a cross-match with Gaia EDR3 is incorporated to infer binarity and kinematics for the stars. We have released the APO-K2 catalog for use as we continue working with the sample. This will be discussed, including a detailed study of the multiplicity of the samples' evolved stars, a closer look at the abundances, and an investigation of the high-mass stars.
Scutt, Owen	The University of Birmingham	**Discrete Grids to Continuous Functions: Neural Network Emulation for Stellar Parameter Inference** Characterising stellar fundamental parameters is difficult. For instance, generating new stellar evolutionary tracks to reflect observations is computationally expensive. Additionally, quantifying the uncertainty inherent in comparison to stellar model grids can be challenging. To

		mitigate this issue, we use an artificial neural network as an emulator, converting discrete grids of stellar models into continuous functions with easily quantifiable emulation uncertainties. We present an example of the use of an emulator in the inference of fundamental parameters of delta Scuti oscillators. To achieve this, we apply Bayesian inference using nested sampling to recover plausible estimates of the posterior distributions. We find that the recovered posteriors for simulated stars can be non-Gaussian, multi-modal, and have strong covariance. Finally, we demonstrate the use of this method on real stars.
Sepulveda, Aldo	UH Institute for Astronomy	**TESS Characterization of Pulsating Stars Hosting Imaged Exoplanets** Characterizing host stars of directly imaged exoplanets is key to better understand their formation history. TESS photometry can be used to detect stellar pulsations and rotation frequencies, which enable asteroseismic analyses and can constrain the obliquity between the planetary orbit and the spin-axis of the host star. We present a TESS study of several stars known for hosting directly imaged giant planets, including 51 Eri, HR 8799, and HIP 65426. We present the discovery of Gamma Doradus pulsations in 51 Eri, and confirm previously found gamma Dor pulsations in HR 8799. We then use the pulsations to infer stellar rotation periods which imply a spin-orbit alignment for 51 Eri b and HR 8799 bcde. We conclude by presenting results on the TESS data for HIP 65426 (the first star with a planet directly imaged by JWST) where we detect a photometric rotation frequency and use it to find evidence for spin-orbit alignment of HIP 65426 b. Taken together, our work contributes to an emerging trend consistent with alignment between imaged long-period giant planets and their host stars.
Stephan, Alexander	The Ohio State University	**A Rapidly-Rotating, Lithium-Enriched Red Giant in the TESS SCVZ: A Compelling Candidate for a Recent Planetary Engulfment Event** Engulfment events are expected to occur for planetary systems with red giant hosts and are expected to spin up the star's rotation. We present compelling evidence of a candidate of such an event in an evolved red giant (log g ~ 1.5 dex) observed by TESS that shows an unusually rapid rotation period. The measured 98-day rotation period is confirmed using p-mode asteroseismology, photometric amplitude modulation, spectral line broadening, and spectral spot coverage measurements. We also find significant evidence for rotational shear in the envelope, which could be responsible for the observed rapid evolution of the spot morphology and thus magnetic activity. Such a high surface rotation rate is categorically incompatible with even the most physically permissive models of angular-momentum transport in single-star evolution. The spectroscopically determined near meteoritic lithium abundance of this star suggests the ingestion of a fairly massive substellar object, with an estimated mass of 12-16 M_jup based on the angular momentum of the rapidly rotating stellar envelope. This study provides further evidence that asteroseismology can be a powerful tool to identify and characterize stars that have recently interacted with substellar companions.
Su, Wenchao	Institut de Recherche en Astrophysique et Planétologie (IRAP)	**A new hybrid sdB pulsator with significant differential radial rotation in short-period binary observed by TESS** We present the discovery and detailed light curve analysis of a new hybrid sdB pulsator, TYC 4427-1021-1 (TIC 441725813), monitored for more than 500 days by TESS. The light curve analysis reveals that frequencies are most in the g-mode domain, but several p-modes are also seen, confirming that TIC 441725813 is a hybrid pulsator. Through methods that include asymptotic period spacing relationships and frequency multiplets, we identify 21 frequencies with $l = 1$ for g-modes, 9 frequencies with $l = 2$ for g-modes, and 2 frequencies for p-modes. Interestingly, frequency multiplets in the g-mode region indicate a rotation period of 85 ± 1.2 days while p-mode multiplets indicate a rotation period of 18.6 ± 0.4 days, which implies the core rotates nearly 4.6 times more slowly than the envelope. We suggest that this might be because it is an sdB+WD short-period binary. This surmise is reinforced by the extracted orbit signal with a period of ~ 6.7 h.
Van-Lane, Phil	University of Toronto	**A data-driven inference model for stellar age estimation using gyrochronology** Gyrochronology is a technique for stellar dating that depends on a star's rotation period, and location on the main sequence (MS) which can be determined using an observable such as colour. It is particularly useful for low mass main sequence stars, and so is a useful complement to techniques such as asteroseismology that perform well in the regime of more massive stars.

		Gyrochronology has gained traction recently due to the increasing availability of photometric data, however a generalized data-driven inference model that can predict stellar ages from observations in a probabilistic manner does not yet exist. To this end we apply a normalizing flow in the context of a Bayesian inference framework. Normalizing flows are neural network-based models designed to optimize the transformation of parameter distributions, and we specifically aim to construct a flow that can accurately predict a rotation period distribution for a population of stars based on their age and colour distributions. We tested and optimized our flow against a simulated toy set, and then against open cluster observational data selected from recent studies. The model trained on the real data generated very reasonable results, indicating that a data-driven approach to gyrochronology shows promise in the context of stellar age predictions. Work for the near future includes extension to more observational data, a more robust approach to uncertainty analysis and selection bias, and more rigorously motivated priors on our observational data (such as model-motivated colour distributions based on age, and the expected stellar age distribution within our galaxy).
Vanlaer, Vincent	Institute of Astronomy, KU Leuven	**Asteroseismic constraints on the internal magnetic field of the TESS beta Cepheid pulsator HD 192575** Internal magnetic fields can affect the evolution of stars considerably, influencing the stellar structure through the Lorentz force. Asteroseismology provides a way to probe the strength of these magnetic fields by analyzing the effect the Lorentz force has on the oscillation frequencies. These effects include asymmetries in rotationally split multiplets, anomalies in period spacing patterns, or suppression of low frequency gravity modes. Thus far, internal magnetic field strengths have only been inferred directly from observations for a handful of red giants and constrained for one rapidly-rotating mid B-type main-sequence pulsator. One of the challenges with expanding this to other stars, is that high-order rotational effects can also contribute to multiplet asymmetries. Up to this point, this issue has been sidestepped by considering slowly rotating stars with strong enough magnetic fields that the contribution from rotation can be neglected. However, rotational effects should be taken into account for stars where the magnetic field plays a less important role in terms of the oscillation frequencies. In this talk we investigate the magnetic field strength of the recently modelled beta Cepheid pulsator HD 192575 from its identified low-order dipole and quadrupole pressure- and gravity-mode multiplets. Small but measurable multiplet asymmetries have been detected in this star, potentially allowing for the determination of the internal magnetic field properties. However, contributions to the asymmetries from high-order rotational effects are of similar order as the measured asymmetries, complicating the inference of the magnetic field strength. Constraining the magnetic field therefore requires detailed modelling of the rotation profile of this star. We will illustrate how the contributions from the rotation and magnetic field can be disentangled and present our constraints on the magnetic field strength for this evolved beta Cepheid pulsator. Our analyses make HD 192575 the most massive star and the only supernova progenitor to date with a direct asteroseismic measurement of the internal magnetic field.
Wainer, Tobin	University of Washington	**Is Blending Even an Issue?: The First Catalog of Star Cluster Ensemble Light Curves** We present the first TESS-based ensemble light curves for star clusters in the Milky Way, Small Magellanic Cloud, and Large Magellanic Cloud and explore the information encoded in these curves, with particular emphasis on variability. These light curves are constructed using our new, publicly available pipeline "elk", which is designed to extract light curves from arbitrary apertures, correct for background light and TESS systematics, and enable detection of variability on time scales shorter than 10 days. We investigate the light curves of star clusters known to contain high-amplitude Cepheid and RR Lyrae variable stars, and find the variability signature from these stars is still detectable when summed together with the light from thousands of other stars. We demonstrate that even low-amplitude stellar variability is preserved when integrating over the HR Diagram.
Walczak, Przemyslaw	University of Wroclaw, Faculty of Physics and Astronomy	**KIC 8264293 - detailed study of the differential rotation** KIC 8264293 is a fast rotating SPB-type pulsator observed by Kepler satellite during its nominal mission. Recently, Szewczuk et al. (2022) built asteroseismic models of the star and constrained its global parameters. It turned out that KIC 8264293 is a very young star with a nearly uniform chemical composition. The authors have found also hints pointing to the differential rotation. We explore this issue in details and try to determine precisely the profile of the internal rotation.

		To this end we apply asteroseismic modelling with the inclusion of differential rotation. We fit frequencies from two sequences of the period spacing patterns, each of which consisting of modes with the same mode degree, ℓ, azimuthal order, *m* and consecutive radial orders, *n*. The first series is built of 14 dipole prograde modes and the second consists of 5 quadrupole sectoral modes. The modes belonging to these two series probe different layers and, therefore, allow for determination of rotation as a function of radius.
Zhang, Jingwen	Institute for Astronomy, University of Hawaii	**The 3D Architecture of a Transiting Planet Orbiting an Oscillating Subgiant with an Outer Companion** The effect of stellar multiplicity on planetary architecture and orbital dynamics provides an important context for exoplanet demographics. I will present a volume-limited catalog up to 300 pc of 63 planet host stars from Kepler, K2, and TESS showing significant Hipparcos-Gaia astrometric acceleration, which indicates the presence of companions. I will specifically focus on TOI-1271, a subgiant hosting a transiting hot Jupiter in an eccentric orbit. A long-term trend in radial velocities and the Hipparcos-Gaia astrometric acceleration both indicate the presence of an outer companion. Using the first science observations from the Keck Planet Finder (KPF), we measure a low sky-projected obliquity for TOI-1271b using the Rossiter-Mclaughlin effect and detect p-mode oscillations in the host star, confirming its evolutionary status. Combined with the stellar rotation period from TESS, we constrain the true obliquity of TOI-1207 b below 20 deg, which indicates an aligned orbit of the planet relative to its host star. The combination of this true obliquity with Gaia/Hipparcos astrometry and long-term RVs enables one of the first constraints on the 3D architecture of a transiting planet with an outer companion, offering a unique testbed to explore the dynamic influence of companions on planet formation and evolution.
Zhou, Yixiao	Aarhus University	**Does the νmax scaling relation depend on metallicity? Insights from 3D surface convection simulations** Solar-like oscillations have been detected in thousands of stars thanks to Kepler and the ongoing TESS mission. Two essential asteroseismic observables are the large frequency separation $\Delta\nu$ and the frequency of maximum power ν_{max}, which together determine stellar radii and masses via the seismic scaling relations. How $\Delta\nu$ scales with basic stellar properties is relatively well understood. The ν_{max} scaling relation assumes that ν_{max} is proportional to the acoustic cut-off frequency, ν_{ac}, which in turn scales with effective temperature and surface gravity. However, the theoretical basis of this relation is very uncertain, and there is an ongoing debate about whether it can be applied to metal-poor stars, which are of great importance in Galactic archaeology. We have made encouraging progress in investigating the metallicity dependence of the ν_{max} scaling relation by carrying out 3D near-surface convection simulations for solar-type stars for a range of metallicities. Firstly, we found a negative correlation between ν_{ac} and metallicity from 3D models. This is in tension with the conclusion by Viani et al. (2017), who proposed that the acoustic cut-off frequency should increase with the mean molecular weight, hence metallicity. Secondly, we estimated theoretical ν_{max} values using velocity amplitudes determined from first principles, by quantifying the mode excitation and damping rates with methods validated in previous works. We found that at solar effective temperature and surface gravity, metal-poor stars have slightly higher ν_{max} compared with the solar value. This study opens an exciting prospect of testing the seismic scaling relations with realistic 3D hydrodynamical stellar models.
Zinn, Joel	California State University, Long Beach	**Nonadiabatic corrections at low frequency: theoretical considerations and practical applications for luminous red giants** A decade after the end of the Kepler prime mission, red giant asteroseismology has proven itself an indispensable tool for understanding both stellar interiors and the stellar populations of the Galaxy. However, due to difficulties in measurement and modelling, the most evolved, luminous red giants are under-utilized in spite of their potential to reveal distant regions of the Galaxy. I will begin by reviewing the challenges of luminous giant ensemble asteroseismology from both an observational and theoretical side, and will argue that the assumption of adiabaticity in scaling relations and in corrections to dnu is an underappreciated contributor to the disagreement between Kepler luminous giant asteroseismic radii and fundamental calibrators. I will then demonstrate that the treatment of convection and atmosphere physics becomes increasingly important for increasingly diffuse stellar envelopes, and will present a new theoretical correction to observed dnu values calculated without the assumption of adiabaticity. This new dnu

		correction can explain a significant portion of the observed discrepancy between evolved asteroseismic and Gaia radii, with remaining systematics possible in the measurement of numax. I will conclude with applications of luminous giant asteroseismology in Kepler and TESS.
Zong, Weikai	Beijing Normal University	**Spectroscopic surveys of Kepler/K2 targets with LAMOST: 1,000,000 visits with homogeneous parameters** LAMOST is a 4m telescope equipped with 4000 fibers, which is the ideal instrument for spectroscopic survey of Kepler and K2 targets. From 2012, LAMOST have obtained high-quality spectra for 44% Kepler targets and 30% K2 targets with >-10°, over a number of one million low-resolution spectra. Since 2018, Phase II of LAMOST have begun to collect the medium resolution spectra for targets with G<15 mag. A selection of 20 LAMOST plates, ~50,000 stars, were observed in the Kepler/K2 fields, targeting to multiple visits of ~60 times. Now LAMOST have collected over two million medium resolution spectra. Under the endeavors from worldwide researchers, all those spectra have fertilized the field of stellar physics, exoplanets and the Galaxy.

Poster Abstracts

Listed by poster number

Poster Number	Name	Institution	Abstract
1	**Zuo, Zhao-Yu**	School of Physics, Xi'an Jiaotong University	**Asteroseismology of High-amplitude δ Scuti Star in the era of Kepler and TESS** By using the high-precision photometric data from the Kepler and Transiting Exoplanet Survey Satellite, the pulsation behavior of four High-amplitude δ Scuti Star sources (HADS): KIC 10975348, TIC 308396022, GSC 4552-1498 and KIC 2857323 was analyzed recently. We conducted the frequency analysis, the O-C analysis, as well as the model fittings, and presented some important new discoveries for these sources. For KIC 10975348 which was previous known as a single-mode HADS, it was recognized as a new radial triple-mode HADS star, based on Kepler data, but the O-C analysis showed no obvious period change, which is in contrast to that of the majority of HADS stars. TIC 308396022 was recognized as a δ Scuti-γ Doradus hybrid with large-amplitude radial fundamental mode and regular g-mode period spacing, based on TESS data spanning 1035 days, and it was further identified to be in a binary system. GSC 4552-1498 was recognized as a new radial double-mode HADS star with non-radial mode, based on TESS data, but the O-C analysis showed that its period change is much larger (about hundreds) than predicted by evolution theories. KIC 2857323 was recognized as the first double-mode HADS to show amplitude decline and warrants further study to ascertain its nature.
2	**Jennings, Zac**	Keele University	**Delta Scuti Eclipsing Binary KIC 9851944** It is possible to measure the fundamental properties of a star to high precision if it exists with a companion in an eclipsing binary system. The comparison of model predicted parameters with those measured from eclipsing binary stars has led to stellar theory being well understood, in general. However, interior processes are generally parametrised and tuned without real measurement and constraint. When a star pulsates, asteroseismology can be used to probe the stellar interior to derive these constraints. Combining the analysis of light and radial velocity curves due to binarity, with the asteroseismological analysis of pulsations, makes pulsating stars in eclipsing binary systems some of the best candidates for constraining our understanding of stellar theory. KIC 9851944 is a detached double lined eclipsing binary system observed by Kepler and TESS. The light curves reveal pressure mode pulsations characteristic of the Delta Scuti type, as well as gravity modes which are characteristic of Gamma Doradus stars. This makes KIC 9851944 a hybrid. We combine the analysis of the light curves and time-series of Hamilton echelle spectra to characterise the system. We derive the masses and radii of the components to less than ~1%, where the results suggest that one of the components in this system is evolving off the main sequence. These results are then used to constrain the analysis of the pulsations signatures revealed in the residuals of the light curve models. Hybrids showing both pressure and gravity pulsations are useful because the pressure modes are sensitive to regions in the upper envelope of the star, while gravity modes propagate in the near core regions. This allows us to learn about two different driving mechanisms acting in different regions of the same star. Stars evolving off the main sequence provide stringent tests for stellar evolution models when they exist in binary with a main sequence star. Our understanding of stellar evolution is most incomplete at evolved stages, and a successful model would need to simultaneously predict the properties of both stars for a single age. These factors make KIC 9851944 a strong candidate for testing stellar theory.

3	**Rodón, José Ramón**	Instituto de Astrofísica de Andalucía.	**Machine learning for understanding pulsating stars: the non-linear phenomenon.** From centuries it has been known that pulsating stars show periodic brightness variations due to perturbations of their internal structure. Thus, observing these brightness variations (i.e. lightcurves) can provide an unmatched amount of information of the stellar interiors. With the advent of space missions ultra-precise photometric observations improve our knowledge of stars significantly but we are also facing challenges to find models that fit the observations with the state-of-the-art theory. In addition, the huge amount of data requires the application of innovative data analysis techniques to exploit the information. Machine learning could help us both to deal with the large amount of data and to explore new ways of processing the lightcurves of pulsating stars. Of special interest for studies of intermediate mass pulsating stars is the decades-old unsolved non-linear phenomenon. The aim of this project is to use machine learning tools in order to characterize a sample of pulsating stars through clustering analysis to shed some light into the nature of this phenomenon. Specifically, we focus on the classification of delta scuti stars as High Amplitude (HADS) and Low Amplitude (LADS) through the analysis of nonlinear parameters characterizing the lightcurves. Subsequently, the same study is extended to hybrid stars, which have g and p-mode pulsation and gamma Dor stars that only pulsate in g modes. The input parameters are extracted from the lightcurves of a sample of stars observed by TESS space satellite.
4	**Townsend, Rich**	University of Wisconsin-Madison	**Multicolor light-curve synthesis with MSG** Multidimensional Spectral Grids (MSG) is an open-source software package for interpolating intensity and flux spectra in pre-calculated grids. MSG supports grids with any number of atmospheric parameters (Teff, logg, Fe/H, etc.), and can evaluate colors in a range of photometric systems via on-the-fly convolution with appropriate response functions. It offers language bindings in Fortran, C and Python, and leverages parallel processing and data load-on-demand to achieve high performance and efficiency. In this presentation I'll give a brief overview of MSG's capabilities. I'll then demonstrate how to use MSG from within Python, to quickly synthesize multi-color (Kepler/GAIA/TESS/etc) light curves of oscillation modes found using the GYRE code.
5	**Wilson, Tanner**	Monash University	**Constraining the Rotation Profile in a Low-Luminosity Subgiant with a Surface Rotation Measurement** Rotationally-induced mode splitting frequencies of low-luminosity subgiants suggest that angular momentum transport mechanisms are 1-2 orders of magnitude more efficient in these stars than predicted by theory. Constraints on the internal rotation profile of low-luminosity subgiants could be used to identify the dominant mechanism for angular momentum transport. We have developed a forward model for the rotation profile given observed rotational splittings, assuming a step-like rotation profile. We identified a consistent degeneracy between the position of a strong rotational gradient and the surface rotation rate of a well-studied low-luminosity subgiant, KIC 12508433. Independent surface rotation priors can be obtained from spectroscopic line broadenings and photometric modulations from stellar spots. Applying the observed surface rotation as a prior, we obtain a factor of two improvement in the precision of the position of strong rotation gradient. Auxiliary measurements of surface rotation could substantially improve inference on the rotation profile of low-luminosity subgiants with already available data.
6	**Shaum, Caroline**	CUNY	**ΦM Radio: Finding stellar companions by phase demodulation of asteroseismic modes**

			Some stars show bright asteroseismic oscillation modes with long coherence times. These modes are like precise clocks for timing experiments. At the same time, many stars have orbital companions. The reaction to any companion appears as a continuous, periodic phase and frequency shift in any asteroseismic mode. This suggests the question: Can we find orbital companions with something akin to a continuous demodulator, like a radio? There are many kinds of demodulators. We consider here a simple phase demodulator (ΦM radio) that works by multiplying the signal by a precisely tuned carrier to detect phase variations indicative of a binary companion. We apply this demodulator to real and artificial data from the NASA Kepler Mission; it detects known and injected companions. Our method involves no binning and is extremely fast; it is optimized for search. It can be used to initialize a more sophisticated, subsequent companion or orbital characterization. It will be relevant to companion searches with Kepler, TESS, and Plato.
7	**Bódi, Attila**	Konkoly Observatory, ELKH	**Blazhko modulated RR Lyrae stars in the K2 and TESS observation fields** Space-based photometry allows us to study the changes of the Blazhko effect over time in detail. Preliminary results have suggested that the correlation between amplitude and phase modulation may be different and/or variable. We investigated several hundred Blazhko stars observed by the K2 and TESS missions by calculating the temporal behaviour of the Fourier amplitude and phase parameters using a template fitting approach. In this talk I present our first findings of modulated stars that show period doubling, and the latest Blazhko incidence rate. I also present the statistical analysis of the sample comparing our new results with the OGLE ones.
8	**Ma, Xiao-Yu**	Beijing normal university	**Short-Timescale Modulation of Amplitude and Frequency in B-type Subdwarf Pulsators** Kepler performed high-precision photometry on 19 campaigns near the ecliptic plane for approximately 80 days, providing valuable data for investigating amplitude and frequency modulation in B-type hot subdwarf (sdB) pulsators. We carried out an in-depth examination of the pulsation modes of two sdB stars and systematically analyzed their modulation properties and timescales. Both sdBs are components of binary systems, yet their rotational speeds differ considerably. This offers crucial samples for understanding the nature of pulsation mode modulation as rotational frequencies transition from indistinguishable to distinguishable. We put forward several innovative methods and concepts to explore the short-timescale modulation of sdB pulsation modes, presenting new perspectives for the study of nonlinear astroseismology samples.
9	**Audenaert, Jeroen**	KU Leuven, Institute of Astronomy	**Stellar variability classification of the TESS Kepler Field-of-View** The TESS Data for Asteroseismology (T'DA) working group has created an automated open-source machine learning pipeline to classify the millions of TESS light curves according to their stellar variability types. The classifier was originally validated on Kepler data because of the large availability of labeled light curves. We have now transferred the classifier from Kepler to TESS by involving the large majority of TASC Working Groups in updating the light curves used for training the classifier. Rather than relying on the light curves delivered by one particular data processing pipeline, we opt to use the light curves from three different pipelines, as this allows us to mitigate the systematic trends that can be introduced by the data processing techniques in each pipeline. We are in the process of releasing the classifications for TESS Sectors 14, 15 and 26 (i.e., containing the Kepler Field-of-View). In this contribution, we plan to present the complete classification results and its astrophysical interpretation. We will also present an updated machine learning classification

			strategy and provide important insights to further improve systematics reduction.
10	**Joyce, Meridith**	CSFK Konkoly Observatory	**Advancing Stellar Physics in the Era of Observational Abundance** Stellar models are the means by which astronomers infer the ages, masses, and distances of stars, thus setting the first rungs of the cosmological distance ladder and allowing us to peer into the history of our Galaxy and Universe. Thanks to instruments like Gaia and TESS, we now have enormous, high-precision data sets comprising millions of stars. However, astronomy has now entered an era in which observational precision eclipses modeling precision by a factor of 10. This means the barrier to more precise fundamental stellar parameters—and hence to progress in astrophysics as a whole—lies in the theoretical and computational domain rather than in the power of our telescopes. Using my studies of bright oscillators, the Milky Way's galactic bulge, and other stellar settings as examples, I will discuss the power, limitations, and future of stellar modeling in the era of unprecedented data volume and quality.
11	**Ong, Joel**	Institute for Astronomy, Univ. of Hawaiʻi	**Mixed-mode Signatures of Misalignments between the Core and Envelope** Some standalone red giants are known to rotate rapidly at their surfaces. One hypothesised origin of such surface rotation is the previous engulfment of an erstwhile planetary companion, depositing angular momentum into the convective envelope. Should the orbit of such a companion have been misaligned from the original equatorial plane of the stellar angular momentum, we should expect the rotational motion of the stellar envelope to become misaligned with the core. However, existing asymptotic analyses of gravitoacoustic mixed modes in these stars assume a priori that the preferred pulsational axes of the core and envelope are exactly aligned, which may not be the case in the event of weak coupling between the two. Conversely, should such misalignment exist, no preferred pulsational axis presents itself for the application of the existing oblique pulsator model developed for classical oscillators. Instead, we develop a new analytic description of such misaligned pulsators where the g-mode and p-mode cavities separately pulsate along different preferred axes, which need not necessarily be aligned, and couple to each other weakly. We find that the corresponding rotational multiplet splittings then exhibit far more complicated avoided crossings than in the case of aligned rotational axes. We explore this phenomenology, and provide quantitative prescriptions for the diagnosis of such misalignment from mixed-mode frequencies and amplitudes.
12	**Lu, Yuting**	University of Tokyo	—
13	**Pollard, Karen**	University of Canterbury	**Spectroscopic line profile variability and magnetic spot mapping of Ap and roAp stars** We present long-term spectroscopic observations using the HERCULES spectrograph at the University of Canterbury Mount John Observatory, complemented by TESS photometric data, of a selection of highly-magnetic chemically-peculiar southern hemisphere Ap and roAp stars. Chemical peculiarities, especially in the Si II lines, creating distortions in both their spectra and stellar surface flux output, are examined using Fourier techniques. By analysing spectral line profiles of various chemical species and using the Invers12 Doppler Imaging tool, we can visualise these distortions on rotationally-phased surface maps. These stellar surface maps reveal the presence and distribution of star spots, and provide a unique insight into how the spot surface distribution may be affected by stellar surface magnetic field strength in these Ap stars.

14	**Crawford, Courtney**	University of Sydney	**The Highest Mass Kepler Red Giants** Recent works have done extensive study on the ensemble of red giants observed by Kepler. I have chosen the highest mass of those red giants to do a detailed study, which includes comparisons of many estimates for T_{eff}, $\Delta\nu$, and ν_{max}. Here I present this sample of high mass red giants, as well as their demographics and trends with observational properties, paying special attention to features such as suppressed dipole modes and radial mode glitches. My further goal is to use these stars to probe the high mass end of the ν_{max} scaling relation and test how well it holds true in this regime.
15	**Nielsen, Martin**	University of Birmingham	**PBjam 2.0 - New methods for automated asteroseismic analysis.** To fully leverage the data from the thousands of solar-like oscillators observed by current and future missions we need new fast and accurate methods for performing asteroseismic analysis. Here we present the latest version of the open-source pipeline, PBjam, which automatically performs a full-spectrum asteroseismic analysis of solar-like oscillators over a wide range of evolutionary stages. PBjam uses a probabilistic method for sampling generative models of power density spectra. This model accurately accounts for the frequency dependent coupling between gravity and pressure dominated modes. While this significantly increases the complexity of the spectrum models, we apply a PCA-based dimensionality reduction method to simplify the sampling process. This method leverages the large quantity of previous measurements of model parameters from the Kepler and TESS missions to construct a prior probability density in a lower-dimensional latent space. This allows PBjam to cover a wide range of stars including main-sequence, sub-giants and low-luminosity red giants, and lets the non-expert user apply asteroseismic information to perform inference on stellar parameters.
16	**Shitrit, Noi**	Tel Aviv University	**Asteroseismology of Massive Stars - A Path to Population Samples** Asteroseismology requires long and well-sampled light curves, which are provided by several space missions. However, performing mode identification for rapid rotators (such as some beta Cep stars) requires also color information, which is not provided by most missions. I will present a feasibility study showing that the Las Cumbres Observatory, a global network of telescopes, can perform high-cadence long time-base observations, and detect the oscillations of massive stars in multiple bands. As a coordinated, robotic, and homogeneous network, Las Cumbres enables scaling up observations to sample studies, in a way that ad-hoc global coordination can not. Such data could be used together with single-band TESS data to perform full asteroseismic analyses on a sample of massive stars. I will review our plans to do just that for a sample of ~20 beta Cep stars, using the Las Cumbres network, which awarded us 9000 hours for this purpose. Any input and discussion regarding target selection and strategy, will be very much appreciated.
17	**Spoo, Taylor**	Texas Christian University	**Metal-Rich Calibration of Asteroseismic Ages and [C/N] Chemical Clock Using Star Clusters** We can investigate Galactic evolution, both chemically and kinematically, through the use of large-scale surveys, but determining reliable stellar ages is an elusive process for a typical star. One powerful new tool in the endeavor to measure ages is asteroseismology. The large numbers of stars are being observed with high-precision photometry space missions such as CoRoT, Kepler, and TESS, will allow us to measure ages across a larger portion of the Galaxy. In particular, the APOKASC catalog, a combination of Kepler data and the APOGEE survey, has measured masses, and thereby ages, for approximately 7000 evolved stars. A natural ally for age-dating stars within the Galaxy is using 'chemical clocks', for instance carbon-to-nitrogen abundances correlate to ages for red giant branch stars. Using star clusters from the SDSS/APOGEE survey, we were able to create an empirical relationship between cluster isochrone-based stellar ages, [C/N] abundances, and

			asteroseismic ages from Kepler when available. This cross-calibration of isochrone, chemical clock, and asteroseismic ages for metal-rich red giant branch stars provides a key calibration for both stellar and Galactic studies.
18	**Charpinet, Stephane**	IRAP / CNRS / Université de Toulouse	**Insight into the core helium burning phase from asteroseismology of evolved compact pulsators** Detailed asteroseismic sounding of the core structure of white dwarf and hot subdwarf pulsators is revealing key -- and sometimes challenging -- features directly connected to the core helium burning (CHeB) phase of low-mass stars. This stage of stellar evolution is notoriously uncertain and evolution models proceeding through it often rely on prescriptions that remain mostly untested. In this contribution, I will link results obtained so far from detailed seismic probing of the core structure of evolved compact pulsators with CHeB evolution and discuss how Kepler and TESS should allow us to lift some of these uncertainties.
19	**Endl, Barbara**	Baylor University	**Seismological Studies of Pulsating DA White Dwarfs Observed with K2** All single stars that are born with masses up to 8.5 - 10$M_\odot$ will end their lives as a white dwarf (WD) star. In this evolutionary stage, WDs enter the cooling sequence, where the stars radiate away their thermal energy, and are basically cooling. As these stars cool, they reach temperatures and conditions that cause the stars to pulsate. Using differential photometry to produce light curves, we can determine the observed periods of pulsation from the WD. We used the White Dwarf Evolution Code (WDEC) to calculate a grid of over one million models with various temperature, stellar mass and mass of helium and hydrogen layers, and calculated their theoretical pulsation periods. In this presentation, we describe our approach to WD asteroseismology using WDEC models and we present seismological studies for 29 observed DAVs in the Kepler and K2 datasets, 25 of which have never been analyzed using these observations, and 19 of which have never been seismically analyzed in any capacity before. Learning about the internal structure of WDs place important constraints on the WD cooling sequence and our overall understanding of stellar evolution for low mass stars.
20	**Ádám, Rozália**	Konkoly Observatory/Eötvös Loránd University	**Monitoring the brightest eclipsing binaries over time with SMEI and TESS** The study of eclipsing binaries is a rewarding field of astronomy as they provide a unique opportunity to determine various stellar physical parameters directly, such as masses, radii and temperatures. The Solar Mass Ejection Imager (SMEI) telescope observed the transient clouds of plasma emitted by the Sun, and - unintentionally - the most luminous stars for almost nine years (2003-2011). The SMEI data set offers many opportunities, e.g. longitudinal studies of variable stars, which can be extended even further when combined with TESS. However, it has been largely unused due to the intense processing it requires. We aim to take advantage of this neglected data set. We started to analyze the most luminous eclipsing binaries observed by SMEI and combine their data with TESS observations. Our three initial targets are gamma Persei, V788 Cen and RR Lyn. Gamma Persei has a famously long orbital period (5329.8 d) for which only two eclipses have been detected so far. We have identified the ingress of the previously unseen 2005 primary eclipse and search for signs of any secondary eclipse. V788 Cen and RR Lyn are both tertiary systems where we aim to update the orbits of the third components via eclipse timing methods. Furthermore, combining the SMEI data with TESS observations helps not only to extend the temporal coverage but also to characterize the systems. For example, TESS has revealed that the primary component of RR Lyn is in fact a very low amplitude delta Scuti star, which had previously eluded detection.

21	**Wilson, Robert**	NASA Goddard Space Flight Center	**Pixel-Level Simulations of Transiting Exoplanets in the Roman Galactic Bulge Time-Domain Survey** Among the core community surveys planned for the Nancy Grace Roman Space Telescope (Roman) is an approximately two square degree survey of the Galactic Bulge at a 15-minute cadence, resulting in over 100 million stars with time series photometry. This dataset will enable the detection of an unprecedented number of transiting exoplanets across an unprecedented breadth of Galactic populations, providing numerous breakthroughs in our knowledge of exoplanet demographics. To understand and predict this population, we developed the Roman IMage and TIMe-series SIMulator (RImTimSim) which can efficiently generate synthetic time-series observations from Roman's Wide Field Instrument. Combining a custom Galactic population model and exoplanet occurrence rates with RImTimSim's simulation framework, we produced synthetic images, extracted light curves, and performed transit detection to estimate the number of exoplanets that Roman will discover. Here, we present these yield estimates, discuss possible variations and opportunities due to areas of parameter space that are not yet well understood, and highlight the unique challenges for producing a large-scale catalog of uniformly searched and vetted exoplanets in the crowded Galactic Bulge fields.
22	**Kosovichev, Alexander**	New Jersey Institute of Technology	**Asteroseismic Inversions of Mixed Acoustic-Gravity Modes to Probe the Stellar Core Structure** The discovery of mixed acoustic-gravity modes of oscillations of moderate mass stars opens a unique opportunity to infer the structure of the inner energy-generating cores and thus test the stellar evolution theory. The mixed modes have properties of internal gravity waves (g-modes) in the convectively stable helium core and properties of acoustic modes outside the core. We select several sets of the oscillation mode frequencies in the mass range from about 1.3 to 1.6 solar masses from the Kepler Legacy database, and apply the optimally localized averaging inversion technique previously developed for low-degree helioseismology. The inversion technique takes into account the uncertainties in the determination of the mass and radius of the stars, as well as the surface effects. The methodology provides sensitivity kernels for various structure properties, including the chemical composition, and, thus, the direct relationship between the stellar properties and the deviation of observed frequencies from the reference models. The inversion results reveal significant deviations in the core structure from the reference models calculated using the MESA evolutionary code for the stellar parameters obtained by the asteroseismic model grid fitting. We discuss other potential applications of asteroseismic inversions.
23	**Beck, Paul**	Universidad de La Laguna & Instituto de Astrofisica de Canarias	**Constraining stellar and orbital evolution from the oscillating red-giant binaries revealed by Gaia DR3** The evolution of stars and their hosting binary systems is a highly interactive process and cannot be investigated in a segregated manner. Due to the constraints drawn by stellar binarity, oscillating red-giant stars in binary systems represent a unique opportunity to study details of the structure and evolution of stars in the advanced phases of stellar evolution. Until recently, the number of known systems hosting solar-like oscillators was small. In this talk, we will discuss the results and lessons-learned from the joint analysis of space photometry from NASA Kepler and TESS, ground-based high-resolution spectroscopy such as APOGEE, and astrometry and spectroscopy from space with the ESA Gaia satellite. The properties of this growing group with currently more than 1000 oscillating stellar objects in binary systems provide vital diagnostics on how binary systems and their stellar components coevolve. In this talk we will highlight the results of the ensemble study on stellar activity and the effects of star-star interaction on the binary orbit as a function of the evolutionary state of the primary component. Finally, we shed light onto the

			mystery of the missing eclipsing binary systems in space photometry of Kepler and TESS.
24	**Szewczuk, Wojciech**	University of Wrocław, Faculty of Physics and Astronomy, Astronomical Institute	**CW Cephei - the binary B-type pulsator.** CW Cephei is an early B-type doubled-lined eclipsing binary. The components have masses of about 13 and 12 $M_{\odot}$. Recently Lee & Hong (2021), using two TESS sectors, have found 8 independent frequencies and associated them with pulsations of β Cep type. With additional three TESS sectors we extracted 36 periodic signals, including at least 13 independent frequencies. Moreover, the pulsational modelling suggests that CW Cep is a hybrid SPB/β Cephei pulsator rather than β Cephei. Firstly, we present the results of the eclipsing light curve modelling using TESS and archival uvby photometry. Then, with MESA evolutionary code, we derive the age of the system from the precise determination of masses and radii of both components. Finally, we compute a grid of nonadiabatic pulsational models in order to reproduce the observed frequency range. CW Cep is another hybrid pulsator that indicates the necessity of the revision of the opacity data, in particular around the Z-bump.
25	**Weeks, Angharad**	University College London	**Homogeneous Characterisation of Stars Hosting Small Exoplanets** Precise host star characterisation is imperative to our understanding of the diversity and architecture of exoplanetary systems. However, most host stars undergo heterogeneous characterisation at the time of planet discovery or analysis. We present a homogeneous analysis of ~100 stars hosting small planets with $R_P < 4R_{\oplus}$. The planets border or sit in the radius valley - a dearth of planets with radii between ~1.5 and 2 $R_{\oplus}$ - and also have planet mass measurements available. Characterisation is done using the Bayesian Stellar Algorithm (BASTA), using photometric, spectroscopic and astrometric data inputs from Gaia DR3 and 2MASS. These results are validated in comparison to stellar parameters from the Nasa Exoplanet Archive, and homogeneous spectroscopic subsets of exoplanet host stars such as the Kepler California Survey, and SweetCat. We use these new stellar parameters to recalculate planet masses, radii and densities, and compare these to values reported in the literature. Their effect on the resultant radius valley is reported, alongside analysis of the differences in 2-D distributions of planets in radius - period and radius - stellar mass space. The implications for the planetary mass - radius diagram are also explored, showing shifts of the positions of these planets in such parameter space. We conclude by recommending a similar homogeneous approach for all host star characterisation.
26	**Rodríguez Sánchez, Miriam**	University of Valencia	**On the path to obtaining non-linear models for delta Scuti Star** Delta Scuti stars are known for their rich power spectrum, in which the immense number of modes that can be excited is reflected. This phenomenon, partly caused by non-linear components, makes it more challenging to obtain asteroseismic parameters and, therefore, to study their phenomenology. Nevertheless, in young delta Scuti stars, an absence of nonlinearities in their spectra is expected due to their evolutionary stage. This makes possible an easier way to identify their pulsation modes and other asteroseismic variables, as previously seen in Bedding et al. (2020). In this work, we present two studies with two very contrasting approaches: the first is based on the analysis of frequency combinations through observations, and the second is more theoretical by focusing on the study of the oscillation equations. In the observational one, we study a set of light curves belonging to a young sample of delta Scuti stars observed by the satellite TESS and selected from young moving groups and open clusters. After analysing their power spectrum, no frequency combinations were found in these stars, supporting the previously mentioned assumption.

			For the other one, a first approximation is presented with the ultimate aim of developing a complete non-linear pulsation code for delta Scuti stars. The process of numerically solving the non-linear differential equations of oscillations for High Amplitude Delta Scuti (HADS) stars is outlined. The equations are described in terms of the so-called Volterra expansion, which uses the generalised transfer functions. These functions, named Volterra coefficients, are required to calculate the values of some equation coefficients. Thanks to the latest ultra-precise photometric data, they can be estimated observationally through amplitude and phase relations between parents and children frequencies (see Lares-Martiz et al. 2020). After obtaining these coefficients, the equations can be numerically solved. In summary, this is an approach to the long-sought-after complete solution of the non-linear pulsation equations that, in its early stage, can already be helpful for the development of models that more precisely describe the behaviour of HADS star.
27	**Pinsonneault, Marc**	Ohio State University, Dept. of Astronomy	**Asteroseismology and Stellar Populations in the Kepler Fields** We present a comprehensive asteroseismic analysis of 15,337 red giants in the Kepler fields with APOGEE spectroscopic data. Using 11 distinct analysis methods we define a "gold sample" of about 10,000 stars with exceptional quality asteroseismic data that can be used as a fundamental reference for population studies. We demonstrate that scaling relations are precise and accurate on the lower red giant branch and red clump; for more luminous stars asteroseismic properties diverge from fundamental data and measurements become method-dependent. Recommended practices for population asteroseismology are discussed. We present an overview of the populations and chemical evolution trends revealed in these precise data, including the field turnoff for thin and thick disk, the properties of the first dredge-up, and the locus of the core He-burning phase.
28	**Monsue, Teresa**	NASA GSFC - Catholic University	**Do Stellar Flares affect Solar-like Oscillations?** It is known that solar flares release large amounts of energy at different layers of the solar atmosphere and large flares excite acoustic waves on the solar surface, thereby affecting the p-mode oscillation characteristics. Even though the basic mechanism by which a flare excites acoustic oscillations is still not yet known, it is believed that these flares can excite velocity oscillations in active regions, especially those regions where a higher class solar flare has occurred. These changes from the excitation of solar oscillations are viewed by full disk image analysis of the Sun. However, does this phenomenon occur on other stars? In this study we ask the question if the equivalent effect (excitation of solar-like oscillations by large flares) on other stars occurs and can we observe it in stellar light curve data. Light curves of stellar flares on solar-type stars and red giants with solar-like oscillations are analyzed to draw conclusions. We present initial results.
29	**Grunblatt, Samuel**	Johns Hopkins University	**Time-Series Analysis of Stellar Clusters** Clusters are believed to be the birthplace of the vast majority of stars, and yet the dynamics, chemical enrichment and evolution of clusters are poorly understood. Understanding star formation and evolution in stellar clusters is essential to explaining the past, present, and future of our Galaxy. Time series data of clusters opens new windows to understand variability, planet occurrence and overall demographics of cluster stars. Here, we present a reanalysis of Kepler time-series data of cluster stars, which has resulted in the re-detection of transiting planets, and detection of previously undetected rotation and asteroseismic signals in over 100 stars. These observations better constrain similarities and differences between clusters and within clusters, testing how strongly star and planet formation are affected by different formation environments. Finally, we highlight the ability of future missions, such as the NASA Roman Telescope, to revolutionize our ability to collect time-series data

			for clusters and detect planets and stellar variability in a wide range of diverse environments, potentially revealing how stars and planets form in varied Galactic and even extragalactic populations.
30	**Tayar, Jamie**	University of Florida	**The Promise of Milky Way Mapper** Building on the success of the APOGEE survey and the widely impactful APOGEE-Kepler Catalog, observations have begun for the next iteration: SDSS-V's Milky Way Mapper. I will discuss the state of operations, and the ongoing efforts. I will show data from the TESS-MWM sample, including the ~17000 red giants already available with asteroseismic detections, and give a sense of the spectral, kinematic, and age coverage of the data set. Finally, I will show a demonstrative example, using the location of the red giant branch bump, of the sort of impact this sample may have on our ability to constrain stellar physics and stellar modeling.
31	**Brinkman, Casey**	University of Hawai'i Institute for Astronomy	**Are Planets Made of Star Stuff? The Relationship Between Planet and Host Star Compositions** Planets and the stars they orbit are born from the same cloud of gas and dust, and the primordial compositions of rocky exoplanets should have iron and refractory abundance ratios consistent with their host star. While we observe that Venus, Earth, Mars, and smaller bodies such as carbonaceous chondrites have solar abundance ratios of iron to magnesium (Fe/Mg), Mercury is enriched in Fe/Mg while the Moon is depleted, indicating that planet formation processes such as giant impacts and magnetic interaction have the ability to alter primordial rocky compositions. To test the extent to which rocky exoplanets have primordial compositions, we model the interior compositions of 26 super-Earth sized (1-1.8$R_\oplus$) planets around stars with known refractory abundances. We compute the mass ratio of iron to magnesium (Fe/Mg) in the planet and host star. We observe a correlation between planetary and stellar Fe/Mg, but not with a 1-1 correspondence. Instead, the planets have a wider range of Fe/Mg values than their host stars, which indicates the prevalence of formation mechanisms that diversify planetary compositions.
32	**Kitiashvili, Irina**	NASA Ames Research Center	**Modeling of Disk-Integrated Oscillations of Solar-Type Stars and the Stellar Jitter Effect** The radial velocity method is one of the most promising approaches to detecting the Earth-mass planets. However, the signal is significantly weaker than noise due to stellar oscillations, surface dynamics, and activity ("the stellar jitter"). Characterization of this noise and the development of a procedure to efficiently remove it from radial velocity measurements are complicated by observational limitations. Current computational capabilities allow us to perform 3D radiative hydrodynamics modeling of selected target stars from the first physical principles, thereby reconstructing disk-integrated observables. We performed a series of such simulations for various target stars using the StellarBox code. These simulations are used to synthesize time series of iron lines (using the radiative code SPINOR) at different locations on the stellar disk with ultra-high spectral resolution and to investigate properties of the photospheric motions and their contribution to observables, thereby creating the potential to investigate stellar oscillations and photospheric noise and filter it out for detecting Earth-mass exoplanets. We present recent results of modeling solar-type stars and discuss center-to-limb variations and other effects contributing to observed stellar oscillations. The work is supported by the NASA EPRV program.
33	**Montet, Ben**	University of New South Wales	**What can asteroseismology tell us about stellar activity cycles?** Kepler and TESS have enabled the study of magnetic activity variations, from changes in stellar flare rates and starspot amplitudes to long-term photometric variability across years of observations. For some of these stars, asteroseismic

			mode shifts provide an opportunity to more deeply understand changes in stellar activity, and the stars for which we have other evidence for magnetic activity variations provide a compelling test sample to understand the opportunities and limitations from these combined data sets. I will present preliminary results and highlight interesting targets which would benefit from future collaborative efforts.
34	**Dholakia, Shishir**	University of Southern Queensland	**Catalog of Binary Stars From Phase Modulation in first four years of TESS Mission Photometry** We showcase a catalog of binaries detected through pulsational phase modulations of delta Scuti stars in the first four years of TESS photometry. This technique has proven invaluable in detecting unresolved binaries and constraining orbital and stellar properties. Following initial triage of 7300 2-min TESS lightcurves of stars near the dSct instability strip, 690 light curves were searched for variations in pulsation phase caused by the dynamical influence of an unseen companion. We find 50 new binary candidates, and we highlight some examples. We also demonstrate methodological sensitivity as a function of the duration of TESS lightcurves and the prevalence of gaps within them. This catalog represents an important search for astrophysically valuable binaries in the TESS photometry so far.
35	**Hey, Daniel**	University of Hawaii	**Time-domain asteroseismology of solar-like oscillators in TESS** The TESS mission has provided a wealth of asteroseismic data for solar-like oscillators. However, this data is subject to varying cadences, large gaps, and unequal sampling which complicates frequency domain analyses. We devise a time-domain model of solar-like pulsations, treating them as stochastically damped simple harmonic oscillators through a linear combination of Gaussian Process kernels. We demonstrate this method on the well-studied subgiant star, ν-Ind, and apply our method to the sample of Kepler red giant stars observed by TESS. We find that the time domain model achieves at least a two-fold increase in precision in contrast to typical frequency domain methods. This effect is especially pronounced for data with significant gaps. We additionally provide a revised asteroseismic target list, updated with Gaia DR3 parameters, and show that our time domain method is sensitive enough to observe marginal detections in several evolved giant stars.
36	**Saunders, Nicholas**	University of Hawaii Institute for Astronomy	**Evidence for Weakened Magnetic Braking in Old Stars** We confirm the existence of significantly weakened magnetic braking in old stars. The technique of 'gyrochronology' estimates the age of a star from its rotation period, which increases as the star ages and loses angular momentum to magnetized stellar winds. Gyrochronology fundamentally depends on reliable calibrator stars of known age to provide precision period-age relations. Recently, observations of stars more evolved than the Sun with faster-than-expected rotation indicated that the rate at which stars lose angular momentum precipitously drops during middle-age. I will present evidence for weakened braking and report updated constraints on the braking model parameters using a hierarchical model for stellar rotation and a set of calibrators that span a wide range of stellar ages. Our model with weakened magnetic braking is consistent with standard calibrator stars including those in well-studied open clusters, asteroseismic targets, and solar twin samples.
37	**Baum, Anna**	Lehigh University	**A Search for Pulsating Red Giants in Eclipsing Binaries** The asteroseismology of pulsating stars in eclipsing binary systems (EBs) provides an opportunity to assess the asteroseismic scaling relations. We can apply asteroseismic scaling relations to the p-modes in solar-like oscillators to determine the mass and radius of the pulsator, and can also extract the same fundamental parameters using EB analysis. With this in mind, we plan to use EB modeling to test the asteroseismic scaling relations. The first step in this work is the identification of EBs containing a red giant pulsating with solar-like

			oscillations in the TESS short-cadence data. We present our pipeline, currently under development, as a streamlined method to generate power density spectra from input photometric data for the detection of pulsations. The pipeline detrends raw TESS data, removes eclipses, and stitches together the data so that outliers, long-term trends, eclipses, and time gaps are eliminated from light curves prior to producing a power density spectrum. During our preliminary search, we are applying this pipeline to an initial sample of 84 EBs listed in the Villanova TESS EB Catalog with characteristics suggesting an evolved component. In the future, we will apply our pipeline to the full TESS EB Catalog, including the TESS FFIs, and will publicly release the final pipeline. We will utilize these EBs to compare the fundamental stellar parameters obtained from the asteroseismic scaling relations against those found through EB modeling.
38	**Stone-Martinez, Alexander**	New Mexico State University	**Stellar ages from APOGEE parameters** We present an update to our work deriving the masses and ages of stars using APOGEE data and machine learning. A network is trained on asteroseismic masses from the Kepler field for evolved stars and from isochrone masses for main sequence stars. For evolved stars, carbon and nitrogen abundances provide mass information because of the mass-dependence of stellar mixing, allowing the determination of stellar masses for stars without asteroseismology. Using the masses for evolved stars, we derive ages based on stellar isochrones. Updates to our work revolve around how changes in asterosiesmic calibrations affect the machine learning model and thus changing the resulting predicted ages. We also present early work on examining the variations in primordial [C/N] abundances across our region of the Galaxy, and we present early work on applying our age methods to low surface gravity stars.
39	**Olszewska, Justyna**	Astronomical Observatory Institute Faculty of Physics Adam Mickiewicz University in Poznań	**Pulsating Stars with the TESS and GATS Project** In our work we would like to present results for the Cepheids, based on observations from the TESS and GATS telescopes. Photometric data from TESS enable precise monitoring of stellar brightness over time. The analysis of these data allowed us to detect characteristic patterns of variability associated with the pulsations of the studied stars. With these data, we were able to determine pulsation frequencies and investigate their physical properties, which is essential for understanding stellar evolution and structure. The Global Astrophysical Telescope System (GATS) is a project conducted by the Institute of Astronomy, Adam Mickiewicz University in Poznań, Poland. The GATS project aims to establish a network of robotic telescopes equipped with spectrographs with resolution R~35000-40000. The system consists of three telescopes, including two dedicated to spectroscopic studies: PST1 (Poznań Spectroscopic Telescope) - operational since August 2007 at the Borowiec Astrogeodynamic Observatory near Poznań, Poland, and RBT (PST2) - operational since autumn 2013 at the Winer Observatory in Arizona, USA. The lightweight design and low-noise camera of the PST1 telescope enable us to obtain spectra with an S/N ratio of approximately 100, for a V = 7 mag star with a 60-minute exposure time. This means that we can accurately measure the radial velocities of late-type stars up to a magnitude of approximately 11.5. The GATS system conducts observations of several pulsating variable stars, including Cepheids, since 2007. Some of the Cepheids have been observed for up to several years, providing an opportunity to collect hundreds of spectra. Data spanning such a long time period will help investigate long-term variability and obtain high-SNR spectra. During the poster session we would like to present the preliminary results of the analysis of the received data for selected stars, for ex.: CO Aur, Alf UMi. We will focus on determining pulsation frequencies from previously derived radial velocities from GATS spectra and photometric data from TESS, as well as determining stellar atmospheric parameters and elemental abundances based on averaged spectra. To estimate

			atmospheric parameters and abundances, we will use the iSpec program (Blanco-Cuaresma et al., 2014, Blanco-Cuaresma, 2019) and spectral synthesis method employing ATLAS9 Kurucz/Castelli models (Kurucz, 2005).
40	**Muntean, Nicolas**	Karl-Franzens-Universität Graz	**Constraining the core-rotation rate along the red-giant evolution** The evolution of the core rotation rate of red giant stars is a key parameter in understanding the stellar behavior in the late phases of stellar evolution. Thanks to the mixed-dipole modes we can constrain the core rotation and internal rotational gradient as a star advances through the red-giant phase. This master thesis project focuses on calculating the core rotation rate of three targets, KIC 8366239, KIC 4770846, and KIC 8872979, which are stationed on the red-giant branch, the red clump, and the secondary clump, respectively. We measure the global seismic parameters, asymptotic period splitting and the rotational splitting of l=1 mixed modes by making use of the Apollinaire Python package. Using the MESA stellar evolution and the GYRE stellar oscillation codes, we calculate the representative models of the selected stars and derive the rotational kernels for the dipole modes. Assuming a two-shell rotation model for the stars, we constrain the rotational gradient in three different stages of the red-giant evolution.
41	**Handler, Gerald**	Nicolaus Copernicus Astronomical Center Warsaw	**Tidally tilted pulsators: newsflash** The tidally tilted pulsators (TTPs) are a group of oscillators in close binary systems whose pulsational axis has been pulled into the orbital plane by the gravitational force exerted by the companion star. As a consequence, their pulsation axes precess over the line of sight of the observer, giving rise to amplitude and phase modulations that allow to identify the excited pulsation modes and constrain the geometries of the systems. We have so far identified some 15 certain TTPs plus a much larger number of candidates. In this poster, we present some exemplary representatives, from very simple cases up to extremely complicated ones, and we provide evidence that TTPs may occur in many different types of oscillating main sequence and evolved stars.
42	**Htet, Swan Yi**	CUNY Queens College	**Characterizing Crowdedness in TESS Images** Given that the plate scale of NASA's Transiting Exoplanet Survey Satellite (TESS) is 21 arcseconds per pixel, assessing source contamination issues is a necessity for an accurate interpretation of TESS data. The TESS SPOC pipeline applies an estimated crowdedness correction to extracted light curves; if this correction is inexact, it introduces systematic errors in measured amplitudes of variability. We aim to determine the precision of crowdedness corrections applied by the TESS SPOC pipeline to enable the propagation of this uncertainty to measured system parameters. We use an MCMC approach to sample the fluxes from stars in the TESS Target Pixel Files to obtain a probability distribution for how contaminated the aperture is, which we compare to the value used by the SPOC pipeline to determine its precision.
43	**K. R., Sreenivasan**	The University of Sydney	**Measuring ν_{max} without fitting the granulation background for 16000 Kepler Red Giants** The importance of ν_{max} for asteroseismology has been demonstrated widely in the previous decade, especially for red giants. With the large amount of photometric data from CoRoT, Kepler and TESS, several automated algorithms to retrieve ν_{max} values have been introduced. All of these algorithms correct the granulation background in the power spectrum by fitting a model and subtracting it before measuring the ν_{max}. We have developed a method that does not require fitting to the granulation background. Instead, we simply divide the power spectrum by a function of the form ν^2, to remove the slope due to granulation background, and then smooth to measure ν_{max}. This method is fast, simple and avoids over-fitting. It also measures the total power and width of the oscillation envelope. We found that the ν_{max} values from this work are in good agreement with those measured using the SYD and COR pipelines. Our

			method is successful in determining ν_{max} close to the Nyquist frequency and works well for stars with weak oscillations. One new result is that our values of width of the power envelope can clearly identify the secondary clump stars as a distinct population.
44	**Eze, Christian**	Nicolaus Copernicus Astronomical Center, Warsaw, Poland	**Photometric sample of early B-type pulsators in eclipsing binaries observed with TESS** The combined strength of asteroseismology and empirical stellar basic parameter determinations for in-depth asteroseismic analysis of massive pulsators in eclipsing binaries shows a great potential in treating the challenging and mysterious discrepancies between observations and models of stellar structure and evolution of massive stars. This paper compiles a comprehensive list of massive pulsators in eclipsing binary systems observed with TESS. The TESS light curves and Discrete Fourier Transforms (DFT) of a sample of 8055 stars of spectral type B0-B3 were examined for eclipses and stellar pulsations and the ephemerides of the resulting sub-sample of massive pulsators in eclipsing binaries were computed. The sub-sample of massive pulsators in eclipsing binaries, which accounts for approximately 1% of the sample, was also cross-matched with existing catalogues of massive pulsators. Our sample of pulsating massive stars in eclipsing binaries allows for future asteroseismic modelling to better understand the internal mixing profile and resolve the mass discrepancies in massive stars. We have already started follow up of some of the most interesting candidates.
45	**Ayala, Andrew**	CUNY Graduate Center	**PULSEY: Simulating Surface Brightness Variations from Stellar Pulsations** PULSEY is a python program built on top of an existing package titled STARRY, which constructs surface maps of 3-D spheres via an amalgamation of individual spherical harmonic modes. The summation of these individual modes produces a static 3-D map that can be inclined, rotated, and inserted into a binary system. Now with PULSEY, one can create periodic pulsation or time evolution of these 3-D surface maps by sinusoidally varying the amplitude of orthogonal spherical harmonic modes. With this new functionality, we can model observed stellar pulsation or photometric variability by periodically modifying spherical harmonic coefficients. Alongside this, the binary system functionality of the package allows for eclipse mapping of pulsation modes to break symmetries and degeneracies witnessed in observational data. Ultimately, PULSEY enables us to model eclipses of pulsating stars to identify the L and M values of the spherical harmonic patterns associated with individual pulsation modes observed in data.
46	**Grossmann, Desmond**	University of Graz	**KIC 9163796 - Age determination by asteroseismic grid modelling for an oscillating red giant binary** Binary systems constitute a valuable tool in astrophysics for gaining a deeper understanding of stellar evolution and determining stellar ages. Doublelined spectroscopic (SB2) binaries, where certain spectroscopic lines are available for both components, provide an even better opportunity to study stellar physics and evolution. Additionally, the presence of observable oscillation power excesses in one or both components in a binary system enables an independent calculation and confirmation of stellar properties, such as mass, radius and composition. This thesis study analyses KIC 9163796, a double-lined oscillating RG binary system, with a mass ratio of almost unity. Its components however vary significantly in temperature, luminosity, radius and lithium abundance. Because of their nature as binary stars, the components are identical in their initial parameters, age and distance to us. We use the differences observed in the stars - from HERMES spectroscopy, KEPLER and GAIA photometry - combined with asteroseismic analysis, to constrain the two combined models for the primary and secondary. In this poster we present the results of our differential

			modelling approach, using the fundamental parameters, constraints from binarity and the oscillation frequencies, from constructing a four-dimensional parameter space grid (M, Z, Alpha_MLT, f_ov) of models with the MESA stellar evolution and the GYRE stellar oscillation code. Such a modelling approach allows us to calibrate the parameters of convection during the first dredge-up event, which provides an important benchmark object for an improved age determination on the red-giant branch.
47	**Krüger, Joachim**	University of Southern Queensland	**Towards resolving pulsation mode ambiguity in delta Scuti stars with multi-site spectroscopy** Delta Scuti stars are pulsating variables that show multiple pulsation modes, making them valuable but challenging targets for asteroseismology studies. High-resolution spectroscopy can reveal the velocity variations associated with pulsations, allowing for mode identification based on the observed frequency shifts and line profile variations. One application can be verifying the frequency of the fundamental radial mode to help solve the reported discrepancy between models and observations (Murphy et al. 2023). Doing so may challenge common assumptions about pulsation modes in delta Scuti stars and is the aim of this work. However, conducting Earth-based time-series observations of delta Scuti stars can be challenging due to the window function caused by gaps in observations. One unique project that aims to tackle this problem is the Stellar Observations Network Group (SONG), a Danish-led global network of telescopes optimized for asteroseismology studies of stars. The network is designed to provide continuous, long-duration time-series observations. There are two operating nodes of SONG, one in Tenerife and one at Mt. Kent in Australia. Additionally, Mt. Kent hosts MINERVA-Australis, which has four telescopes capable of high-resolution spectroscopy and can be used to complement the observations. We showcase some early applications of spectroscopic observations for asteroseismology of the delta Scuti star HD99506.
48	**Berry, Ian**	Institute for Astronomy	**Electron scattering emission in the light curves of CM stars observed with TESS and K2** Early-type B stars with strong magnetic fields and rapid rotation form Centrifugal Magnetospheres (CMs) as their relatively weak winds become magnetically confined above the Kepler co-rotation radius. Approximating the magnetic field as a dipole, CM material becomes confined and concentrated at and above the Kepler co-rotation radius along the intersection of the magnetic and rotational planes. Magnetospheric plasma can lead to deep photometric eclipses as well as emission via electron scattering, depending on whether the material is projected in front of or beside the stellar disk. Using high-precision space photometry from TESS and K2 for stars with strong Hα emission for comparison, we apply simulated light curves from the Rigidly Rotating Magnetosphere model in order to directly infer the magnetic, rotational and geometric properties of these stars. By comparing determined from photometric modeling to those independently found through spectropolarimetry, we find that magnetic obliquity angle β, viewer inclination angle i, and critical rotation fraction W can be approximately recovered. However, there are considerable discrepancies in the optical depth at the Kepler co-rotation radius τ_K . Our results suggest that in the absence of spectrophotometric constraints, results from simple tilted dipole models applied to space photometry should be interpreted with caution.
49	**Bindas, Jakob**	University of Hawai'i and University of Pittsburgh	**Estimating ν_{max} Using Instantaneous Frequencies** Measurements of the frequency of maximum power, ν_{max}, for solar-like oscillators often rely on fitting a model to the frequency-power spectrum. To improve the robustness of our ν_{max} measurements across light curves with different observing strategies, we develop a novel, model-free estimation of ν_{max}, which is based on the instantaneous frequencies of the autocorrelation of

			light curves. Preliminary applications of our method to Kepler and TESS light curves demonstrate an effective recovery of literature ν_{max} values for red giants, and upcoming efforts will develop this approach into a new tool for ensemble asteroseismology.
50	**Chun, Alicia**	University of Chicago, University of Hawaii	**Testing the Asteroseismic Detection Limits of Ground-based Transient Surveys with Kepler and TESS** The high-precision, long-baseline photometry provided by space-based telescopes enables us to detect oscillations in a wide range of main sequence and red giant branch stars. Since the amplitude of these oscillations correlates with stellar luminosity, ground-based transient surveys have the capability to detect low-frequency oscillations specifically within red giants. However, precise limits on apparent magnitude and oscillation frequency detectable by ground-based telescopes remain largely unexplored. I will present new constraints on the recovery fraction of asteroseismic detections by ground-based transient surveys, namely the Asteroid Terrestrial-impact Last Alert System (ATLAS) and the All-Sky Automated Survey for Supernovae (ASAS-SN), in relation to the spaced-based telescopes, TESS and Kepler. We investigate the recovery fraction of M giant oscillations as a function of the dominant frequency of oscillation and apparent magnitude. We find that ATLAS and ASAS-SN combined are capable of detecting oscillations with frequencies ≤ 3 μHz and as faint as apparent magnitudes of 18. This will allow us to make precise estimates for the distances and luminosities of a large sample of red giants across large portions of the Milky Way galaxy.
51	**Roselli, Ella**	Columbia University, University of Hawaii	**Mapping the kinematics of the Sagittarius dwarf stream with semi-regular variables** We determine the structure and kinematics of the Sagittarius (Sgr) dwarf stream through the PL relation of luminous red-giants observed by ASAS-SN, ATLAS, and TESS. We show the distribution of the evolved stellar population in the stream across the Milky Way, and additionally constrain the distance to the core of the dwarf galaxy. The Sgr stream is one of the largest stellar streams that is tidally disrupted by the Milky Way, and so constraints on its structure and kinematics provides a prime opportunity to learn about galaxy evolution and to probe the Galactic potential. We demonstrate that the PL relation is more precise than Gaia parallaxes for distant stars (beyond several parsecs).
52	**Mansfield, Mia**	University of Pennsylvania, University of Hawaii	**Modeling the Large Magellanic Cloud Passage in FIRE-2 Simulations** We present a series of strategies to observe the dynamical influence exerted on Milky Way (MW) stars by the Large Magellanic Cloud (LMC) on first infall. We use MW-like simulations from the Feedback In Realistic Environments-2 (FIRE-2) suite to examine cosmological simulations of MW mass (10^{12} $M_{\odot}$) galaxies with and without large LMC-like satellites. We find that MW-like galaxies in simulations with an LMC analogue undergo significant kinematic changes as a result of MW-LMC interactions, most notably in vertical perturbations of stars in the LMC's path as well as in MW barycentric shifting. Such effects are expected to be observed in MW halo stars 20-50 kpc from the MW's center of mass as well as in the alignment of the outer halo.

Online Poster Abstracts

Listed by poster number

Poster Number	Name	Institution	Abstract
e1 (online)	**Bétrisey, Jérôme**	University of Geneva	**Studying angular momentum transport processes of main-sequence F-type stars with asteroseismology** With the advent of space-based missions such as CoRoT, Kepler, and TESS, asteroseismology has become a powerful tool to study the internal rotation of stars. The internal rotation depends on the efficiency of the angular momentum (AM) transport, and its study allows to constrain the internal AM transport processes and better understand their physical nature. In this context, we compared the rotation rates predicted by asteroseismology and by starspots measurements for four main-sequence stars from the Kepler LEGACY sample, considering different AM transport prescriptions, and investigated if some of these prescriptions could be ruled out (Bétrisey et al. submitted). Due to the slow rotation of these stars, we decoupled the modelling of the structure and of the rotational profile, respectively obtained by an asteroseismic characterization and by using rotating models including a detailed treatment of the AM transport. We then compared the mean asteroseismic rotation rate with the surface rotation rate from starspots measurements for each of the AM transport prescriptions. In the hotter part of the HRD (M > ~ 1.2Msun), combining asteroseismic constraints from splittings of pressure modes and surface rotation rates does not allow to conclude on the need for an efficient AM transport in addition to the sole transport by meridional circulation and shear instability. Both prescriptions are indeed consistent with the quasi-solid rotation measured by Benomar et al. (2015) and Nielsen et al. (2017). In the colder part of the HRD, the situation is different due to the efficient braking of the stellar surface by magnetised winds. We find a clear disagreement between the rotational properties of models including only hydrodynamic processes and asteroseismic constraints, while models with magnetic fields correctly reproduce the observations, similarly to the solar case. This shows the existence of a mass regime corresponding to main-sequence stars around ~ 6000 - 6200 K for which it is difficult to constrain the AM transport processes, unlike for hotter, Gamma Dor stars or colder, less massive solar analogs.
e2 (online)	**Rocha, Danilo**	Observatório Nacional	**Study of Be Stars in Binary Systems Observed with TESS** Be stars are luminous, blue-white stars with a surface temperature between 10,000K and 30,000K. Its main features are the presence of a circumstellar disk and Balmer emission lines (T. Rivinius, 2013). Furthermore, due to their uniqueness within the branch of B stars, such objects are very relevant to understanding the evolution of high-mass stars. In addition to their rapid rotation, non-radial pulsationsare proposed to explain Be phenomena (T. Rivinius, 1998). The combination of the Doppler shift of stellar surface elements is associated with temperature variations due to the compression/expansion caused by the passage of waves through the photosphere. Furthermore, binarity dominates the evolutionary patterns of stars that live with a companion (H. Sana, 2012); this is due to the exchange of matter and high rotation between the components of the system, resulting in high levels of internal chemical mixing of the stars. Our goal is to study TESS photometric time series of Be stars belonging to a binary system with simultaneous terrestrial spectroscopic observations for our targets. We have access to terrestrial telescopes in both hemispheres capable of obtaining medium resolution optical spectra (380-860 nm), allowing us to: (a) determine physical parameters of stars; and (b) tracking changes in Hα emission observables, such as equivalent width (EW) and red-violet ratio, which may be

			linked to outbursts in the star (C. Neiner, 2012). Be stars, as easily observable objects that give a privileged view of the structure of rapidly rotating stars, are among the most suitable laboratories for investigating fundamental problems in contemporary astrophysics, such as the effects of rapid rotation on stellar evolution. Changes in NPR frequencies during outbursts seen in the light curve are linked to changes in the star's internal structure. Furthermore, these observations reinforce that the non-radial pulsations is the triggering mechanism of the Be phenomenon, since these explosions are proposed as a mechanism for the creation of the circumstellar disk in these stars.
e3 (online)	**Chahal, Deepak**	Macquarie University	**Unravelling the Period Gap using LAMOST Chromospheric Activity Indices** In our recent catalogue of BY Draconis (BY Dra) variables based on Zwicky Transient Facility data, we found traces of a period gap in the period–colour diagram. We combined our BY Dra database with catalogues from the Kepler and K2 surveys, revealing a prominent period gap. Here, we use this combined ZTF–Kepler–K2 data set to investigate the origin of the period gap observed for BY Dra stars using chromospheric activity indices. We use low- and medium-resolution spectra from the LAMOST Data Release 7 to derive magnetic activity indices for the Ca ii H and K and Hα emission lines. We find a strong dependence of chromospheric activity on both stellar mass and rotation period. For partially convective K–M-type stars, the activity decreases steeply until the age of the Praesepe cluster ($\sim$670 Myr), subsequently evolving to the type of low-level saturation associated with spin-down stallation. In contrast, F–G-type stars with thinner convective envelopes exhibit constant activity with increasing age. We suspect that the observed steep decrease for partially convective stars is driven by core–envelope coupling. This mechanism reduces differential rotation at the core–envelope transition, hence leading to decreased magnetic activity. Moreover, we derive activity indices for previously known star clusters and find similar trends as regards their activity levels as a function of age. In particular, very low-level activity is observed around the location of the period gap. Therefore, we conclude that the period gap, defined by the non-detection of variable sources, is driven by a minimum in chromospheric activity.
e4 (online)	**Keszthelyi, Zsolt**	National Astronomical Observatory of Japan	**Evolutionary and Population Synthesis Models of Magnetic Massive Stars** Magnetism is a ubiquitous property of astrophysical plasmas. In some hot, massive stars (with spectral types O, B, and A) surface magnetic fields have been detected. It is evidenced that these magnetic fields form a magnetosphere, which crucially impacts the dynamics and evolution of the star via mass-loss quenching and magnetic braking. We have incorporated these effects into new stellar structure and evolution models (Keszthelyi et al. 2022, MNRAS, 517, 2, 2028). In addition, we have also implemented and contrasted two different chemical mixing schemes. The evolutionary models show the expected rapid spin-down due to magnetic braking in combination with the effects of rotational mixing. The base grid of evolutionary models is now being used to model stellar populations, including sampling and interpolation along two axes (initial mass and initial magnetic field strength). Our findings indicate that magnetic massive stars have noticeably different surface abundances, which could help identify them in stellar populations. Moreover, we find a main sequence splitting and bi-modal rotational velocity distribution to be caused by the inclusion of magnetic models. While this has been qualitatively expected, our models offer a quantitative explanation for these open questions that can be tested against observations.

e5 (online)	**Guzik, Joyce**	Los Alamos National Laboratory	**Highlights of Cepheid Light Curve Analysis from TESS GI Cycle 3 and 4 Data** For TESS Guest Investigator Cycles 3 and 4, we proposed observations of bright Galactic Cepheids in 2-minute cadence photometry. Our objective was to search for transient, possibly phased, brightenings in the optical light curves, indicative of pulsation-produced shocks. Hydrodynamic modeling has shown that shocks can plausibly explain X-ray brightenings discovered in delta Cep (phased) and beta Dor using Chandra and XMM observations. Shocks have been proposed to drive mass loss in Cepheids that may help explain the Cepheid mass discrepancy. A second objective is to collect high-precision data that could be used to constrain hydrodynamic modeling and help to understand the origins of, e.g., cycle-to-cycle period and amplitude variations, bumps, and other features that are being discovered in TESS Cepheid light curves. We present a summary and highlights of light curve analyses for 61 (out of 73 proposed) Cepheid light curves obtained during Cycle 3 (south of the Ecliptic plane) and 44 (out of 46 proposed) Cepheid light curves obtained during Cycle 4 (north of the Ecliptic plane). While we do find some features that may be associated with transient brightenings, more work will be required to rule out spacecraft artifacts or pixel contamination from nearby objects in the field of view.
e6 (online)	**Moedas, Nuno**	Intituto de Astrofísica e Ciência do Espaço	**Accurate Characterisation of FG-type Stars with Improved Chemical Transport Mechanisms** The Kepler/K2 and the TESS mission provided us with asteroseismic data for a large sample of stars that impose a major constraint on the stellar characterisation. These two missions enriched the sample of asteroseismic targets that allow us to better determine the fundamental stellar properties (especially age). However, the current stellar models do not support us in taking full advantage of these data. The chemical transport mechanisms, for instance, are key ingredients in stellar evolution. However, the computation of stellar models, often includes only a simple atomic diffusion treatment, ignoring other additional processes, like radiative accelerations, fundamental for studying FG-type stars. It is, therefore, necessary to improve stellar models to better characterize stars and support the interpretation of the data from upcoming missions. In this talk, we present a new characterisation of a sample of FG-type stars observed by Kepler, using atomic diffusion. In these stellar models, we introduce a parametrised turbulent mixing in order to address the problem of surface chemical over-variations. This turbulent mixing was calibrated not only to avoid the extreme abundance variations but also to include the radiative acceleration effects in iron. This approach provides a much more accurate treatment of the physics in the stellar models with a much smaller computational cost. The new stellar models show relative differences to models of F-type stars without atomic diffusion that are currently used, of 5%, 2% and 20% for mass, radius and age respectively, when characterising these stellar types.. These results demonstrate the need for more accurate modelling of the transport of chemical elements in stellar models in order to obtain fundamental stellar properties.
e7 (online)	**Clara, Miguel**	Centro de Astrofísica da Universidade do Porto	**Towards a Comprehensive Characterization of Grid Interpolation in the context of Grid-based Modelling** Grid-based modelling techniques have been shown to enable the determination of stellar properties with a significant accuracy, justifying their use in the context of data exploitation from space missions like Kepler, TESS or PLATO as a way to better constrain stellar evolution models. In this context, the subgiant phase is both particularly interesting and challenging. Indeed, changes to the stellar structure allow the emergence of mixed modes, whose frequencies are characterized by a fast evolution with age,

			which can potentially allow the determination of stellar properties with great precision. However, current modelling techniques consider stellar grids that lack the necessary resolution to properly account for the fast mode frequency evolution, and require an interpolation algorithm to cover the parameter space in between the grid models when applying model-data comparison methods. The errors resulting from the interpolation of non-radial modes across different masses in a typical grid of subgiant models can be as high as a few tens of muHz (this is up to 2 orders of magnitude higher than the observational errors in some stars). In this presentation, we characterize the problem of frequency interpolation in the subgiant phase, and explore several possibilities to improve on the current procedures. We discuss the advantages of considering central density as the age proxy of interpolation over age, and cubic polynomial interpolation over linear, while interpolating along and across evolutionary tracks with different masses, quantifying the errors obtained with the different algorithms. We also discuss possible improvements resulting from the application of a variable transformation to the system, proposing a new age proxy for interpolation.
e8 (online)	**Panchal, Alaxender**	ARIES, Nainital	**Characterization of Kepler eclipsing binary candidate EPIC 211915147** The Kepler/K2 eclipsing binary (EB) candidate EPIC 211915147 is characterized with the help of photometric and high-resolution spectroscopic data. The light curve analysis uses the R-band photometric data from the 1.3-m Devasthal Fast Optical Telescope (DFOT , India) and Kepler mission. In addition to photometric obsevations, the radial velocity data from HERMES spectrograph are analyzed with the help of the modeling package PHOEBE 1.0. The component masses are determined as 1.48(0.01) and 1.27(0.01) in solar mass units for primary and secondary component, respectively. The component radii are determined as 1.66(0.02) and 1.53(0.02) in solar radius units. MESA Isochrones and Stellar Tracks are used to understand the evolutionary status of both systems.
e9 (online)	**Brogaard, Karsten**	University of Bologna	**An asteroseismic age estimate of the open cluster NGC6866** Asteroseismic investigations of solar-like oscillations allow the derivation of masses and radii of stars. For members of open clusters this allows an age estimate of the cluster which should be identical to the age estimate from the colour-magnitude diagram, but independent of the uncertainties that are present for that type of analysis. We identified six giant members of NGC6866 using Gaia DR3 observations. Five of these were observed by Kepler allowing asteroseismic measurements and estimates of stellar properties including the mass, radius and evolutionary state. Comparisons to stellar model isochrones constrains the amount of convective core overshoot and yields a more precise and accurate age estimate than previously possible. Our age estimate of NGC6866 is significantly younger than most previous estimates, while suggesting that rotation has very little effect on the evolution of the stars in NGC 6866. A comparison to mass and age estimates from machine learning methods of the same and other giant stars uncovers potential biases for automated asteroseismic and non-asteroseismic age estimates of secondary clump stars.
e10 (online)	**Thomsen, Jeppe Sinkbæk**	DIFA Unibo	**KIC10001167: An old tidally interacting eclipsing binary hosting an oscillating red giant** KIC10001167 is a previously studied eclipsing and spectroscopic double-lined binary, hosting a red giant star with strong asteroseismic oscillations. I will present new high-precision spectroscopic follow-up observations of the system from FIES@NOT, and show that its chemistry and age is compatible with the thick disk. Its light curve shows both tidal interaction and evidence of Doppler beaming, and with FIES it was possible to detect apsidal motion caused by tidal

			interaction. This makes it an excellent candidate for cross-validation between eclipse analysis, stellar atmosphere and interior modelling, and asteroseismic analysis.
e11 (online)	**Córsico, Alejandro Hugo**	University of La plata, Argentina	**Relativistic pulsations of ultra-massive ZZ Ceti stars** Ultra-massive ($M_\star \gtrsim 1.05\ M_\odot$) white dwarf stars are currently being discovered at a high rate, thanks to surveys such as the *Gaia* space mission. These dense and compact stellar remnants probably play a role in merger episodes and type Ia Supernovae explosions. When these stars exhibit pulsations, their relevance becomes extreme because it is possible, in principle, to probe their interiors thanks to asteroseismology. A crucial point, in the case of the most massive white dwarfs, is that General Relativity could affect their structure and pulsations substantially. In this work, we present results of relativistic gravity(g)-mode pulsation calculations employing relativistic ultra-massive white dwarf models, with the aim of assessing the impact of General Relativity on the adiabatic period spectrum of very-high mass ZZ Ceti stars. We have pulsationally analyzed fully evolutionary ONe-core ultra-massive white dwarf models with hydrogen-rich atmospheres and masses from 1.29 to 1.369 $M_\odot$ computed in the frame of General Relativity. We have employed the LPCODE and LP-PUL evolutionary and pulsation codes, respectively, appropriately adapted for relativistic calculations. In particular, for the pulsation analysis, we have employed the relativistic Cowling approximation.
e12 (online)	**Calcaferro, Leila M.**	IALP-CONICET-UNLP (Argentina)	**Probing the internal rotation of the extremely low-mass white dwarf GD 278 with TESS asteroseismology** We present the first exploration of the internal rotation of GD 278, the only known pulsating extremely low-mass white dwarf (WD) star to exhibit rotational frequency splittings within its periodogram, according to the mode identification presented in Lopez et al. (2021) based on TESS observations. Using an asteroseismological model representative of the pulsations of GD 278, we assessed the theoretical frequency splittings expected for different ad hoc rotation profiles and compared them to the observed frequency splittings of this star. We also derived a rotation profile that results from detailed evolutionary calculations and used it to infer the expected theoretical frequency splittings. The results from our different approaches, obtained by employing two independent evolutionary codes, agree with one another and suggest that the rotation profile of GD 278 is only slightly differential and certainly compatible with rigid rotation, as expected for WDs and pre-WDs in general.
e13 (online)	**Hall, Oliver**	European Space Agency - ESA ESTEC	**TESS field rotation rates of tidal tail stars doubles number of known Hyads** Tidal tails of stellar clusters are important laboratories for the evolution of stellar populations and the Milky Way at large. Recent data from the Gaia mission has allowed identification of new tidal tail structures thanks to its high-precision astrometric data. One such tidal tail belongs to the Hyades, recently detected by Jerabkova et al. 2021 (and confirmed using Gaia EDR3 data). However, Gaia data alone is not enough to robustly confirm tail membership. In this work in preparation, we confirm the coeval status of stars in the newly identified Hyades tidal tail through the use of gyrochronology, which provides a relationship between stellar rotation and age. Using multiple detection methods applied to multiple TESS Full Frame Image (FFI) pipelines, we measure robust rotation rates for Hyades tidal tail stars, including those longer than 13 days (where the TESS orbit inserts strong periodic signals). Using a hierarchical mixture model we compare the period-colour distribution of the tidal tail stars to those of the core Hyades cluster, the Praesepe cluster (which is of a similar age to the Hyades) and the background distribution in the field, providing a comprehensive list of membership probabilities for the newly detected Hyads.

e14 (online)	**Martinelli, Lorenzo**	University of Bologna	**The effect of rotation-induced mixing on the properties of secondary-clump stars** Uncertainties on the nature and efficiency of internal mixing processes in stars are becoming the dominant limitation to inferring accurate stellar ages. One particularly relevant uncertainty is that of the efficiency of additional mixing at the boundary of convective cores in the core hydrogen-burning phase due to rotation. We compute rotating models using the Geneva stellar evolution code for the main sequence and combine these with MESA models that are evolved to the core helium burning phase. This allows us to constrain such mixing processes by studying their imprint on the observed luminosity distribution and core properties of low to intermediate-mass core helium burning stars. In this poster I will present preliminary results on these investigations.
e15 (online)	**Merc, Jaroslav**	Astronomical Institute of Charles University, Prague, Czech Republic	**Accretion-induced variability of interacting red giant binaries masquerading as oscillations** Symbiotic stars are strongly interacting binaries with long orbital periods, containing an evolved red giant and a white dwarf or a neutron star embedded in a circumbinary nebula. They constitute unique astrophysical laboratories important for understanding the binary evolution and diverse processes occurring also in many other types of astrophysical objects. In this contribution, we present the first results of the analysis of the TESS light curves of a sample of symbiotic stars. In particular, we focus on the short-term photometric variability of these binaries on a timescale from minutes to days. Although this variability reminds the solar-like oscillations of luminous red giants at first sight, we demonstrate that this variability originates from a different process, most likely from the accretion disks around the hot companions, and therefore is connected with the mass transfer. Up to now, such variability, known as flickering in the symbiotic stars community, has been observed only in a small fraction of these interacting systems, either from quasi-visual inspection of the light curves or from the comparison of the variability with nearby stars. We present an effective, quantitative method to reliably distinguish between flickering sources and oscillating red giants.
e16 (online)	**Breton, Sylvain**	INAF - Osservatorio Astrofisico di Catania	**Measuring stellar rotation and activity with the PLATO mission** Space-based photometry is an extremely powerful observing method in order to measure surface rotation of large samples of main-sequence solar-type stars. The PLATO mission (launch schedule for late 2026) will provide, for bright stars, years-long continuous light curves of exquisite quality which should allow characterisation of surface rotation in tens of thousands of stars. This poster presents the rotation and activity analysis module currently under consideration for the PLATO stellar analysis system (SAS), which combines Fourier analysis, autocorrelation of time series and machine learning methodologies to measure both stellar surface rotation and long-term modulations related to stellar magnetic activity. In particular, the ROOSTER random forest methodology guarantees the completeness and the robustness of the automated analysis of rotation in the SAS. In order to underline this efficiency, results of the first tests performed on a Kepler reference data set and PLATO simulated light curves are presented. Combining these measurements with asteroseismic inference will enable us to improve in an unprecedented manner our understanding of the evolution of the angular momentum of late-type stars and of their planetary systems.
e17 (online)	**Gautam, Anuj**	University of Southern Queensland	**Asteroseismic Age Estimation of the Pleiades Open Cluster** We used asteroseismology to determine the age of the Pleiades open cluster. We fitted pulsation frequencies of young delta Scuti stars using a neural network emulator of theoretical stellar models. The network was trained on pulsation models calculated using the GYRE stellar oscillation code, applied to uniformly rotating stellar models. The stellar evolutionary tracks were computed with MESA in a discretely sampled grid. Our sample comprised delta Scuti stars

			from the literature that were recently discovered in lightcurves from NASA's TESS and K2 missions; we use those same lightcurves to identify the pulsation modes with the help of echelle diagrams. By applying metallicity constraints derived from the spectroscopy of K dwarf stars, we were able to reduce the complexity of the search, allowing the age of the Pleiades cluster to be constrained. Overall, our study showcases the potential of using asteroseismology and optimally trained neural networks to determine the internal rotation rates of stars and to derive more accurate asteroseismic ages for field stars, clusters, and stellar associations. Furthermore, our research opens up avenues for future studies to explore the systematic uncertainties associated with the modelling of delta Scuti stars.
e18 (online)	**Briganti, Lorenzo**	University of Bologna	**Calibration of overshooting efficiency at the boundary of the convective envelope through the study of the Red-Giant Branch bump** Mixing beyond the boundaries of convective zones in stellar interiors plays an important role in the chemical evolution of stars and galaxies. Indeed, since it affects the transport of chemical elements toward the outer part of a star, constraining the extra mixing mechanism will lead to a better understanding of the physical mechanism underlying the observed chemical abundance patterns. The comprehension of the full scale on which extra mixing impacts the chemical evolution of stars is quite uncertain. In particular, concerning low mass stars, in the past decades, several works highlighted a discrepancy between the observed luminosity of the Red-Giant Branch bump (RGBb) and its predicted position in standard stellar models. This discrepancy can be fixed including overshooting at the base of the convective envelope. Using the luminosity of the RGBb as diagnostic, in this work is provided a preliminary calibration of two different types of overshooting, instantaneous and diffusive, analysing simulations and Globular Clusters' data. The aim is to understand which of the two mixing processes is the most suitable in reproducing the observed behaviour and, in case both provide reliable results, under what conditions they produce the same effects on the RGBb position. The main results show a dependence of the overshooting efficiency on metallicity: in less metallic Globular Clusters overshooting seems to be more efficient. This seems in line with what could be obtained from hydrodynamic considerations which, ultimately, could lead to build a self-consistent overshooting model. Finally, the validity range of these findings will be extended by using the asteroseismic data from Kepler and K2, thus providing insights on the overshooting mechanism to solar and super-solar metallicities and younger ages.
e19 (online)	**Gautam, Anuj**	University of Southern Queensland	**Quantifying Systematic Uncertainties in Delta Scuti Star Modelling** We present an analysis of the impact of various physical and computational parameters on the modeling of Delta Scuti (dSct) stars. We use stellar evolution tracks created by MESA and pulsation frequencies determined with GYRE to ascertain the most critical parameters, and to identify those that yield minimal or inconsequential effects on the modeling process. Our analysis, founded on a comparative study of different parameter sets, sheds light on the effects of parameter perturbations on the resultant stellar properties. A significant component of our approach involved a thorough assessment of five distinct nuclear reaction networks within the MESA suite, revealing variations of up to 5% in pulsation frequencies. Our investigations led us to recognize the \`pp_and_cno_extras\` network as the most comprehensive, despite its computational intensity. Nevertheless, our custom network, \`pp_extras+hot_cno\`, delivered comparable outcomes with a decrease in computation time by 10%, making it our preferred choice for proficient and precise modeling of dSct stars. In addition, we introduce a set of benchmark systems intended to act as a guiding framework for future research in this domain. We underscore that these

			uncertainties not only influence the estimation of fundamental astronomical measures, like cluster ages, but also have implications on subsequent stellar evolution models.
e20 (online)	**Godoy-Rivera, Diego**	Instituto de Astrofisica de Canarias (IAC)	**Characterizing the Kepler Targets with Gaia DR3: Identification of Binary Systems and Color-Magnitude Diagram Classification** The original Kepler mission has delivered unprecedented high-quality photometry. These data have impacted numerous research fields, and continue to be a goldmine for astrophysics to this day. Because of this, thorough characterizations of the ~ 200,000 stars observed by Kepler remain of paramount importance. In this work, we use the EDR3 and DR3 Gaia data to investigate the Kepler targets. We produce comprehensive lists of interesting populations. These include a number of color-magnitude diagram categories (e.g., dwarfs, subgiants, red giants), as well as identifying several categories of binary systems (e.g., photometric, RUWE, Non-Single-Star Two-Body-Orbit, radial velocity variables, among others). We demonstrate the applications of our catalog by reporting a sample of potential asteroseismic targets for follow-up investigations. Our classification flags based on the Gaia data will be a valuable resource for the community in the continued exploration of the stars observed by the Kepler mission.
e21 (online)	**Hedlund, Anne**	Los Alamos National Laboratory/New Mexico State University	**Uncovering 'hidden' Kepler pulsating binaries through spectroscopic detection** Multiple star systems are ubiquitous in the universe—they are comprised of stars at every evolutionary stage and can be found in almost every astrophysical environment. Studying multiple star systems is crucial to our understanding of stellar interiors and stellar evolution and directly influences our understanding of astrophysical processes on larger physical scales. Binary star systems present a unique set of properties, such as the constraint of coevality and the ability to derive dynamical masses, which make them ideal testbeds for stellar astronomy. As space-based photometric missions continue to revolutionize asteroseismology and call into question our understanding of stellar interiors and evolution, studying stellar pulsators in binary star systems provides the unique opportunity to test our stellar models in well-constrained systems with precise stellar parameters. Kepler and TESS have increased the sample of known pulsating binaries significantly, but the current sample suffers from observational biases which propagate into the stellar/orbital parameters of the binary sample. To increase the sample of pulsating binaries and hopefully expand into new regions stellar/orbital parameter space, I identified 21 potential 'hidden' binaries from a sample of Kepler red giants. The targets appear to have signatures of solar-like and classical oscillations, but no signs of eclipse. By taking time series spectroscopic follow-up observations of these targets, I can detect orbital motion that was 'hidden' from photometric detection. 17 of these targets have been observed 4+ times over the last 1 ½ years using the high-resolution visible echelle spectrograph on the 3.5-meter telescope at Apache Point Observatory. Through the detection of periodic Doppler shifts in spectral lines and the derivation of radial velocities using the broadening function technique, 16 targets have been confirmed as spectroscopic binaries. This work has uncovered previously 'hidden' binaries, increasing the sample of pulsating binaries for study, and providing added value to Kepler data archive.
e22 (online)	**Forró, Adrienn**	Konkoly Observatory, CSFK	**Investigating Pan-STARRS RR Lyrae stars through the lens of K2** Pan-STARRS observed a large number of RR Lyrae stars during its PS1 3π survey. The identification and period determination of these stars, however, were based on light curves that are sparsely sampled and contain only a few (~ a dozen or so) data points in each of the 5 filters. The Kepler space telescope observed a subset of these variable stars during its K2 campaigns and provided us with continuous light curves with significantly higher sampling frequency.

			The two catalogs that list the RR Lyrae stars identified from the Pan-STARRS data sets (Hernitschek et al. 2016 and Sesar et al. 2017) were first cross-matched with the list of RR Lyrae stars that were observed by the K2 mission in at least one of the campaigns. Then the selection was cross-matched with the Gaia DR3 RR Lyrae catalog as well. Analyzing the frequency spectra of the targets, we found that for the majority of the stars, the periods calculated from the K2 light curves are in agreement with those derived from the Pan-STARRS data. However, for a subset of stars, an alias frequency with ±1 or 2 c/d offset was found instead of the true one, most likely due to the fact that Pan-STARRS observed from the ground, causing regular gaps in the data during daytime. Among the subtypes, the RRc variables were found to be the ones that are the most likely to have alias frequencies because of their less sharp light curve shapes.
e23 (online)	**Labadie-Bartz, Jonathan**	Paris Observatory	**TESS photometry + simultaneous spectroscopy of classical Be stars: pulsation, mass ejection, and disk formation** Classical Be stars are massive main-sequence rapid-rotators that mechanically eject material, forming gaseous circumstellar 'decretion' disks. These stars are multi-mode pulsators, and evidence is mounting that pulsation plays a key role in the mass ejection mechanism. Analysis of TESS photometry for ~1,000 Be stars reveals many different types of variability, including stochastic variability, coherent and variable pulsation in both low and high frequencies, groups of closely-spaced frequencies and combination modes, and discrete mass ejection episodes. These systems are sufficiently complex that photometry alone, no matter how precise, is often ambiguous. We have therefore been monitoring ~200 Be stars with time-series optical echelle spectroscopy contemporaneous with their TESS observations. These spectra probe the star and circumstellar environment in ways that are complementary to TESS. Combining these datasets allows for the characterization of: 1) stellar pulsation modes, 2) mass ejection events (and the concurrent changes in pulsational patterns), 3) the initial asymmetric distribution of ejecta and its subsequent evolution (on timescales of hours to days) into a circumstellar disk, and 4) stellar properties including rotation rate, mass, radius, and inclination angle. SPH and radiative transfer models are being developed to describe the behavior of the ejecta after it is launched into orbit, allowing us to quantify the efficiency of viscosity and the amount of mass and angular momentum that is ejected and subsequently carried out of the system. The simultaneous space photometry and spectroscopy provide tight constraints, as various regions in the disk are probed by different observational features.
e24 (online)	**Bhalotia, Vanshree**	Natl Radio Astronomy Observatory	**A New Asteroseismic Kepler Benchmark Supports Weakened Magnetic Breaking in Mature Sun-Like Stars** Stellar spin down is a critical yet poorly understood component of stellar evolution. In particular, recent results from the Kepler Mission imply that mature age, solar-type stars have inefficient magnetic braking, resulting in a stalled spin down rate. However, a large number of precise asteroseismic ages are needed for mature (~ 3Gyr) stars in order to probe the regime where traditional and stalled spin-down models differ. In this paper, we present a new asteroseismic benchmark star for gyrochronology discovered using reprocessed Kepler short cadence data. KIC 11029516 (Papayu) is a bright (Kep mag = 9.63) solar-type star with well-measured rotation period of 21.1 +/- 0.8 days from spot modulation over 4 years of Kepler long cadence data. We combine asteroseismology and spectroscopy to obtain an Effective Tempetarure of 5888 +/- 100 K, [Fe]/[H] of 0.30 +/- 0.06 dex, Mass of 1.24 +/- 0.05 Solar Mass, Radius of 1.34 +/- 0.02 Solar Radius and Age of 4.1 +/- 0.4 Gyr, making Papayu one of the closest stars to the Sun in terms of mass and radius with a well measured age and rotation period. We find that Papayu sits at the transition of where traditional and weakened spin-down models diverge. A comparison with stars of similar zero-age main-

			sequence temperatures supports previous findings that weakened spin-down models are required to explain the ages and rotation periods of old solar-type stars.
e25 (online)	**Bellinger, Earl**	Max Planck Institute for Astrophysics	**Solar evolution models with a central black hole** Hawking (1971) proposed that the Sun may harbor a primordial black hole whose accretion supplies some of the solar luminosity. Such an object would have formed in the first 1 s after the Big Bang with an initial mass of at least 10^{-20} $M_\odot$. These dwarf-planet-mass black holes are a candidate solution to the dark matter problem, and would be a source of solar-mass black holes if they are captured by stars. Here we extend the stellar evolution code MESA to compute the evolution of stars having such a black hole at their center. We find that models of the Sun with a black hole of up to 10^{-10} $M_\odot$ are compatible with observational constraints. Such a scenario would result in the Sun being consumed within 8 Gyr of now, leading to a 0.9 $M_\odot$ black hole instead of a red giant. We furthermore consider a wide range of black hole seed masses, stellar masses, and metallicities. We find that stars with a central black hole can be surprisingly long-lived, which suggests that asteroseismic surveys could potentially identify stars harboring these objects, thus providing a unique mechanism to search for and confirm or falsify the existence of primordial black holes. Finally, this channel could also explain the origin of LIGO's recently discovered ~100 $M_\odot$ black holes, which are difficult to produce via known stellar and binary evolutionary pathways.

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