Kepler & K2 Science Conference V Program

Version 3, February 20, 2019

Science Program

Monday, March 4, 2019

Session 1	*Kepler/K2 Mission History and Future (Chair: Dawn Gelino)*
8:00-8:30	Registration
8:30-9:00	Bill Borucki (invited): History of the Kepler Mission
9:00-9:30	Katelynn McCalmont (invited): Flying the Kepler Spacecraft's Second Mission: K2 Operations
9:30-9:45	Douglas Caldwell: The Kepler photometer
9:45-10:00	Geert Barentsen: Kepler's Discoveries Will Continue: 21 Scientific Opportunities with Kepler & K2 Archive Data
10:00-10:30	*Break*
Session 2	*Precise Stellar and Planetary Radii (Chair: Dan Huber)*
10:30-11:00	Mia Lundkvist (invited): Asteroseismology of exoplanet host stars from the Kepler/K2 missions
11:00-11:15	Vincent Van Eylen: Understanding planet formation through asteroseismology
11:15-11:30	Hilke Schlichting: Observational Signatures of the Core-Powered Mass-Loss Mechanism: The Radius Valley as a Function of Stellar Mass
11:30-11:45	Travis Berger: Precise Characterization of Kepler Stars and Planets Using Gaia DR2
11:45-12:00	Benjamin Fulton: Revisiting the Radius Gap in the Era of Gaia
12:00-13:30	*Lunch*
Session 3	*Stellar Magnetism and Activity (Chair: David Ciardi)*
13:30-13:45	Matteo Cantiello: Internal Magnetic Fields Asteroseismology: Kepler's Legacy and TESS's opportunities
13:45-14:00	Angela Santos: Seismic signatures of magnetic activity in solar-type stars observed by Kepler
14:00-14:15	Ellianna Schwab Abrahams: The Fundamental and Magnetic Characteristics of M Dwarfs in the Kepler Field
14:15-14:30	Michael Gully-Santiago: K2 constraints on stellar surface inhomogeneities and their systematic bias of transit-derived exoplanet densities
14:30-14:45	Sharon Xuesong Wang: RVxK2: Using Simultaneous Kepler Photometry to Mitigate Stellar Jitter
14:45-15:00	Lisa Bugnet: FliPer: a powerful tool to detect and characterise Solar-like pulsators

15:00-15:30	*Break*

Session 4	*Exoplanet Occurrence Rates (Chair: Jessie Christiansen)*
15:30-16:00	Courtney Dressing (invited): Probing the Frequency of Planetary Systems with Kepler and K2
16:00-16:15	Gijs Mulders: Exoplanet population synthesis in the era of large exoplanets surveys
16:15-16:30	Timothy Morton: The Probabilistic Validation Revolution: How Kepler forced a paradigm shift in how we treat transiting planet candidates
16:30-16:45	Marko Sestovic: The occurence rate of planets around ultracool dwarfs
16:45-17:00	Christina Hedges: Are there any more planets in the Kepler / K2 data?

Tuesday, March 5, 2019

Session 1	*Kepler Benchmark Systems (Chair: Courtney Dressing)*
8:30-9:00	Sarah Ballard (invited): Lessons from the Multi-planet Systems
9:00-9:15	Christopher Shallue: Can deep learning help find Earth analogues?
9:15-9:30	Michelle Hill: Exploring Kepler Giant Planets in the Habitable Zone
9:30-9:45	Kai Rodenbeck: Revisiting the exomoon candidate signal around Kepler-1625 b
9:45-10:00	Ashley Chontos: The Curious Case of KOI-4: Confirming Kepler's First Exoplanet

10:00-10:30	*Break*

Session 2	*K2 Benchmark Systems (Chair: Jessie Dotson)*
10:30-11:00	Andrew Vanderburg (invited): Benchmark Exoplanet Systems Discovered by the K2 Mission
11:00-11:15	Juliette Becker: Dynamically Determining Observationally Ill-Constrained Planet Parameters: Towards Precise Transit Ephemerides for the Benchmark System HIP 41378
11:15-11:30	Kevin Hardegree-Ullman: Space Telescope Synergy: Spitzer Follow-up of K2 Targets
11:30-11:45	Joey Rodriguez: K2-266: A Compact Multi-Planet System With A Planet That Is "Way Out of Line"
11:45-12:00	Fei Dai: New perspective on the ultra-short-period planets

12:00-13:30	*Lunch*

Session 3	*Methods, Microlensing, and Accretion Physics (Chair: Steve Howell)*
13:30-13:45	Rodrigo Luger: Gradient-based inference techniques for exoplanet light curves
13:45-14:00	Sebastiano Calchi Novati: An isolated microlens observed from K2, Spitzer and Earth

14:00-14:30	Krista Lynne Smith (invited): Kepler/K2 and Active Galactic Nuclei: New Insights into Accretion and High Energy Phenomena
14:30-14:45	Paula Szkody: Insights into Accretion in Cataclysmic Variables Gleaned from Kepler
14:45-15:00	Ryan Ridden-Harper: Hunting transients in K2 with the K2: Background Survey

15:00-15:30	*Break*

Session 4	*Extragalactic Science (Chair: Michael Gully-Santiago)*
15:30-16:00	Peter Garnavich (invited): Better Understanding Supernovae from Kepler/K2 Observations
16:00-16:15	Georgios Dimitriadis: K2 Observations of SN 2018oh Reveal a Two-Component Rising Light Curve for a Type Ia Supernova
16:15-16:30	Thomas Holoien: ASASSN-18bt: Evidence for Nickle on the Surface of a Type Ia Supernova found by the rising K2 light curve
16:30-16:45	Edward Shaya: A Tidal Disruption Event in a Seyfert 2 Observed with K2
16:45-17:00	Armin Rest: A Fast-Evolving, Luminous Transient Discovered by K2/Kepler

17:00-18:30	*Poster Session I*

Wednesday, March 6, 2019

Session 1	*Galactic Archaeology (Chair: Katrien Kolenberg)*
8:30-9:00	Marc Pinsonneault (invited): Galactic Archeology with Kepler and K2
9:00-9:15	Dennis Stello: The K2 Galactic Archaeology Program: revealing the jigsaw puzzle one campaign at a time
9:15-9:30	Jie Yu: Ensemble asteroseismology of 20,000 oscillating red giants observed by Kepler
9:30-9:45	Rafael Garcia: A Comprehensive Full Kepler Red Giant Legacy Catalog
9:45-10:00	Daniel Huber: An Asteroseismic Age for the Galactic Halo Measured with Distant Kepler Giants

10:00-10:30	*Break*

Session 2	*Binaries, Exoplanets, and Citizen Science (Chair: Andrew Howard)*
10:30-10:45	Adam Kraus: The Perilous Lives of Planets in Binary Star Systems
10:45-11:00	Rachel Matson: Detecting Unresolved Binaries in Exoplanet Transit Surveys with Speckle Imaging
11:00-11:15	Nicole Hess: Identifying Bound Stellar Companions to Kepler Exoplanet Host Stars With Speckle Imaging
11:15-11:30	Wei Zhu: Many Kepler planets have distant companions

11:30-12:00	Chris Lintott (invited): Citizen Science with Kepler and K2
12:00-13:30	*Lunch*

Session 3 *Simultaneous Breakout Sessions I*

13:30-15:00 David Soderblom: Opportunities and limitations of the cluster data from Kepler/K2
Christina Hedges: The Lightkurve package for Kepler & TESS data analysis: tutorials and consulting breakout
Eric Feigelson: Finding Planets in Kepler lightcurves with R
Sharon Wang: Data Hack for RVxK2: Battling Stellar Jitter with Simultaneous K2 Photometry and RVs

15:00-15:30 *Break*

Session 4 *Simultaneous Breakout Sessions II*

15:30-17:00 Ann Marie Cody: A Crowded Field Photometry Challenge
Michael Gully-Santiago: Modeling correlated noise with Gaussian processes
Lee Rosenthal: RadVel: The Radial Velocity Fitting Toolkit
Tom Barclay/Knicole Colón: Community Data Products and Early Science from the TESS Mission

Thursday, March 7, 2019

Session 1 *Stellar Rotation and Gyrochronology (Chair: Ann Marie Cody)*

8:30-9:00	Ruth Angus (invited): The Kepler revolution: stellar rotation and activity in clusters and the field
9:00-9:15	Jason Curtis: Building Precision Stellar Clocks with Kepler and Gaia
9:15-9:30	Beate Stelzer: The rotation-activity-age relation of M dwarfs in the era of Kepler and K2
9:30-9:45	Lauren Doyle: The Rotational Phase distribution of Stellar Flares on M dwarfs
9:45-10:00	Joshua Reding: The Confluence of Hardware Failures That Lead to the Discovery of the Most Rapidly Rotating Isolated White Dwarf
10:00-10:30	*Break*

Session 2 *Exoplanets Over Time (Chair: Matthew Holman)*

10:30-11:00	Andrew Mann (invited): Tracing Planetary Evolution with K2
11:00-11:15	Ann Marie Cody: Young Stars in the Time Domain: the View with Kepler
11:15-11:30	Eric Gaidos: What Orbits a Mysterious Young “Dipper” Star in Taurus?
11:30-11:45	Laura Venuti: A dynamical view of star-disk interaction processes in the

	Lagoon Nebula with Kepler/K2
11:45-12:00	Samuel Grunblatt: Planetary Archaeology: Exploring the Planet Population of Evolved Stars
12:00-13:30	*Lunch*
Session 3	*Fundamental Stellar Parameters (Chair: Savita Mathur)*
13:30-14:00	Patrick Gaulme (invited): Asteroseismology, Red Giants, and Eclipsing Binaries
14:00-14:15	Timothy White: Testing asteroseismic ages of red giants with the Hyades
14:15-14:30	Benjamin Pope: Naked-Eye Stars in Kepler and K2
14:30-14:45	Dominic Bowman: Blue supergiants reveal diverse pulsational variability in K2 photometry
14:45-15:00	Simon Murphy: Pulsating Stars in Binaries
15:00-15:30	*Break*
Session 4	*Planetary Architectures (Chair: Eric Mamajek)*
15:30-16:00	Lauren Weiss (invited): Planetary System Architectures and Dynamics
16:00-16:15	Jack Lissauer: Architecture and Dynamics of Kepler's Multi-Transiting Planet Systems: Comprehensive Investigation Using All Four Years of Kepler Mission Data
16:15-16:30	Darin Ragozzine: Getting more out of information-rich Kepler multis that show TTVs
16:30-16:45	Sarah Millholland: Obliquity Tides and their Role in Understanding the Kepler Planet Period Ratio Distribution
16:45-17:00	Miranda Herman: Revisiting the Long-Period Transiting Planets from Kepler
17:00-18:30	*Poster Session II*

Friday, March 8, 2019

Session 1	*Internal Rotation and Asteroseismology (Chair: Dennis Stello)*
8:30-9:00	Sebastian Deheuvels (invited): Monitoring the internal rotation of stars along their evolution with Kepler
9:00-9:15	Jim Fuller: A Solution to the Slow Spins of Stellar Cores
9:15-9:30	Barbara Endl: Asteroseismology of white dwarfs observed by Kepler and K2
9:30-9:45	Roberto Szabo: Classical pulsating variables in the Kepler/K2 era
9:45-10:00	Katrien Kolenberg: RR Lyr, an old friend in a new light, with Kepler
10:00-10:30	*Break*

Session 2	*Kepler/K2 Follow-Up Programs (Chair: Christina Hedges)*
10:30-10:45	David Ciardi: The Legacy of Kepler and K2: The Follow-up Observation Programs
10:45-11:00	David Latham: Contributions from HARPS-N to the Mass-Radius Diagram for Kepler/K2 Planets
11:00-11:15	Erik Petigura: Metal-rich Stars Host a Greater Diversity of Planets
11:15-11:30	Cintia Fernanda Martinez: An Independent Spectroscopic Analysis of the California-Kepler Survey Sample: A Slope in the Small Planet Radius Gap
11:30-11:45	Eric Mamajek: Small (In)temperate Planets: A Closer Look at Habitable Zone Terrestrial-sized Planet Candidates
11:45-12:00	Ian Crossfield: Atmospheric Characterization of Kepler/K2 Planets
12:00-13:30	*Lunch*
13:30-13:45	*Poster Competition Winners (2x7 min)*
Session 3	*Solar System Science, Other Missions, and Reflections (Chair: Tom Barclay)*
13:45-14:00	Andras Pal: New results with K2 in Solar System exploration
14:00-14:15	Jessie Dotson: Observations of Solar System Objects with K2
14:15-14:30	Andrea Fortier: The CHEOPS Mission
14:30-14:45	George Ricker: The TESS Mission: Current Status and Future Plans
14:45-15:15	Jessie Christiansen (invited): Reflections
15:15	*End of Conference*

Kepler & K2 Science Conference V Program

	Monday March 4	Tuesday March 5	Wednesday March 6	Thursday March 7	Friday March 8
Session 1 (8.30am-10.00am)	*Kepler/K2 Mission History and Future (Chair: Dawn Gelino)*	*Kepler Benchmark Systems (Chair: Courtney Dressing)*	*Galactic Archaeology (Chair: Katrien Kolenberg)*	*Stellar Rotation and Gyrochronology (Chair: Ann Marie Cody)*	*Internal Rotation and Asteroseismology (Chair: Dennis Stello)*
8:30-8:45	Bill Borucki (invited): History of the Kepler Mission	Sarah Ballard (invited): Lessons from the Multi-planet Systems	Marc Pinsonneault (invited): Galactic Archeology with Kepler and K2	Ruth Angus (invited): The Kepler revolution: stellar rotation and activity in clusters and the field	Sebastian Deheuvels (invited): Monitoring the internal rotation of stars along their evolution with Kepler
8:45-9:00					
9:00-9:15	Katelynn McCalmont (invited): Flying the Kepler Spacecraft's Second Mission: K2 Operations	Christopher Shallue: Can deep learning help find Earth analogues?	Dennis Stello: The K2 Galactic Archaeology Program: revealing the jigsaw puzzle one campaign at a time	Jason Curtis: Building Precision Stellar Clocks with Kepler and Gaia	Jim Fuller: A Solution to the Slow Spins of Stellar Cores
9:15-9:30		Michelle Hill: Exploring Kepler Giant Planets in the Habitable Zone	Jie Yu: Ensemble asteroseismology of 20,000 oscillating red giants observed by Kepler	Beate Stelzer: The rotation-activity-age relation of M dwarfs in the era of Kepler and K2	Barbara Endl: Asteroseismology of white dwarfs observed by Kepler and K2
9:30-9:45	Douglas Caldwell: The Kepler photometer	Kai Rodenbeck: Revisiting the exomoon candidate signal around Kepler-1625 b	Rafael Garcia: A Comprehensive Full Kepler Red Giant Legacy Catalog	Lauren Doyle: The Rotational Phase distribution of Stellar Flares on M dwarfs	Roberto Szabo: Classical pulsating variables in the Kepler/K2 era
9:45-10:00	Geert Barentsen: Kepler's Discoveries Will Continue: 21 Scientific Opportunities with Kepler & K2 Archive Data	Ashley Chontos: The Curious Case of KOI-4: Confirming Kepler's First Exoplanet	Daniel Huber: An Asteroseismic Age for the Galactic Halo Measured with Distant Kepler Giants	Joshua Reding: The Confluence of Hardware Failures That Lead to the Discovery of the Most Rapidly Rotating Isolated White Dwarf	Katrien Kolenberg: RR Lyr, an old friend in a new light, with Kepler
Break (10am-10.30am)					
Session 2 (10.30am-12pm)	*Precise Stellar and Planetary Radii (Chair: Dan Huber)*	*K2 Benchmark Systems (Chair: Jessie Dotson)*	*Binaries, Exoplanets, and Citizen Science (Chair: Andrew Howard)*	*Exoplanets Over Time (Chair: Matthew Holman)*	*Kepler/K2 Follow-Up Programs (Chair: Christina Hedges)*
10:30-10:45	Mia Lundkvist (invited): Asteroseismology of exoplanet host stars from the Kepler/K2 missions	Andrew Vanderburg (invited): Benchmark Exoplanet Systems Discovered by the K2 Mission	Adam Kraus: The Perilous Lives of Planets in Binary Star Systems	Andrew Mann (invited): Tracing Planetary Evolution with K2	David Ciardi: The Legacy of Kepler and K2: The Follow-up Observation Programs

10:45-11:00			Rachel Matson: Detecting Unresolved Binaries in Exoplanet Transit Surveys with Speckle Imaging		David Latham: Contributions from HARPS-N to the Mass-Radius Diagram for Kepler/K2 Planets
11:00-11:15	Vincent Van Eylen: Understanding planet formation through asteroseismology	Juliette Becker: Dynamically Determining Observationally Ill-Constrained Planet Parameters: Towards Precise Transit Ephemerides for the Benchmark System HIP 41378	Nicole Hess: Identifying Bound Stellar Companions to Kepler Exoplanet Host Stars With Speckle Imaging	Ann Marie Cody: Young Stars in the Time Domain: the View with Kepler	Erik Petigura: Metal-rich Stars Host a Greater Diversity of Planets
11:15-11:30	Hilke Schlichting: Observational Signatures of the Core-Powered Mass-Loss Mechanism: The Radius Valley as a Function of Stellar Mass	Kevin Hardegree-Ullman: Space Telescope Synergy: Spitzer Follow-up of K2 Targets	Wei Zhu: Many Kepler planets have distant companions	Eric Gaidos: What Orbits a Mysterious Young ``Dipper'' Star in Taurus?	Cintia Fernanda Martinez: An Independent Spectroscopic Analysis of the California-Kepler Survey Sample: A Slope in the Small Planet Radius Gap
11:30-11:45	Travis Berger: Precise Characterization of Kepler Stars and Planets Using Gaia DR2	Joey Rodriguez: K2-266: A Compact Multi-Planet System With A Planet That Is "Way Out of Line"	Chris Lintott (invited): Citizen Science with Kepler and K2	Laura Venuti: A dynamical view of star-disk interaction processes in the Lagoon Nebula with Kepler/K2	Eric Mamajek: Small (In)temperate Planets: A Closer Look at Habitable Zone Terrestrial-sized Planet Candidates
11:45-12:00	Benjamin Fulton: Revisiting the Radius Gap in the Era of Gaia	Fei Dai: New perspective on the ultra-short-period planets		Samuel Grunblatt: Planetary Archaeology: Exploring the Planet Population of Evolved Stars	Ian Crossfield: Atmospheric Characterization of Kepler/K2 Planets
Lunch (12pm-1.30pm)					
Session 3 (1.30pm-3pm)	*Stellar Magnetism and Activity (Chair: David Ciardi)*	*Methods, Microlensing, and Accretion Physics (Chair: Steve Howell)*	*Simultaneous Breakout Sessions I*	*Fundamental Stellar Parameters (Chair: Savita Mathur)*	*Solar System Science, Other Missions, and Reflections (Chair: Tom Barclay)*
1:30-1:45	Matteo Cantiello: Internal Magnetic Fields Asteroseismology: Kepler's Legacy and TESS's opportunities	Rodrigo Luger: Gradient-based inference techniques for exoplanet light curves	David Soderblom: Opportunities and limitations of the cluster data from Kepler/K2 Christina Hedges: The Lightkurve package for Kepler & TESS data analysis: tutorials and	Patrick Gaulme (invited): Asteroseismology, Red Giants, and Eclipsing Binaries	Poster Competition Winners (2x7 min)
1:45-2:00	Angela Santos: Seismic signatures of magnetic activity in solar-type stars observed by Kepler	Sebastiano Calchi Novati: An isolated microlens observed from K2, Spitzer and Earth			Andras Pal: New results with K2 in Solar System exploration

2:00-2:15	Ellianna Schwab Abrahams: The Fundamental and Magnetic Characteristics of M Dwarfs in the Kepler Field	Krista Lynne Smith (invited): Kepler/K2 and Active Galactic Nuclei: New Insights into Accretion and High Energy Phenomena	consulting breakout Eric Feigelson: Finding Planets in Kepler lightcurves with R Sharon Wang: Data Hack for RVxK2: Battling Stellar Jitter with Simultaneous K2 Photometry and RVs	Timothy White: Testing asteroseismic ages of red giants with the Hyades	Jessie Dotson: Observations of Solar System Objects with K2
2:15-2:30	Michael Gully-Santiago: K2 constraints on stellar surface inhomogeneities and their systematic bias of transit-derived exoplanet densities			Benjamin Pope: Naked-Eye Stars in Kepler and K2	Andrea Fortier: The CHEOPS Mission
2:30-2:45	Sharon Xuesong Wang: RVxK2: Using Simultaneous Kepler Photometry to Mitigate Stellar Jitter	Paula Szkody: Insights into Accretion in Cataclysmic Variables Gleaned from Kepler		Dominic Bowman: Blue supergiants reveal diverse pulsational variability in K2 photometry	George Ricker: The TESS Mission: Current Status and Future Plans
2:45-3:00	Lisa Bugnet: FliPer: a powerful tool to detect and characterise Solar-like pulsators	Ryan Ridden-Harper: Hunting transients in K2 with the K2: Background Survey		Simon Murphy: Pulsating Stars in Binaries	Jessie Christiansen (invited): Reflections
Break (3pm-3.30pm)					
Session 4 (3.30pm-5pm)	*Exoplanet Occurrence Rates (Chair: Jessie Christiansen)*	*Extragalactic Science (Chair: Michael Gully-Santiago)*	*Simultaneous Breakout Sessions II*	*Planetary Architectures (Chair: Eric Mamajek)*	
3:30-3:45	Courtney Dressing (invited): Probing the Frequency of Planetary Systems with Kepler and K2	Peter Garnavich (invited): Better Understanding Supernovae from Kepler/K2 Observations	Ann Marie Cody: A Crowded Field Photometry Challenge Michael Gully-Santiago: Modeling correlated noise with Gaussian processes Lee Rosenthal: RadVel: The Radial Velocity Fitting Toolkit Tom Barclay/Knicole Colón: Community Data Products and Early Science from the TESS Mission	Lauren Weiss (invited): Planetary System Architectures and Dynamics	**End of Conference (3:15pm)**
3:45-4:00					
4:00-4:15	Gijs Mulders: Exoplanet population synthesis in the era of large exoplanets surveys	Georgios Dimitiadis: K2 Observations of SN 2018oh Reveal a Two-Component Rising Light Curve for a Type Ia Supernova		Jack Lissauer: Architecture and Dynamics of Kepler's Multi-Transiting Planet Systems: Comprehensive Investigation Using All Four Years of Kepler Mission Data	
4:15-4:30	Timothy Morton: The Probabilistic Validation Revolution: How Kepler Forced a Paradigm Shift in	Thomas Holoien: ASASSN-18bt: Evidence for Nickle on the Surface of a Type Ia Supernova		Darin Ragozzine: Getting more out of information-rich Kepler multis that show TTVs	

	How We Treat Transiting Planet Candidates	found by the rising K2 light curve			
4:30-4:45	Marko Sestovic: The occurence rate of planets around ultracool dwarfs	Edward Shaya: A Tidal Disruption Event in a Seyfert 2 Observed with K2		Sarah Millholland: Obliquity Tides and their Role in Understanding the Kepler Planet Period Ratio Distribution	
4:45-5:00	Christina Hedges: Are there any more planets in the Kepler / K2 data?	Armin Rest: A Fast-Evolving, Luminous Transient Discovered by K2/Kepler		Miranda Herman: Revisiting the Long-Period Transiting Planets from Kepler	
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List of Contributed Posters

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Kosovichev, Alexander	New Jersey Institute of Technology	Resolving Power of Asteroseismic Inversion of the Kepler Legacy Sample	3
Mathur, Savita	Instituto de Astrofisica de Canarias	On understanding the non detection of acoustic modes in solar-like stars observed by Kepler	4
Singh, Raghubar	Indian Institute of Astrophysics India	Asteroseismic and spectroscopic study of Li-rich red giants	5
Vanderbosch, Zach	University of Texas at Austin	Pulsating Helium White Dwarfs in the Age of Kepler/K2	6
Ziaali, Elham	Research Institute for Astronomy and Astrophysics of Maragha, Iran	The period-luminosity relation for delta Scuti stars using Gaia DR2 parallaxes	7
Zinn, Joel	Ohio State University	Testing the radius scaling relation with Gaia DR2 in the Kepler Field	8
Data/Statistical/Numerical Methods			
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Breakout Session Abstracts

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Barclay, Tom and Colón, Knicole	NASA Goddard Space Flight Center	Community Data Products and Early Science from the TESS Mission	Since beginning science operations in July 2018, TESS is poised to provide a wealth of data on a wide variety of astrophysical objects, ranging from solar system bodies to exoplanets to stars to galaxies. We will provide an overview and update on data products and toolkits available for use by the broader community to enable TESS data analysis. These products and toolkits are supported by both active members of the community and the TESS Guest Investigator Program Office. We will also highlight early science results produced by the community, based on the first few months of TESS data.
Hedges, Christina	NASA Kepler/K2	The Lightkurve package for Kepler & TESS data analysis: tutorials and consulting breakout	Lightkurve is a community-developed, open-source Python package which offers a user-friendly and accessible way to analyze data from NASA's Kepler, K2, and TESS missions. The package is supported by a rich syllabus of tutorials which aim to lower the barrier for students, astronomers, and citizen scientists alike to analyze data from NASA's exoplanet space telescopes (cf. https://docs.lightkurve.org). This breakout session will start with an introductory tutorial (25 min) which demonstrates the most important features. We will then split the breakout into small groups to focus on particular use-cases, including: (i) custom aperture photometry, (ii) systematics removal, (iii) rolling band identification and removal, and (iv) periodogram and asteroseismology extraction. A developer or expert user will be assigned to each group to help new users get started, provide expert advice, and troubleshoot problems.
Cody, Ann Marie	BAERI/NASA Ames	A Crowded Field Photometry Challenge	Kepler is known for its exoplanet discoveries and exquisite variable time series of many different types of stars. Hundreds of thousands of light curves are available from the mission's pipeline as well as from community teams. Much of the data analysis to date has focused on moderately bright, isolated stars. Precise light curves remain to be extracted from fainter, more crowded targets that exist in star clusters, as well as the galactic bulge. Precision photometry for these objects is challenging, but achievable. To enable breakthrough progress of crowded field photometry, we are organizing a challenge in which participants will be provided in advance with a set of images from K2's Campaign 9 fields. The goal will be for several teams to produce precision time series photometry on a small set of prespecified variable targets, using methods of their choosing. The breakout session will start with an introductory overview of the problem and potential science (20 mins). Next, a summary will be presented of the participating teams' results, followed by a group discussion on the merits of the different techniques. To secure the success of the breakout, we will be providing the community with tutorial and data challenge materials ahead of the meeting.
Feigelson, Eric	Penn State University	Finding Planets in Kepler lightcurves with R	R is the premier statistical software environment with millions of users and ~100,000 functions covering all of modern statistics. It is particularly strong for the analysis of evenly-spaced time series (missing data permitted). In this hands-on tutorial, we guide you through several steps of the AutoRegressive Planet Search methodology: display of light curves, differencing to reduce nonstationarity, ARIMA & ARFIMA modeling of short- & long-memory stochastic processes, and the new Transit Comb Filter to search for transit-like periodicities (Caceres et al. 2019). A variety of time series diagnostics are applied such as: interquartile range to measure noise, autocorrelation function to measure autocorrelation, Durbin-Watson and Ljung-Box tests for autocorrelation, Anderson-Darling test for normality, and the Adjusted Dickey-Fuller test for stationarity. Several graphical presentations are illustrated. Other analysis approaches using R are outlined: Fourier & Lomb-Scargle spectral analysis, wavelet analysis, nonparametric smoothing & interpolation, change point analysis, nonlinear modeling, and time series clustering. Participants should download R in advance from http://www.rproject.org. Resources for further study of time series analysis with R are provided.

Gully-Santiago, Michael	Kepler/K2 Guest Observer Office	Pushing Kepler/K2 signal-to-noise ratio limits by modeling correlated noise with Gaussian processes	Data analysis with Kepler and K2 can be broadly summarized as the quest to distill astrophysical or exoplanetary information from noisy, biased time series data. So far, heuristic methods have been successful in rapidly delivering discoveries in many high or modest signal-to-noise ratio applications. Advanced statistical techniques matter most in the lowest signal-to-noise ratio regimes-- the marginal detections. These margins represent scientific frontiers of understanding: the existence of Earth 2.0, the spin-down behavior of solar-age stars, pulsation amplitudes in faint white dwarfs, the weak extra light from the first moments of a supernova explosion. In all of these low signal-to-noise ratio scenarios, understanding and quantifying noise shares equal footing as understanding the astrophysics of interest. In this clinic, we will offer instructor-led tutorials and hands-on practice for modeling correlated noise, which can arise from either instrumental artifacts (e.g. rolling band) or astrophysical phenomena (e.g. starspot modulation). We will emphasize applications of likelihood-based inference with sampling or optimization. We will show how to get started with several common Python packages for scalable Gaussian Process regression: scipy, George, and celerite. Finally, we will mention new GPU-based frameworks for scaling Gaussian Processes such as GPyTorch.
Rosenthal, Lee	California Institute of Technology	RadVel: The Radial Velocity Fitting Toolkit, its applications to transiting planet characterization, and to blind searches in RV data	I will lead a tutorial on the use of the RadVel Python package to characterize Keplerian orbits of transit-detected planetary systems with radial velocity (RV) data. RadVel can model multi-planet, multi-instrument datasets, while incorporating constraints such as transit ephemerides and secondary eclipse times. It includes several built-in Gaussian process kernels for the treatment of stellar activity, and employs MCMC and Bayesian modeling techniques to precisely determine the posterior distributions of planetary properties. I will demonstrate how to use RadVel in conjunction with RV, Kepler, and K2 data, to better characterize the masses and orbits of transiting planets. I will also introduce an associated software package, rvsearch, which is currently under development and can be used for blind RV planet detection in conjunction with RadVel. Rvsearch combines the Bayesian methods and Keplerian fitting tools of RadVel with a periodogram-based algorithm to search for planets in RV datasets, iteratively accepting potential planetary signals until they fail to surpass an empirically calculated threshold for goodness-of-fit. To learn more about RadVel, visit radvel.readthedocs.io.
Soderblom, David	Space Telescope Science Inst	Opportunities and limitations of the cluster data from Kepler/K2	By providing significant samples of stars of the same age and composition, clusters are fundamental to astrophysics. Kepler and K2 have added greatly to our knowledge of stellar evolution, stellar behavior, and the nature of the clusters themselves. This breakout session will bring together researchers who have worked on clusters with Kepler/K2 or who want to understand better the opportunities that have not yet been explored. A panel will be assembled of some of the people who have worked on Kepler/K2 for the Pleiades, Praesepe, Hyades, M67, star-forming regions, the 4 Kepler-field clusters and so on. Some questions to be addressed include: o How well have Kepler/K2 observed the clusters in the fields observed? Aspects include completeness relative to known members; brightness and mass ranges; confusion issues. o What systematics has Kepler/K2 imposed? For example, the visit durations for K2 were ~80 days, making the detection of rotation periods of 30-40 days problematic. Artifacts in the data make detection of transients difficult. o What ancillary data are there to add in? Gaia is the obvious example, but there are many other high-quality surveys, as well as targeted projects. o What do we know about clusters due to Kepler/K2? o What gaps still need to be filled to more fully exploit Kepler/K2 cluster data? Does TESS help? Some of the science areas directly relevant to this session include: rotation, activity, asteroseismology, and stellar evolution.

Wang, Sharon	Carnegie DTM	Data Hack for RVxK2: Battling Stellar Jitter with Simultaneous K2 Photometry and RVs	Stellar jitter is the current bottleneck for achieving < 1 m/s radial velocity (RV) precision, and the RVxK2 project (rvxk2.com) addresses this issue with simultaneous RV and photometry with the best cadence and precision available today, provided by a suite of ground-based RV instrument and Kepler. RVxK2 team members will be examining the data we have collected so far and brain storm projects to interpret these data (including finding/confirming planets!). We invite anyone at the conference who's interested in RVxK2 to join us and work on our data (data can be made available to new members immediately upon signing the RVxK2 collaborative agreement and code of conduct). For an overview of the RV data we have collected, please visit rvxk2.com.

Invited Talk Abstracts

Name	Institution	Title	Abstract
Angus, Ruth	American Museum of Natural History & Flatiron Institute	The Kepler revolution: stellar rotation and activity in clusters and the field	Amongst its many success stories is Kepler’s incredible contribution to the study of stellar rotation and magnetic activity. Its exquisite photometry, ideal for exoplanet detection, also happens to be perfect for observing the variability of stars caused by the rotation of magnetically active surface regions in and out of view. The field and cluster stars observed over Kepler’s four year baseline and K2’s multiple fields provide the ideal data set for rotation and activity studies, and the challenge of extracting signals from Kepler’s light curves has taught us, as a community, new statistical time series analysis methods. Several rotation period catalogs have been built from Kepler light curves and these repositories are heavily used by both the stellar and exoplanet communities. The results from the Kepler and K2 missions have already revolutionized stellar astronomy but only a fraction of Kepler’s potential has been mined so far. Kepler’s rotation and activity legacy will continue through the next several decades. In this talk I will review highlights from Kepler’s 10 years of revolutionary stellar astronomy.
Ballard, Sarah	MIT	Lessons from the Multi-planet Systems	Among the many benchmark exoplanets uncovered by Kepler are a wealth of systems with multiple transiting planets. The first star with two transiting planets, Kepler-9, was among the first results published with Kepler photometry. Hundreds more followed, including the first system with multiple sub-Earth-sized planets, Kepler-42, and the first M dwarf host to the potentially habitable planet: Kepler-186. The Kepler multi-planet systems have now furnished, via transit timing variations, half of the measured masses for planets smaller than 2 Earth radii. Yet, the discoveries enabled with Kepler multi-planet systems extend beyond individual stars. Multi-planet systems also enable statistical analyses on the architecture of planetary systems in the Milky Way, including the typical number of planets per star and the orbits of those planets. I will describe some of the scientific highlights from Kepler multi-planet systems, and discuss the future for multis with TESS.
Borucki, William	NASA Ames Research Center	History of the Kepler Mission	The Kepler Mission was the result of an obvious need to determine if other habitable planets and intelligent life exist in our galaxy. Rather than endless speculation, I felt that it was necessary to determine which of the two alternatives represented reality. The photometric approached seemed simple and the least expensive way forward. The challenge was the development of a photometer that was 1000 times more precise than any before it and that could simultaneously monitor at least 100,000 stars. The period from 1983 through 2000 was spent investigating methods to achieve the photometric precision and multi-target capability needed for a survey that would provide the data necessary to obtain statistically valid answers. With the advent of Discovery-Class missions, a Kepler team was formed and we proposed the Mission at the 1992 opportunity and at every two-year opportunity until the Mission was accepted for development in December of 2001. Teams at Ames, Ball Aerospace, Brashear, JPL, LASP, LHS, SAO, and the SETI Institute worked together to build and operate the spacecraft, analyze and archive the data, conduct follow up observations, and bring the discoveries to the public. Shortly after the launch in 2009, the downlinked data showed that planets were plentiful. However it was clear that a careful analysis of the data and measurements from follow up observations were necessary to separate false-positives from true planets. Results showed that: there are more planets than stars, many of the planets and planetary systems are quite different from ours, Earth-size planets in the habitable zone are common. Further, asteroseismic analyses showed the presence of brightness oscillations that allowed the sizes of stars and planets to be accurately determined and provided information about the evolution and structure of stars. Not only has the Kepler Mission been a huge success with respect to the science it has accomplished, but it has also encouraged the development of new missions and new

			observatories. Thousands of students have been attracted to astronomy and astrophysics and many have written PhD theses based Kepler results. The public has not only been entranced by the results, but has also participated in the discoveries. The gate is open for Humankind to explore the galaxy.
Christiansen, Jessie	Caltech/IPAC-NExScI	Reflections	As evidenced by the myriad topics discussed this week, the NASA Kepler and K2 missions have contributed substantially to many fields in astronomy and planetary science. In this closing talk I will summarise the significant results of the missions, and attempt to capture their impact on both astronomy and the wider cultural zeitgeist. Finally, I will look ahead to the future, to how Kepler and K2 have helped to shape the next decade of astronomy, and what the next big game-changers might be.
Deheuvels, Sébastien	IRAP Toulouse	Monitoring the internal rotation of stars along their evolution with Kepler	One of the greatest achievements of the Kepler mission has been its key contribution to the long-standing problem of angular momentum transport inside stars. The exquisite quality of Kepler data has led to the detection and precise measurement of the signature of rotation in the oscillation modes of main sequence stars, red giant stars (both in the H-shell-burning phase and in the He-core-burning phase) and compact pulsators (hot subdwarf B stars and white dwarfs). This has given the unprecedented opportunity to monitor the internal rotation of stars at different stages along their evolution. After reviewing these results, I will show how they have already been used to place new constraints on the mechanisms that are transporting angular momentum within stars.
Dressing, Courtney	University of California, Berkeley	Probing the Frequency of Planetary Systems with Kepler and K2	Over nine remarkable years and two missions, the Kepler spacecraft transformed our view of the universe by detecting over 5000 planets and planet candidates. Kepler taught us that planetary systems are widespread and that small, short-period planets are intriguingly prevalent. We have learned that multiplanet systems tend to be flat and that many stars host closely-packed systems of multiple planets orbiting well within the orbital distance of Mercury. Statistical analyses of the multitude of planets detected by Kepler and detailed follow-up observations of their host stars have allowed astronomers to probe how the frequency of planets depends on planet radius, orbital period, insolation flux environment, and host star properties. I will review key insights into planet occurrence gleaned from the Kepler and K2 missions and then highlight a few open questions that could be answered in the near future.
Garnavich, Peter	University of Notre Dame	Better Understanding Supernovae from Kepler/K2 Observations	Kepler/K2 began as a way to discover planets and evolved into a study of how to blow them up. The fast cadence and near-continuous coverage of Kepler/K2 has provided us a unique view of supernovae and extragalactic transients. From a long-lived type IIn event to fast-evolving luminous transients, to exquisite light curves of type Ia supernovae, Kepler/K2 has studied a wide variety of explosions. I will outline these discoveries and discuss their possible impact on stellar astrophysics and cosmology.
Gaulme, Patrick	Max Planck Institut für Sonnensystemforschung	Asteroseismology, Red Giants, and Eclipsing Binaries	Given the potential of ensemble asteroseismology for understanding fundamental properties of large numbers of stars, it is critical to determine the accuracy of the scaling relations on which these measurements are based. Eclipsing binary systems hosting at least one star with detectable solar-like oscillations constitute the ideal test objects for validating asteroseismic radius and mass inferences. By combining radial-velocity measurements and photometric time series of eclipses, it is possible to determine the mass and radius of each component of a double-lined (SB2) spectroscopic binary. The Kepler mission was the first to discover solar-like oscillators in eclipsing binary systems. A few tens have been identified and all are low mass red giants (less than 3 solar masses). A little over ten are SB2 and have been be used to test the accuracy of asteroseismology. The others are very valuable as well, as they offer unique views on the evolution of binary systems thanks to the information carried by their oscillations modes. The purpose of this presentation is to review what has been learnt from the red giants in eclipsing binaries observed by Kepler, both about testing asteroseismology and understanding the evolution of close binary systems.

Lintott, Chris	University of Oxford	Citizen Science with Kepler and K2	I will review citizen science projects with Kepler and K2 data, concentrating on the results from Planet Hunters and Exoplanet Explorers, both of which are hosted on the Zooniverse platform. I will discuss both serendipitous discoveries such as Boyajian's star and systematic attempts to search for planetary signals which produced discoveries such as Planet Hunters-1b, the only known planet in a four star system. . The use of large crowds of volunteers to assist with planet hunting proved effective, especially in cataloguing single transit events; the majority of those in the literature come from volunteers. Lessons in community management, and especially in how to encourage more advanced volunteers will be presented, along with preliminary results from citizen science with TESS.
Lundkvist, Mia Sloth	Stellar Astrophysics Centre, Aarhus University, Denmark	Asteroseismology of exoplanet host stars from the Kepler/K2 missions	During the almost 10 years where the Kepler/K2 mission was operating, it has delivered data of an outstanding quality, which have enabled asteroseismic analyses of more than a hundred exoplanet host stars. The highlights from these studies benefiting from the synergy between asteroseismology and exoplanets are many, spanning from highly interesting individual systems to large ensemble studies. In this presentation I will give a brief introduction to asteroseismology and review a selection of some of the compelling highlights that the asteroseismology/exoplanet field has experienced in the Kepler era. These will include the determination of spin-orbit angles and eccentricities for many systems, confirmation of the effect of photo-evaporation on ultra-short and short-period planets as well as few results from individual systems. For example, asteroseismology has been used to establish the age of the oldest exoplanet system know to date (Kepler-444), the radius of the so far smallest detected exoplanet (Kepler-37b) and a radius precise to 125 km for the first rocky exoplanet discovered by Kepler (Kepler-10b).
Mann, Andrew	University of North Carolina at Chapel Hill	Tracing Planetary Evolution with K2	Planets are not born in their final state. Before reaching a more mature and stable phase, young planets actively evolve as they interact with their host star, other planets in the system, and their greater environment. The first few hundred million years are the most formative, but planets in this age range are also the most difficult to identify and characterize. K2 has helped to change this paradigm by observing stars in nearby young clusters and star forming regions along the ecliptic. The resulting light curves have enabled the discovery of Earth- to Neptune-sized planets with ages spanning 10 to 650 Myr. The properties of these young systems demonstrate that young planets are statistically larger than their older counterparts, and the relative planet occurrence rate across clusters of different ages provides limits on the timescale for exoplanet migration. In this talk, I will review some of these science results and discuss how we can build on early successes through continued follow-up of K2 cluster planets and by identifying planets in nearby young moving groups with TESS.
McCalmont-Everton, Katelynn	Ball Aerospace	Flying the Kepler Spacecraft's Second Mission: K2 Operations	The Kepler spacecraft was designed and built to study one field of view for the duration of its 3.5 year prime mission. When the spacecraft experienced its second reaction wheel failure after four years of operations, it was no longer possible to control all three axes with the two remaining reaction wheels. A new way to precisely balance the spacecraft and continue operations was devised and implemented by Ball Aerospace and a new science mission was conceived by NASA Ames Research Center. The new K2 mission required science observing campaigns to be limited to 85 days. The operations concept was fundamentally different from the prime mission as the engineering team learned the delicacies of flying a spacecraft that is trying to balance on solar pressure. K2 was constantly running against two life-limiting factors: a finite amount of hydrazine fuel and an ever-decreasing telecom margin due to increasing Earth distance. This talk will discuss the methods used to combat these life-limiting factors in the final years of K2's life. New modes of operations were devised, tested and implemented to conserve fuel. A new downlink strategy was implemented prior to Campaign 9 that saved enough fuel over the mission lifetime to extend K2 by more than one full campaign. A new zero-fuel safe mode was enacted to give the operations team a place to rest the spacecraft when evaluating anomalies and fuel exhaustion at the end of life. This talk will discuss these modes as well as the strategies that were implemented to monitor for fuel exhaustion with extremely limited downlink bandwidth during science campaigns. Ultimately, the changes

			made in the final year of the mission allowed for the K2 team to accurately identify fuel exhaustion and downlink the data for both Campaigns 18 and 19.
Pinsonneault, Marc	Ohio State University	Galactic Archeology with Kepler and K2	Kepler and K2 have yielded a wealth of information about the formation and evolution of the Milky Way galaxy, otherwise known as galactic archeology. The main driver of this advance has been the measurement and characterization of stellar oscillations in tens of thousands of evolved stars. When combined with modern spectroscopic surveys, this makes the measurement of precise and accurate masses and radii for bulk stellar population a reality. In this talk I trace through the highlights of how the Kepler and K2 data have informed Galactic archeology. I review two distinct and important contributions: tests of stellar physics and studies of stellar populations. Kepler data revealed problems with standard isochrones and models, especially for the core He-burning phase, and has challenged our ideas about mass loss in first ascent red giants. It has also revealed an unexpected population of relatively massive stars with abundance patterns associated with old (and low mass) stars and permitted striking measurements of the age of the disk and age-abundance patterns. I also show that the Kepler and K2 samples have served as a crucial calibration set, enabling galaxy-wide age maps and opening up a new window for understanding the formation and evolution of the Milky Way, especially the galactic disk. I close by discussing the powerful complementary role of Gaia data for our understanding of stellar physics and populations.
Smith, Krista Lynne	Stanford University	Kepler/K2 and Active Galactic Nuclei: New Insights into Accretion and High Energy Phenomena	Accretion is ubiquitous in the universe, but our current understanding derives mainly from theoretical simulations with few observational checks. This is especially true because accretion disks are too small to be directly imaged. Optical variability is therefore one of the only direct observational tools to explore the structure and processes within accretion disks. The Kepler/K2 light curves of active galactic nuclei (AGN) explore a completely new parameter space, enabling comparison with very well studied X-ray AGN light curves, and can inform models of both accretion physics and the relationship between X-ray and optical emitting regions in the central engine. Kepler light curves of AGN show new behavior unseen in ground-based timing studies and reveal characteristic variability timescales that scale with black hole mass in a manner reminiscent of X-ray results. There is also great promise in the discovery of a possible quasi-periodic oscillation in a Kepler light curve. Kepler and K2 data will be critical in learning how to interpret AGN light curves from upcoming large variability surveys like LSST, with implications for estimates of supermassive black hole binary populations. Kepler and K2 data may also be a promising avenue into searching for low-mass AGN through variability in dwarf galaxies, and offer unprecedented insights into the physical processes in the jets of blazars. Finally, all of these efforts will be critical in designing TESS experiments regarding these high energy phenomena.
Vanderburg, Andrew	University of Texas at Austin	Benchmark Exoplanet Systems Discovered by the K2 Mission	The prime Kepler mission may be best remembered for its statistical results, like the existence of large population of super-Earths orbiting tightly and the prevalence of small planets in the habitable zones of their host stars. The K2 mission, on the other hand, may be best remembered for the extraordinary individual systems it discovered and characterized. In this talk, I will review some of the most surprising, unusual, and spectacular planetary systems discovered or characterized by the K2 mission, and I will comment on the potential for these systems to remain important astrophysical laboratories in the future.
Weiss, Lauren	University of Hawaii, Manoa	Planetary System Architectures and Dynamics	Is the solar system rare? How do planets form? To answer these questions, we must broaden our perspective from individual planets to whole planetary systems. Each planetary system can be thought of as a laboratory in which the planets all formed around the same star and from the same protoplanetary disk. By comparing the properties of planets within the same system, we can perform controlled experiments that directly test hypotheses about planet formation. Systems with multiple transiting are a particularly rich testing ground, as the planet orbital periods, radii, and masses can be measured and compared. I will describe how photometry from the Kepler Mission, follow-up observations, and innovative data analysis techniques have revealed the fundamental properties of, and patterns in, the architectures of exoplanetary systems. I will discuss

			what these patterns mean for planet formation. I will conclude with suggestions for future experiments the community can perform to enrich our knowledge of planetary systems.

Contributed Talk Abstracts

Name	Institution	Title	Abstract
Barentsen, Geert	NASA Kepler/K2	Kepler's Discoveries Will Continue: 21 Scientific Opportunities with Kepler & K2 Archive Data	Kepler has collected high-precision, high-cadence time series photometry on 781,590 unique postage-stamp targets across 21 different fields of view. These observations have already yielded more than 2,500 scientific publications by authors from 63 countries. The full data set is now public and available from NASA's data archives, enabling continued investigations and discoveries of exoplanets, oscillating stars, eclipsing binaries, stellar variability, star clusters, supernovae, galaxies, asteroids, and much more. In this talk, I will summarize 21 important data analysis projects that are enabled by the archive data. The aim of this talk is to help the community understand where there are important scientific gains left to be made in analyzing Kepler data, and to encourage the continued use of the archives. The Kepler mission has provided an unprecedented data set with a precision and duration that will not be rivaled for decades. My talk will demonstrate that many of Kepler's contributions still lie ahead of us, owing to the emergence of complementary new data sets like Gaia, novel data analysis methods, and advances in computing power.
Becker, Juliette	University of Michigan	Dynamically Determining Observationally Ill-Constrained Planet Parameters: Towards Precise Transit Ephemerides for the Benchmark System HIP 41378	In the post-Kepler era, K2 and TESS will continue to discover planetary systems and deepen our understanding of the physics underlying planet formation. However, both K2 and TESS data pose challenges that Kepler did not: observational baselines are both shorter and non-continuous in these two newer missions. As such, deriving orbital parameters is not always as straightforward as it was with Kepler data. In this talk, I discuss methods of using dynamical techniques, including secular theory and numerical simulations, to supplement the K2/TESS data and derive or constrain orbital parameters that are not uniquely recoverable from the light curves alone. As an example, I will discuss HIP 41378, a five planet system discovered in K2 Campaign 5 and re-observed in Campaign 18 for which the orbital periods of three planets could not be uniquely determined due to the significantly baseline gap between observations. I show how using a combination of legacy ground-based data and dynamical methods we can constrain the orbital periods of these planets, enabling the more efficient use of follow-up resources. I will also discuss our method more generally, and how it can be applied in TESS.
Berger, Travis	Institute for Astronomy, University of Hawaii at Manoa	Precise Characterization of Kepler Stars and Planets Using Gaia DR2	A major bottleneck for the exploitation of data from the Kepler mission for stellar astrophysics and exoplanet research has been the lack of precise properties for most of the observed stars. In this talk, I will present the first reclassification of radii for ~180,000 Kepler stars derived by combining parallaxes from the Gaia Data Release 2 with the DR25 Kepler Stellar Properties Catalog. The median radius precision is ≈8%, a typical improvement by a factor of 4–5 over previous estimates. Using Gaia-revised properties for >4000 exoplanets and their host stars I will discuss several intriguing features in the planet radius versus incident flux plane, including a re-investigation of the radius gap for small planets, the discovery that several confirmed exoplanets occupy a previously described “hot super-Earth desert” at high irradiance, and the relation between gas-giant planet radius and stellar incident flux. I will furthermore present the first bona fide sample of 38 Kepler planets smaller than two earth radii in the habitable zone. Finally, I will present first estimates of homogeneously derived masses and ages of all Kepler host stars using Gaia parallaxes, and discuss trends of Kepler exoplanet properties as a function of these parameters. These results demonstrate the transformative impact of Gaia data on the characterization of stellar and exoplanet populations.

Bowman, Dominic	KU Leuven	Blue supergiants reveal diverse pulsational variability in K2 photometry	All massive stars inevitably end their lives in a violent supernova explosion and form a black hole or neutron star. Supernovae enrich the interstellar medium with chemical elements and impact the next generation of star formation and the evolution of their host galaxy. However the mass of the compact remnant and the supernova chemical yield depend strongly on the internal physical properties of the progenitor star, which are currently not well-constrained from observations. The large theoretical uncertainties in the models of massive star interiors accumulate throughout stellar evolution, with the lack of a robust theory of stellar structure and evolution being particularly pertinent for blue supergiant stars. Asteroseismology of stellar oscillations allows us to uniquely probe stellar interiors, yet inference from blue supergiants has been limited by a dearth of detected pulsations in these stars until recent space photometry missions. In this talk, I report the discovery of diverse pulsational variability in a large sample of blue supergiants observed by the K2 space mission. The discovery of coherent pulsation modes and stochastic low-frequency variability caused by damped internal gravity waves in numerous blue supergiants, allow their interior properties to be mapped from the main sequence to the later stages of their evolution. Asteroseismic modelling provides important constraints on ages, core masses, interior mixing, rotation and angular momentum transport, which are essential input parameters in stellar evolution models. The discovery of pulsational variability in K2 photometry of blue supergiants provides a necessary first step towards a data-driven empirical calibration of theoretical evolution models for the some of most massive and short-lived stars in the Universe.
Bugnet, Lisa	CEA Saclay	FliPer: a powerful tool to detect and characterise Solar-like pulsators.	Stellar parameters such as mass, radius and surface gravity are the key to understanding stellar evolution. They can be determined for many stars with solar-like oscillations with asteroseimology by using the scaling relations based on the measurement of global seismic parameters (the frequency of maximum power and the large frequency spacing) and effective temperature. However, only stars showing acoustic oscillation mode patterns in their power density spectra can be studied with this seismic methodology through global seismic pipelines. It thus excludes stars for which oscillation modes are not visible in the power spectra because they either oscillate with a frequency higher than the Nyquist frequency (e.g. main-sequence stars observed in Kepler long-cadence mode) or the signal-to-noise ratio is too low. Seismic-independent methods are now being developed in order to estimate physical parameters of solar-like pulsators (showing oscillations in their PSD or not) with better precision than by using spectroscopy only. We present the new metric called FliPer (that stands for Flicker in Power) that measures the global power in the power density spectrum (in opposition to the Flicker method computed in the time domain). Our method exploits the use of Random Forest machine learning algorithms that take into account FliPer values and effective temperatures. We are able not only to classify stars to distinguish Solar-like pulsators from classical pulsators with a 99% accuracy, but also to provide an estimation of surface gravity or numax for any Solar-like star (including main-sequence stars and red giants) extending the typical range of the Flicker to a broader regime of surface gravities (from 0.1 to 4.6 dex). Typical uncertainties we obtain on surface gravities or numax are about 0.03 dex (representing a few percents error), and can be even smaller depending on the evolutionary state of the star.
Calchi Novati, Sebastiano	Caltech/IPAC	An isolated microlens observed from K2, Spitzer and Earth	In 2016 K2C9 was devoted to a survey towards the Galactic Bulge to monitor microlensing events, being observed at the same time also from ground. The simultaneous observation of a microlensing event from ground and a space-based satellite at ~1 AU allows one to measure the microlensing parallax, which then leads to measurements of the relevant lens physical characteristics, mass and distance. The measure of the microlensing parallax is however affected by a twofold degeneracy. I will discuss the nature of this degeneracy and in particular I will discuss the case of MOA-2016-BLG-290 for which the degeneracy was broken thanks to the simultaneous observation from Spitzer, a second satellite at ~1 AU from ground. Altogether the lens is found to be an extremely low mass star or brown dwarf located in the Galactic bulge.

Caldwell, Douglas	SETI Institute	The Kepler photometer	The Kepler spacecraft was launched in March 2009 to carry out a planned 3 1/2 year mission, but was recently turned off after nearly a decade in space. During this time the Kepler photometer has taken more than 44 million 6.5 second exposures, revealing thousands of planets and enabling diverse scientific discoveries across all of astronomy. Even as the spacecraft was ending its operational life due to lack of fuel to power the attitude control thrusters, the photometer continued to meet design requirements. We will report on the aging of the focal plane through the Kepler Mission and K2, detailing the changes in low-level photometer characteristics and offering an indication of how they might affect scientific investigations. The most significant changes have been the loss of focal plane modules in 2010, 2014, and 2016, reducing the science field of view to just under 100 square degrees. More subtle changes have been seen throughout the missions; for example, the overall system throughput has dropped by 1% per year, resulting in a ~5% increase in star shot noise after 10 years. In addition to the expected aging, the focal plane hosts a number of electronic artifacts that are sensitive to temperature and position, the most notorious of which is the "rolling band artifact," a high-frequency instability in the electronics that is aliased into the science data. With the larger and more rapid temperature changes in K2, these artifacts are more prominent and changing on faster timescales. We will describe the behavior and potential impacts of the rolling band and other artifacts for Kepler and K2 data, as well as how the rolling band flags in the archive products can best be used to track them.
Cantiello, Matteo	Flatiron Institute	Internal Magnetic Fields Asteroseismology: Kepler's Legacy and TESS's opportunities	One of the most interesting asteroseismic puzzles revealed by Kepler's exquisite photometry, is the existence of a group of red giants showing low-amplitude dipolar modes (depressed modes). These stars represent about 20% of all red giant pulsators. Moreover, their occurrence rate seems to be a strong function of the stellar mass, with basically no depressed dipole modes observed in red giants with M < 1.1 Msun. From the theoretical perspective, one possible explanation for the occurrence of depressed dipole modes in red giants is the existence of strong core magnetic fields. These magnetic fields could be generated by a convective-core dynamo in a previous phase of stellar evolution. I will review the current status of our theoretical understanding of dipole modes in red giants, including successes and challenges to the theory. I will discuss what are the next steps, and show that coupling the rich legacy of Kepler data together with future observations from TESS, could help us build a picture of internal magnetic fields evolution in stars.
Chontos, Ashley	Institute for Astronomy, University of Hawaii	The Curious Case of KOI-4: Confirming Kepler's First Exoplanet	The discovery of thousands of planetary systems by Kepler has demonstrated that planets are ubiquitous. However, a major challenge with Kepler has been the confirmation of planet candidates, many of which still await confirmation. One of these is KOI-4, Kepler's first exoplanet detection. Here we present the confirmation and characterization of KOI-4 using a combination of asteroseismology and spectroscopy. KOI-4 is a massive, evolved subgiant hosting a massive, hot Jupiter (Mp = 5.24 MJ, Rp = 1.10 RJ). KOI-4 joins a small population of evolved hosts with short-period (≤ 100 days) planets and is now the closest known planet around an evolved star with an orbital period of only 3.85 days. Because of its uniqueness, KOI-4 is a benchmark system for testing tidal dissipation and hot Jupiter formation theories. Using 4 years of Kepler data, we test for orbital period decay and report the first firm observational lower limit of Q ≥ 104 for the tidal quality factor in evolved stars. Furthermore, with an effective temperature Teff = 6200 K, KOI-4 sits close to the spin-orbit misalignment boundary at ~6250 K, making it a prime target for follow-up observations to better constrain orbital period decay and to provide insight into hot Jupiter formation and migration theories.

Ciardi, David	NExScI Caltech/IPAC	The Legacy of Kepler and K2: The Follow-up Observation Programs	Kepler and K2 discovered thousands of transiting exoplanet candidates but it was the intensive world-wide ground-based follow-up program that turned those candidates into bona-fide exoplanets. Kepler follow-up was dominated by the project-based program while K2 follow-up was dominated entirely by community driven collaborations. Thousands of telescope nights were used to obtain stellar spectra, high resolution, time series photometry, and radial velocities which were needed to turn transiting candidates into confirmed planetary systems. Without these critical observations, the candidates of Kepler and K2 would never have become planets. I will present an overview of the follow-up programs that were pursued by the Kepler Project and the K2 community - securing the lasting legacy of Kepler and K2.
Cody, Ann Marie	BAERI/NASA Ames	Young Stars in the Time Domain: the View with Kepler	We have entered a golden era for time domain astronomy, particularly for variability studies of young T Tauri stars. These 1-10 million year old young stellar objects (YSOs) occupy a key epoch in the evolution from molecular clouds to mature star/planet systems. Many of them host protoplanetary disks and complex magnetic field structure which mediates gas accretion. At the stellar surface, hot spots form at the base of accretion columns, while cold spots appear as a result of local magnetic field structure. Dust orbiting within the inner 0.1-1 AU of the disk forms clumps, some of which may appear to occult the central star. Many years of ground-based monitoring studies have revealed that these phenomena contribute to high levels of variability in young stars, on sub-hour to year timescales. Yet only recently have we begun to link detailed time domain features with the structure and dynamics of YSOs and their surroundings. In this talk I will review the astounding progress that we have made in classifying and understanding young star variability, thanks in large part to the rise of precision space photometry missions. I will focus on recent results from the K2 Mission's campaigns on several young clusters and associations, highlighting emerging correlations between variability behavior and accretion or circumstellar disk geometry. Understanding of these correlations illuminates the final stages of stellar mass accretion and the initial conditions underlying planet formation in inner circumstellar disks. Our results from the mainly low-mass young stars observed with K2 are now paving the way for new studies on higher mass Herbig stars targeted by the TESS Mission.
Crossfield, Ian	MIT	Atmospheric Characterization of Kepler/K2 Planets	Kepler and k2 showed that Mini-Neptunes, planets 2-4 times the size of the Earth, are an abundant outcome of planet formation and occur around more than a quarter of all stars --- yet they are absent in the Solar System. Mini-Neptunes bridge the gap between terrestrial planets and gas giants, and atmosphere characterization of these planets has much to reveal about their current properties, origins, and evolutionary histories. However, only a handful of mini-Neptunes have been amenable to atmospheric study so far. Just as Kepler and K2 demonstrated the ubiquity of these systems, they also revealed a smaller number of especially favorable new systems for atmospheric characterization. I will report on our space-based infrared transit survey of these planets, which aim to eventually provide precise constraints on the planets' atmospheric metallicities, elemental abundances, C/O ratios, and aerosol content, and to identify trends in planet properties as a function of equilibrium temperature, UV irradiation, planet mass, and stellar spectral type. These trends will also help us prioritize follow-up and atmospheric characterization of the many small planets expected from the TESS survey.

Curtis, Jason	Columbia University	Building Precision Stellar Clocks with Kepler and Gaia	Gyrochronology has been demonstrated to work at least up to the age of the Sun for solar analogs. What comes later remains controversial, where periods for Kepler's asteroseismic touchstone stars have been used to argue for a reduced braking efficiency at older ages. However, this effect should not affect lower-mass stars (0.5-0.9 solar masses), which are even more problematic to age-date with isochrone methods than F/G dwarfs. The difficulty with calibrating K dwarfs gyrochronology is that few are known with published periods that have precise ages older than the Hyades or Praesepe (650 Myr). This is because asteroseismology is not efficient for this class of stars and those located in the 2.5-Gyr-old Kepler cluster NGC 6819 are too faint. Furthermore, evidence has accumulated over the past decade that indicates that K dwarfs spin down more slowly than G dwarfs, meaning gyrochronology formulas cannot be as simple as originally hoped. Our K2 Survey of Ruprecht 147 remedies this by expanding the sample of 2.5 Gyr rotators from 0.85 down to 0.5 solar masses. Our new sample shows tension with expectations from various empirical models (e.g., Barnes 2010, Angus et al. 2015), semi-physical models (e.g., van Saders et al. 2013, Matt et al. 2015), and the observed Praesepe period sequence projected forward in time to the age of Ruprecht 147, all of which predict periods for K dwarfs much longer than observed in Ruprecht 147. Considering all of the rotation data we now have for Praesepe (0.7 Gyr, K2), NGC 6811 (1 Gyr, Kepler), NGC 752(1.3 Gyr, PTF), NGC 6819 (2.5 Gyr, Kepler), Ruprecht 147 (2.5 Gyr, K2), and M67 (4 Gyr, K2), it has become clear that K dwarfs do not simply spin-down more slowly than G dwarfs; they do not spin down at all for an extended period of time, the duration of which grows with decreasing mass. After exiting this epoch of stalled braking, continuous spin-down ensues as expected. Combining these rotation data with Gaia, we can now refine the cluster properties (particularly age and reddening), clean the sample of outliers (non-members and binaries), and use this database to reformulate gyrochronology so that it actually describes the discrete phases of stellar spin-down and accurately represents all cluster benchmark data. Based on our improvements to the cluster sample, we will extend the gyrochronology calibration from K1V to M1V, approximately doubling its range of validity.
Dai, Fei	MIT	New perspective on the ultra-short-period planets	At the hottest extreme of planet formation are the so-called ultra-short-period planets (USP, Porb <~1day). USPs are super-Earths (<2R⊕) and are found around 0.5% of Sun-like stars. In the core-accretion paradigm, it seems very unlikely that these planets could have formed exactly in-situ: many of them have current-day orbits well within the dust sublimation radius. Through careful transit analysis and refined stellar parameters from Gaia, we showed that these shortest-period planets tend to have larger mutual inclinations and larger orbital spacing relative to their neighbors than most Kepler planets. Such an orbital architecture betrays a dynamically hot formation scenario for USP that generated orbital shrinkage and inclined orbits simultaneously. One possibility is the orbital migration through “Secular Chaos”. Moreover, the larger mutual inclination of close-in planets also offers a possible explanation of the “Kepler Dichotomy”: an overabundance of singly-transiting systems. Weiss et al. 2018 recently showed that the overabundance of singly-transiting systems is only limited to short orbital periods (<3 days). If close-in planets tend to have larger mutual inclinations as we have shown (Dai et al. 2018), it is only natural that they will be more likely observed as singly-transiting. The compositions of the USP planets also shed light on their formation/migration history as well a long-standing puzzle of iron enrichment of Mercury. We performed a uniform analysis of all USP planets with radial velocity measurements. We used Gaia DR2 to refine the stellar parameters and planetary radii. Moreover, we employed Gaussian Process regression to model stellar activity in the measured radial velocities. The results revealed that USP generally has an Earth-like composition of iron-rock mixture consistent with formation from water-poor materials within the snowline. None of the USP planets (exposed rocky cores due to strong photoevaporation) is more massive than 10M⊕ i.e. the theoretical threshold for run-away accretion. Finally, USPs do not show extreme iron enrichment as some of proposed Mercury formation scenarios would predict.

Dimitriadis, Georgios	University of California Santa Cruz	K2 Observations of SN 2018oh Reveal a Two-Component Rising Light Curve for a Type Ia Supernova	The K2 Supernova Experiment, carried out during the forward-facing Campaigns 16 and 17, provided a unique opportunity for probing the early-time physical processes in Type Ia Supernovae (SNe Ia). The continuous, 30-minute cadence monitoring of ~10,000 galaxies with Kepler, alongside simultaneous observations from the ground, would enable us to study the explosion physics of these events with unprecedented quality. I will present the early-time K2 light curve of SN 2018oh, the brightest SN Ia observed by Kepler, that shows an unusual two-component shape, where the flux rises with a steep linear gradient for the first few days, followed by a quadratic rise, as seen for typical SNe Ia. SN 2018oh is especially blue during the early epochs, with the first rise-component peaking ~2 days after explosion at a temperature of ~17,500 K. I will compare SN 2018oh to several models that may provide additional heating at these early times, including the collision with a companion star and a shallow concentration of radioactive nickel in the ejecta. While all of these models generally reproduce the early K2 light curve shape, the interaction scenario at a distance of ~2x10^12 cm with a 1-6 solar mass Roche-lobe-filling companion star is slightly preferred, due to the early blue colors.
Dotson, Jessie	NASA Ames Research Center	Observations of Solar System Objects with K2	The K2 mission has targeted observations of over 300 solar system objects. The range of solar system objects observed – including planets (e.g. Uranus and Neptune), moons (e.g. Titan and Enceladus), and various small bodies. Data has been obtained for over 200 asteroids, more than 60 TNOs and 19 comets. In addition, numerous solar system objects have been observed by K2 serendipitously as the objects move through pixels stored in order to observe other objects. In particular, large 'superstamps' designed to observe clusters and planets have provided observations of high numbers of solar-system bodies. I will review the Solar System results from K2 data. In addition, I will also describe a recent effort to develop a user-friendly data format and python tools to analyze K2 solar system observations.
Doyle, Lauren	Armagh Observatory and Planetarium	The Rotational Phase distribution of Stellar Flares on M dwarfs	Amplitude variations in stellar lightcurves are widely considered to result from a large, dominant starspot which rotates in and out of view. Flux minimum is therefore taken to represent the rotational phase where the starspot is most visible. In solar physics the relationship between sunspots and solar flaring activity has been studied for decades and it is generally accepted these are closely related. If the analogy between the physics of solar and stellar flares holds then we would expect to see a correlation between the time of a flare and the stellar rotational phase. Using K2 short cadence data of 34 M dwarfs taken using Campaigns 1-9, we found no evidence that flares showed any preference for rotational phase (Doyle et al 2018). Three scenarios are outlined as potential causes for this unexpected finding including, polar spots, binary systems and star-planet systems. In addition, the magnetic field in M dwarfs is formed in a different way to solar type stars, especially after spectral type M4. Here, we present preliminary results for a similar analysis on short cadence K2 data for ~60 M dwarfs in Campaigns 10-18. With the combined datasets we look to further investigate the phenomenon by closely examining the original three scenarios and also considering the magnetic properties and effects on these stars.
Endl, Barbara	Baylor University	Asteroseismology of white dwarfs observed by Kepler and K2	In this review, I will present the seismological analysis of all white dwarf stars observed by Kepler and K2. We compared the observed independent pulsation models with our model grid. Our models were calculated using the evolutionary code WDEC, where polytrope functions are cooled, and excited periods are computed. We have calculated millions of models, varying effective temperature, surface gravity, hydrogen mass layer, and helium mass layer. We have also computed self-consistent models using the evolutionary LPcode, where stars are evolved from the zero age main sequence to a certain temperature in the white dwarf cooling sequence. For this model grid, the only quantity that we have varied is the thickness of the hydrogen layer, since all the other parameters depend on the previous evolutionary phases. We will discuss the differences in varying the model grids, as well as the fitting techniques (eg. including the observed amplitudes as weights for the periods). Our goal is to estimate the true external uncertainties in asteroseismology of white dwarfs. Finally, besides the individual fits, we will discuss the ensemble results for white dwarfs. The better understanding of the

			internal structure of white dwarf stars places important constrains in low-mass stellar evolution.
Fortier, Andrea	University of Bern	The CHEOPS Mission	The CHaracterising ExOPlanet Satellite (CHEOPS) is a mission jointly led by Switzerland and ESA which was selected in October 2012 as the first small-class mission in the ESA Science Programme. CHEOPS will be the first mission dedicated to search for transits by means of ultrahigh precision photometry on bright stars already known to host planets in the super-Earth to Neptune mass range (1 M_E< Mplanet < 20 M_E). By being able to point at nearly any location on the sky, it will provide the unique capability of determining accurate radii for a subset of those planets for which the mass has already been estimated from ground-based spectroscopic surveys. The mission will also provide precision radii for new planets discovered by the next generation of ground and space-based transit surveys (Neptune-size and smaller). While unbiased ground-based searches are well-suited to detect the transits and fix the ephemerids, CHEOPS is crucial to obtain precise measurements of planet radii. Knowing where and when to observe makes CHEOPS the most efficient instrument to search for shallow transits and to determine accurate radii for planets in the super-Earth to Neptune mass range. The main objective of the CHEOPS mission is to provide ultra-precise transit lightcurves of exoplanets smaller than Saturn orbiting bright stars with revolution periods below 50 days. With an accurate measure of masses (coming from RV surveys) and radii for an unprecedented sample of planets, CHEOPS will set new constraints on the structure and hence on the formation and evolution of planets in the sub-Saturn mass range. To reach its goals, CHEOPS is designed to measure photometric signals with a precision of 20 ppm in 6 hours of integration time for a 9th magnitude star and 85 ppm in 3 hours of integration for a 12th magnitude star. The CHEOPS payload consists in a single instrument, a space telescope of 30 cm clear aperture, which has one CCD focal plane detector. The optical configuration consists of a Ritchey-Chrétien telescope, which provides a defocussed image of the target star on the focal plane. The main design drivers are related to the compactness of the optical system and to the capability to reject the stray light. The nominal CHEOPS operational orbit is a polar Sun-synchronous orbit (SSO) with an altitude of 700 km and a local time of the ascending node (LTAN) of 6 am; the orbit inclination is about 98° and the orbital period is ~100 min. CHEOPS will offer up to 20% of open time to the community to be allocated through competitive scientific review. CHEOPS will have the capability to provide precise photometric measurements (lightcurves) of a large number of variable light sources in the universe. Time will be made available for this ancillary science. The nominal mission lifetime is 3.5 years, with a possible extension to a total of 5 years enabled by appropriate sizing of the consumables budget. CHEOPS launch is expected by the second half of 2019. With the launch coming up in less than a year, the satellite (instrument and platform) is already fully assembled and tested. This paper will review the scientific goals of the mission in combination with the expected performance of the instrument, the latter derived from the measurements taken during the calibration campaign.
Fuller, Jim	Caltech	A Solution to the Slow Spins of Stellar Cores	The angular momentum (AM) evolution of stellar interiors, along with the resulting rotation rates of stellar remnants, remains poorly understood. Asteroseismic measurements of red giant stars reveal that their cores rotate much faster than their surfaces, but much slower than theoretically predicted, indicating an unidentified source of AM transport operates in their radiative cores. Motivated by this, we investigate the magnetic Tayler instability and argue that it saturates when turbulent dissipation of the perturbed magnetic field energy is equal to magnetic energy generation via winding. This leads to larger magnetic field amplitudes, more efficient AM transport, and smaller shears than predicted by the classic Tayler-Spruit dynamo. We provide prescriptions for the effective AM diffusivity and incorporate them into numerical stellar models, finding they largely reproduce (1) the nearly rigid rotation of the Sun and main sequence stars, (2) the core rotation rates of low-mass red giants during hydrogen shell and helium burning, and (3) the rotation rates of white dwarfs. We discuss implications for stellar rotational evolution, internal rotation profiles, rotational mixing, and the spins of compact objects.

Fulton, Benjamin	NExScI / IPAC / Caltech	Revisiting the Radius Gap in the Era of Gaia	The size of a planet is an observable property directly connected to the physics of its formation and evolution. We previously used precise radius measurements from the California-Kepler Survey (CKS) to detect a deficit in the distribution of planet radii between 1.5-2.0 $R_\oplus$. This gap splits the population of close-in (P < 100 d) small planets into two size regimes: $R_p < 1.5\ R_\oplus$ and $R_p = 2.0$-$3.0\ R_\oplus$, with few planets in between. The feature is predicted by several planet formation theories which can be tested by measuring the detailed characteristics of the radius gap. Here we rederive the stellar radii incorporating distance constraints available in the second data release from Gaia. With the higher precision stellar and planetary radii we measure the detailed shape and location of the gap and and identify changes in the distribution as a function of stellar host mass.
Gaidos, Eric	University of Hawaii at Manoa	What Orbits a Mysterious Young ``Dipper'' Star in Taurus?	Most stars younger than a few Myr host disks containing the building blocks of planets. These disks can be studied by imaging and spectroscopy but also by photometric time-variability with space telescopes including Kepler/K2. These observations reveal that some young late-type stars exhibit episodic drops in flux or ``dips''. Nearly all such ``dipper'' stars have disks, supporting the idea that dips are the result of circumstellar dust crossing the line of sight. Most dippers are episodic, but a few exhibit highly periodic dips that can be predicted and efficiently studied. We discovered a pre-main sequence Taurus M dwarf which exhibits V-shaped highly periodic dimming of a few percent. Very unusual for dipper stars, this object has no detectable excess IR emission indicative of a disk. Although the lightcurve somewhat resembles that of an eclipsing binary (EB), the dips are not symmetric and their depth and shape change in an irregular fashion. We obtained RVs based on spectra from the InfraRed Doppler spectrograph on Subaru, find a single set of lines, constrain the RV variation, and rule out the EB explanation. We hypothesize that the dips are produced by a variable cloud of dust with an extended tail, analogous to the ``disintegrating'' planet described by Rappaport et al. 2012. Multi-bandpass monitoring is planned to search for the expected wavelength dependence of dips produced by scattering dust. Adaptive optics IR imaging of this star revealed three much fainter sources within 7". While the colors and locations of two are consistent with background M dwarfs, those of the third suggest it is a Jupiter-mass companion. A low-resolution infrared spectrum supports this scenario. We are planning further follow-up observations to definitively distinguish between the different scenarios. A 1-3~Myr old Jupiter is a useful test of models of giant planet formation, evolution, and atmospheres.
Garcia, Rafael A.	Astrophysics Department, CEA Saclay	A Comprehensive Full Kepler Red Giant Legacy Catalog	After 4 years of continuous operations, the Kepler main mission has been a success in characterizing low-mass red giant stars (M □ 3M☉) through asteroseismology. While providing constraints on stellar interiors dynamics, it also allowed us to determine precise stellar parameters (e.g. mass, radius and evolutionary stage) of a large number of field stars, providing strong constraints for Galactic Archaeology studies. However, prior efforts have included only a subset of the full data set. A complete set of stars is essential for modeling the populations in the field. Here we report on the community effort done to provide the most complete catalog of low-mass red giant stars in the Kepler field. To build this catalog, we have applied asteroseismic pipelines combined with machine learning techniques such as neural networks to the full DR25 Kepler stellar catalog. We have attempted to identify and analyze all of the low-mass red giants showing solar-like oscillations in the Kepler field. Then, we have also used complementary information from GAIA DR2 and APOGEE observations to look for non-pulsating stars that the above-mentioned methods could miss in the analysis. Hence, we present in this talk the most complete Kepler red giant catalog established based on a robust methodology. We will statistically compare the global stellar parameters obtained, the biases relative to the underlying stellar population, and discuss interesting sub-populations that may be missed or misinterpreted in traditional stellar population studies.

Grunblatt, Samuel	University of Hawaii Institute for Astronomy	Planetary Archaeology: Exploring the Planet Population of Evolved Stars	While the Kepler mission discovered thousands of planets around main sequence stars, red giant stars were largely unexplored. A sample of transiting planets around these more evolved stars can test theories of giant planet inflation and migration, problems that have remained unsolved for more than 20 years. I have searched for transits around red giant stars with the K2 Mission to reveal the effects of stellar evolution on planet inflation, migration, and occurrence. My survey increased the number of confirmed transiting planets around red giant stars by more than 50%. Comparing these and similar planets orbiting main sequence stars to planet evolution models revealed that planets orbiting red giants can be re-inflated by the rapid evolution of their host stars. Additional followup measurements of this population showed that these planets reside on moderately eccentric orbits, suggesting that stellar evolution can also result in inward planet migration and orbit circularization. Furthermore, planet occurrence estimates suggest red giant stars host as many or more gas giant planets at short orbital periods as main sequence stars, at odds with earlier Doppler surveys of similar stars, providing intriguing insight into the effect of star-planet interaction on planetary evolution. Soon, the TESS Mission will shed new light on unexplored dimensions of this interaction with its predicted discovery of an order of magnitude more transiting planets orbiting evolved stars over the next two years. In short, exploring exoplanets transiting evolved stars will improve our understanding of planet evolution, and reveal the fate of planetary systems like our own.
Gully-Santiago, Michael	Kepler/K2 Guest Observer Office	K2 constraints on stellar surface inhomogeneities and their systematic bias of transit-derived exoplanet densities	Stellar rotation periods derived from starspot-induced lightcurve modulation inform gyrochonology and our understanding of cosmic ages. Still little is known about the bulk properties of starspots themselves, or how starspot physical properties vary through stellar age or mass or evolutionary state. The stellar surface map cannot be uniquely determined from Kepler/K2 lightcurves alone. The amplitude of spot-induced lightcurve modulation conveys the extent to which one projected stellar hemisphere possesses more spot coverage than the other. In this talk, we compare Kepler/K2 lightcurves with simulated spotted lightcurves with a range of distributions in latitudes, longitudes, and stellar inclinations to constrain spot coverage fractions and temperature contrasts. We overview complementary observations capable of assessing the entire starspot coverage fraction. The most heavily spotted young stars possess greater than 50% coverage fractions of spots, with strong longitudinal symmetries that mask their appearance in K2 lightcurves. We find evidence that starspots could be responsible for both large apparent age spreads and significant (up to 100%) systematic biases in isochrone-derived cluster ages. We quantify to what extent unocculted starspots induce astrophysical biases in transit-derived exoplanet densities, by simulating the Transit Light Source Effect (TLSE) on transiting planet host stars, and offer strategies for how to mitigate TLSE.
Hardegree-Ullman, Kevin	Caltech/IPAC-NExScl	Space Telescope Synergy: Spitzer Follow-up of K2 Targets	K2 successfully built upon Kepler's legacy by unveiling hundreds of planets across the ecliptic plane. Many of these planets are smaller than Neptune, with shallow transits which are difficult, if not impossible, to detect with most ground-based telescopes. Spitzer has become indispensable for transiting exoplanet follow-up, and we present an overview of an 800+ hour program to study exoplanets identified by the K2 mission. We have over 70 observations of 36 different systems containing 47 planets or planet candidates. Our high cadence observations help constrain planet properties and considerably improve ephemerides, which will aid future studies by JWST and other facilities. We will discuss some of the challenges of removing systematics in the Spitzer data reduction and highlight recent results from our observations of K2-3, K2-55, K2-96, and K2-138.

Hedges, Christina	Kepler/K2 Guest Observer Office	Are there any more planets in the Kepler / K2 data?	The Kepler/K2 mission has been exceptionally successful at detecting transiting exoplanets. The Kepler mission has detected more than 2300 confirmed exoplanets to date, with K2 detecting more than 300 additional confirmed exoplanets. Kepler/K2 is able to identify some of the smallest exoplanets around solar-like stars, owing to its extreme photometric precision and long baseline. Several of these planets have become vital components in our modeling of planet formation and composition, as well as targets for atmospheric characterization. However, there is a wealth of data that is currently under-utilized. In particular, several K2 campaigns have provided fewer exoplanets, due to difficult instrument systematics and crowding complicating data analysis. For example, campaigns 9 and 11 are extremely crowded, causing contamination and diluting exoplanet transits. These campaigns require precise extraction techniques (e.g. PSF photometry) to rebuild subtle exoplanet transits, such as PSF photometry. With the new TESS photometry likely to require more complex extraction techniques, now is the ideal time to revisit Kepler/K2 data and find the planets that remain in this huge dataset. Additionally, there are several K2 campaigns that have been underutilized purely because of the sheer volume of data, including the recent campaigns 16, 17 and 18. In this talk I will highlight some of the Kepler/K2 datasets where valuable, undiscovered planets are still hiding.
Herman, Miranda	University of Toronto	Revisiting the Long-Period Transiting Planets from Kepler	Long-period exoplanets are notoriously difficult to identify in transit surveys like the Kepler mission as they only transit once or twice within the observational baseline. Until recently, their elusive nature has therefore limited our ability to construct a clear picture of the architecture of planetary systems at large orbital separations. With minor modifications, we use the automated search procedure developed by Foreman-Mackey et al. (2016), combined with revised stellar radii from Gaia, to place new constraints on the occurrence rate of outer planets and their relationship with inner companions. The radius revisions from Gaia boost the sizes of the majority of the planet candidates from Neptunes to Jupiters, necessitating a reanalysis of the occurrence rate reported for transiting long-period planets. From a sample of 61,418 Sun-like stars we identify 12 promising long-period planets, including two that have never been reported before. Five of these candidates contain inner transiting companions, including one with a five-planet system. This high rate of long-period planets with inner transiting companions confirms the strong correlation between inner small planets and outer giants. Furthermore, it indicates that across a large orbital range, systems with higher multiplicities should have smaller mutual inclinations. After correcting for detection efficiency we report a revised planet occurrence rate as a function of planet radius over a period range of 2-10 years, and find our results are generally consistent with those of radial velocity surveys.
Hess, Nicole	Southern Connecticut State University	Identifying Bound Stellar Companions to Kepler Exoplanet Host Stars With Speckle Imaging	The Kepler mission and subsequent ground-based follow-up work have revealed a number of Kepler exoplanet host stars with nearby stellar companions (within ~1 arcsec). Recent observations of these stars over a 3 - 8 year baseline have shown that it is possible to track their proper motions and the subsequent positions of the companion using speckle imaging and astrometry. By tracking the position angle and linear separation of the companion with respect to the primary, we can determine if the pair exhibits common proper motion, indicating it is a bound binary system. We will present ~60 Kepler exoplanet host stars (or candidates) with comprehensive common proper motion results. We compare our results with estimates of the multiplicity rate of exoplanet hosts from other methods and comment on the use of our data for constraining the binary orbital parameters at this point, particularly the inclination angle. For transit observations, the inclination of the planetary orbit is already known, and the relationship between planetary and stellar orbital planes will have implications for star and planet formation.

Hill, Michelle	UC Riverside	EXPLORING KEPLER GIANT PLANETS IN THE HABITABLE ZONE	While the search for exoplanets has been focused primarily on trying to find Earth like planets, or planets of a similar size, distance from its star and composition as Earth, there have been discoveries of many different worlds that have caused us to revise our ideas as to what could be a potentially habitable world. Interestingly Kepler discovered a significant number of giant exoplanets (>3 earth radii) in the habitable zone of their star, the region around a star where water can exist in a liquid state on the surface of a planet with sufficient atmospheric pressure. These giant planets are likely gas giants and thus are not considered habitable on their own, but they each could potentially be host to large rocky exomoons which would also exist in the habitable zone. These moons, should they exist, will offer new ways to understand the formation and evolution of planetary systems, and widen the search for signs of life out in the universe. The occurrence rates of these moons are related directly to the occurrence rates of giant planets in the habitable zone of their star, thus we estimated the frequency with which we expect giant planets to occur in the habitable zones. These results will be presented, along with calculations of potential exomoon properties of Kepler and K2 habitable zone giant planets, and the results of radial velocity follow up observations of habitable zone giant planets that have shown indications of linear trends.
Holoien, Thomas	Carnegie Observatories	ASASSN-18bt: Evidence for Nickle on the Surface of a Type Ia Supernova found by the rising K2 light curve	The Type Ia supernova ASASSN-18bt, discovered in February 2017 by the All-Sky Automated Survey for Supernovae (ASAS-SN), is the nearest and brightest supernova observed by Kepler. The K2 early-time light curve has an unprecedented 30-minute cadence and photometric precision for an SN Ia light curve, and it unambiguously shows a ~4 day nearly linear phase followed by a steeper rise. This double power law rise implies that two physical processes must be responsible for the observed emission, but we find that current models of the interaction with a non-degenerate companion predict an abrupt rise and cannot adequately explain the initial, slower linear phase. Spectra obtained later during the event support this picture. In contrast, we find that existing, published models with shallow 56Ni may be able to reproduce the ASASSN-18bt lightcurve. While further theoretical work is needed to model this and other early-time SN Ia light curves, ASASSN-18bt highlights the power of well-sampled, early-time data for making progress in our understanding of Type Ia supernovae.
Huber, Daniel	University of Hawaii	An Asteroseismic Age for the Galactic Halo Measured with Distant Kepler Giants	The Milky Way halo is one of the most critical components for unraveling the formation history of our galaxy, but its formation history is poorly understood. A particularly important piece of information to discern proposed formation scenarios comes from stellar ages, which however are typically difficult to measure using conventional methods. Additionally, galactic archeology surveys such as APOGEE are typically not sensitive enough to sample a significant sample of faint halo stars. In this talk I will present deep, high-resolution spectroscopy using HDS/Subaru of the most distant known sample of oscillating red giants discovered by Kepler. By combining detailed chemical abundances from HDS with asteroseismology from Kepler, I will present the first systematic asteroseismic age estimate of halo stars in our galaxy.
Kolenberg, Katrien	KU Leuven, University of Antwerp	RR Lyr, an old friend in a new light, with Kepler	Even though RR Lyr was initially deemed too bright to be observed, Kepler data of the prototype RR Lyrae star have led to many developments and discoveries. These include a custom aperture for the star, the discovery of the period doubling phenomenon that (sometimes) accompanies the still mysterious Blazhko effect, new models for this effect, the observation of additional radial pulsation modes and hints of nonradial pulsations, all in one (bright) star. I will review the findings done so far and explain how a detailed study of the shock wave behavior in the star with the Kepler short cadence (SC) data can bring us closer to the explanation of the Blazhko effect.

Kraus, Adam	UT-Austin	The Perilous Lives of Planets in Binary Star Systems	The majority of solar-type stars are found in binary systems, and the dynamical influence of binary companions is expected to profoundly shape planetary systems. However, the difficulty of identifying planets in binary systems has left the magnitude of this effect uncertain; despite numerous theoretical hurdles to their formation and survival, at least some binary systems clearly host planets. We present high-resolution imaging of nearly 500 Kepler Objects of Interest (KOIs) obtained using adaptive-optics imaging and nonredundant aperture-mask interferometry on the Keck II telescope. We super-resolve some binary systems to projected separations of under 5 AU, showing that planets might form in these dynamically active environments. However, the full distribution of projected separations for our planet-host sample more broadly reveals a deep paucity of binary companions at solar-system scales. Our results demonstrate that a fifth of all solar-type stars in the Milky Way are disallowed from hosting planetary systems due to the influence of a binary companion. We now update these results with multi-epoch imaging to reject non-comoving background stars and securely identify even the least massive stellar companions, as well as tracing out the orbital motion of stellar companions and robustly determining occurrence rates for wider binaries that are subject to numerous selection biases in the original Kepler survey. These results are beginning to reveal not just the fraction of binaries that do not host planets, but also potential explanations for planet survival even in some very close, dynamically active binary systems.
Latham, David	Center for Astrophysics | Harvard & Smithsonian	Contributions from HARPS-N to the Mass-Radius Diagram for Kepler/K2 Planets	David W. Latham for the HARPS-N Collaboration Motivated by the need for a northern version of the original HARPS to help with mass determinations for planets identified by Kepler, the HARPS-N Collaboration was formed with members from Switzerland, the United States, the United Kingdom, and Italy. HARPS-N began science operations in August 2012 on the 3.6m Telescopio Nazionale Galileo on La Palma, with 80 nights per year dedicated to measuring masses of Kepler planets and a survey for rocky planets around nearby quiet FGK stars. On this the tenth anniversary of the launch of Kepler, we will highlight the contributions of HARPS-N to our understanding of the mass-radius diagram based on observations of planets identified by the Kepler Space Telescope.
Lissauer, Jack	NASA Ames	Architecture and Dynamics of Kepler's Multi-Transiting Planet Systems. III. Comprehensive Investigation Using All Four Years of Kepler Mission Data	We study the orbital architectures of planetary systems orbiting within ~1 AU of their stars by analyzing the ensemble of Kepler systems having two or more planet candidates. We use data from the entire Kepler mission, and in many cases we apply improved analysis techniques (e.g., replacing histograms by top-hat Kernel Density Estimators that avoid the loss of information resulting from choosing a particular phase for the bin boundaries) to extend and enhance the studies of Lissauer et al. (2011, ApJS 197, 8) and Fabrycky et al. (2014, ApJ 790, 146). These data show ~ 1700 transiting planet candidates in > 600 multiple-planet systems, far more than were available for our previous two studies. The increased numbers and better information about planetary radii and the properties of stellar hosts made possible by Gaia DR2 allow more statistically-robust analyses of the entire ensemble of Kepler multis as well as independent analyses of subsets of the population. We are thus able to contrast the dynamical configurations of small and large planets, short-period and longer-period planets, and planets orbiting various types of host stars. We reinforce our previous findings that most pairs of planets within the same system are neither in nor near low-order mean motion resonances and that there is a substantial excess of planets having period ratios slightly larger than those of first-order mean-motion resonances. However, neglecting three systems whose planets are locked in 3-body resonances and summing over all first-order mean motion resonances, the deficit of planet pairs with period ratios just narrow of resonance is as large as the excess of planets wide of resonance (within statistical uncertainties), suggesting that overall there is no overall excess of planet pairs in the vicinity of resonance. Other aspects of our study, including estimates of the typical relative inclinations of planetary orbits and their variations as functions of orbital period, planet sizes and stellar properties, are in progress, with results expected to be available for presentation by the time of the conference.

Luger, Rodrigo	Flatiron Institute	Gradient-based inference techniques for exoplanet light curves	The past decade has seen a surge in the use of Markov Chain Monte Carlo (MCMC) methods for inferring the properties of systems of transiting exoplanets, given their relative ease of use and the guarantee that, as long as it is run for long enough, the Markov chain will converge to the target posterior distribution. However, MCMC sampling is very inefficient, as it requires many model evaluations per independent posterior sample. This becomes an issue particularly in the case of compact multi-planet systems, where the dimensionality is large and photodynamical model evaluations can be expensive. In the first part of my talk, I will discuss the advantage of gradient-based inference methods such as Hamiltonian Monte Carlo (HMC), which use knowledge of the gradient of the model -- and hence of the likelihood function -- to efficiently sample the parameter space, reducing the number of required function evaluations by potentially orders of magnitude. I will connect this to my work on STARRY, a suite of fast and generalized analytic models of exoplanet light curves and their gradients, demonstrating how to easily and efficiently infer the properties of exoplanet systems observed by Kepler and TESS. In the second part of my talk, I will discuss how HMC and STARRY can be harnessed to model phase curves and secondary eclipses of exoplanets, as well as planet-planet occultations and transits of planets across stars with arbitrary limb darkening profiles in an analytic and fully self-consistent way within a single modeling framework. These tools will be extremely useful for JWST and future generations of telescopes, allowing us to fully exploit the information content of photometric observations.
Mamajek, Eric	JPL/Caltech	Small (In)temperate Planets: A Closer Look at Habitable Zone Terrestrial-sized Planet Candidates	Goal 2 of the 2018 Exoplanet Science Strategy is "to learn enough about the properties of exoplanets to identify potentially habitable environments and their frequency, and connect these environments to the planetary systems in which they reside." Potentially habitable planets are of intense scientific and public interest. Rigorous statistical analysis of Kepler data has established that small, habitable zone planets are common. However, due to their small size and long periods — confirming potentially habitable planets (particularly around sun-like stars) is near the limits of our current observational capabilities. The physical properties of transiting and RV planets depend critically on our understanding of their host star's properties. We will discuss recent updates in the stellar parameters of host stars for proposed small, temperate planet candidates and examine the implications for their planet's properties. Gaia DR2 has led to improved luminosities, and improved stellar and planetary radii for many exoplanet host stars. Some host stars of previously proposed small temperate planets appear to have been grossly mischaracterized, with the planets turning out to likely be too hot or too large to be candidates for habitable worlds. Improved stellar parameters and reasonable variation in the criteria for potential habitability can change the number of confirmed potentially habitable planets by an order of magnitude.
Martinez, Cintia Fernanda	Observatorio Nacional	An Independent Spectroscopic Analysis of the California-Kepler Survey Sample: A Slope in the Small Planet Radius Gap	Authors: Cintia Martinez(1), Katia Cunha(1,2), Luan Ghezzi(1), Verne Smith(3) Affiliations: (1)Observatorio Nacional, Rio de Janeiro, RJ-Brazil;(2)Steward Observatory, University of Arizona, Tucson, AZ-USA;(3)National Optical Astronomy Observatory, Tucson, AZ-USA The accurate determination of the stellar parameters of the planet-hosting stars is fundamental in characterizing the size and nature of the planets themselves. We used the archival Keck/HIRES high-resolution spectra from the California-Kepler Survey (CKS) sample of exoplanet host stars to conduct an independent spectroscopic analysis based on the classical method of equivalent width measurements of a carefully selected sample of 158 Fe I and 18 Fe II lines, resulting in precise values for the effective temperatures and surface gravities of the host stars. We then used Gaia DR2 parallaxes and precise distances to constrain stellar luminosities that combined with the derived stellar parameters resulted in stellar radii with a median internal uncertainty of 2.6%. Such a precision in stellar radii led us to derive planetary radii with a median uncertainty of 3.7%. The derived planetary radii exhibit two peaks in the distribution of small radius planets, ~ 1.6 Earth-radii and ~ 2.7 Earth-radii, with a clear gap in between at ~ 2 Earth-radii. The two planetary radii peaks are systematically shifted to larger radii relative to previous

			determinations in the literature. The high internal precision achieved in the derived planetary radii reveals that the radius gap for the CKS decreases as a function of the planetary orbital period following a power law of the form $R_{pl} \sim P^{-0.07}$. This slope is in agreement with a previous determination in the literature for a small sample of planets with host stars having precise stellar radii from asteroseismology. Our results are also in agreement with planetary formation models of photo-evaporation and Earth-like core composition.
Matson, Rachel	NASA Ames Research Center	Detecting Unresolved Binaries in Exoplanet Transit Surveys with Speckle Imaging	Kepler/K2 has discovered thousands of planets orbiting other stars and shown that planetary systems are remarkably common. While many exoplanet searches target only single stars or very wide binaries, Kepler was relatively unbiased to stellar multiplicity, resulting in the discovery of planets orbiting one or both stars in a number of binary systems. However, as the impact of stellar multiplicity on planet occurrence is not well understood and many binaries remain unresolved in such surveys, planet properties and population statistics are, in general, determined as if all stars are single. Not accounting for the effects of stellar multiplicity statistically biases planets toward smaller radii and gives rise to systematic errors in planet occurrence rates and completeness corrections. Detecting unresolved stellar companions can mitigate some of these biases and help us understand the fraction of exoplanets found in binaries. Using high angular resolution speckle imaging we detect stellar companions within ~1 arc second of Kepler\K2 (and TESS) planet candidate host stars in order to validate planets, derive accurate planetary radii, and determine the binary fraction of exoplanet host stars.
Millholland, Sarah	Yale University	Obliquity Tides and their Role in Understanding the Kepler Planet Period Ratio Distribution	The ubiquity of systems containing several short-period super-Earth/sub-Neptune sized planets was one of the main findings of the Kepler mission. Early data from Kepler revealed a mysterious trend in the population-level properties of these short-period compact systems: They are rarely found with planet pairs in mean-motion resonances (MMRs) -- configurations in which the planetary orbital periods exhibit a simple integer ratio -- but there is a significant overabundance of planet pairs lying just wide of the first-order resonances. Previous work suggests that tides raised on the planets by the host star may be responsible for forcing systems into these configurations by draining orbital energy to heat. This tidal explanation, however, is insufficient unless there exists a significant and as-yet unidentified source of extra dissipation. Here we show that this cryptic heat source may be linked to ``obliquity tides'' generated when a large axial tilt (obliquity) is maintained by secular resonance-driven spin-orbit coupling. We present evidence that the typical compact, nearly-coplanar systems discovered by Kepler frequently experience this mechanism, and we highlight other key features in the observed planet population that may be its signatures.
Morton, Timothy	University of Florida	The Probabilistic Validation Revolution: How Kepler forced a paradigm shift in how we treat transiting planet candidates	The quantity and character of the detections made by Kepler defied the traditional follow-up confirmation methods that were standard practice in the transiting exoplanet field when the mission launched. The concept of probabilistic validation---where the probability for a signal to be a false positive is demonstrated to be negligibly small---was developed as response to this challenge. I will review the history of the development and eventual broad acceptance of probabilistic validation, recap its influence on the results and legacy of the Kepler and K2 missions, discuss some important caveats, and look forward to the future.

Mulders, Gijs	University of Chicago	Exoplanet population synthesis in the era of large exoplanets surveys.	The Kepler survey has shown that planets orbiting within 1 au from their host stars are extremely common. The distribution of planet properties in terms of their sizes, orbital periods, and system architectures provide strong empirical constraints on planet formation theories. Planet population synthesis models can be used to understand how various planet formation mechanisms and protoplanetary disk initial conditions work together to shape the final distributions of planetary systems that we observe. In this talk I will present simulated planet populations from an updated version of the Bern planet population synthesis model. I will show how different physical processes included in this model give rise to an abundant population of planetary systems with hot super-earths and temperate giants, while hot jupiters remain rare. Through detailed statistical comparison with kepler and radial velocity survey data, I will show that these models can reproduce most properties of the observed exoplanet populations but require different initial conditions for the protoplanetary disk than commonly assumed. I will conclude with an outlook of how exoplanet populations from ongoing and future surveys can be used to test the predictions of these planet population synthesis models.
Murphy, Simon	University of Sydney	Pulsating Stars in Binaries	Binaries anchor many of the fundamental relations we rely upon in our analyses. Masses and radii are rarely constrained better than when measured via orbital dynamics and eclipse depths. Pulsating binaries have so much to offer! They are clocks, moving in space, that encode orbital motion in the Doppler shifted pulsation frequencies. They offer twice the opportunity to obtain an asteroseismic age, which is then applicable to both stars. They enable comparative asteroseismology - the study of two stars by their pulsation properties, whose only fundamental differences are the mass and rotation rates with which they were born. And when their orbits are eccentric, oscillations can be excited tidally, informing our knowledge of tidal dissipation and resonant frequency locking. I will present an overview of these themes in light of both observational and theoretical developments recently made possible by Kepler.
Pal, Andras	Konkoly Observatory	New results with K2 in Solar System exploration	By turning to the ecliptic plane, the K2 mission took the advantage to look into various classes of Solar System bodies in details. This advantageous property yielded hundreds of individual time-domain observations of minor bodies on timescales ranging from a few days up to several weeks, depending on the orbital characteristics. In this presentation, we review the latest results of Solar System science by going through our closest neighborhood - ranging from main-belt asteroids and Jupiter Trojans to Centaurs and extreme Centaurs and as far as irregular satellites and trans-Neptunian objects. We also demonstrate how the precise light curves can be incorporated to provide more detailed shape models of these objects. Regarding to the algorithmical details, we demonstrate how subpixel-level dithering can be involved in order to provide more accurate photometric fluxes for these moving targets. Finally, we make some comparison regarding to preliminary TESS results, focusing on the differences in the sampling methods, and statistical biases and homogeneity of the two instruments. The conclusion is simple: we will really miss Kepler/K2.
Petigura, Erik	Caltech	Metal-rich Stars Host a Greater Diversity of Planets	Probing the connection between a star's metallicity and the presence and properties of any associated planets offers an observational link between conditions during the epoch of planet formation and mature planetary systems. I will present new insights into the planet-metallicity connection made possible by the California-Kepler Survey. Curiously, small planets ($R_p < 1.7 R_e$) with long orbital periods ($P > 10$ days) show little correlation with host star metallicity. However, the planet-metallicity correlation steepens with increasing planet size and decreasing orbital period. High metallicities in protoplanetary disks may increase the mass of the largest rocky cores or the speed at which they are assembled, enhancing the production of large planets. The association between high metallicity and short-period planets may reflect disk density profiles that facilitate the inward migration of solids or higher rates of planet–planet scattering.

Pope, Benjamin	New York University	Naked-Eye Stars in Kepler and K2	Naked-eye stars in Kepler and K2 are so bright that they saturate the detector to such an extent that they cannot be observed conventionally. Because they are so amenable to follow-up observation, they nevertheless have great scientific value. Two methods have been developed to recover light curves of these valuable targets: smear photometry, using collateral calibration data; and halo photometry, using unsaturated wings of scattered light. I will present the first data release of the Kepler Smear Campaign, consisting of light curves of 102 extremely bright stars and making Kepler magnitude-complete down to 9th mag. These include hot pulsators and eclipsing binaries, and also a sample of red giants which we have very precisely characterized as benchmark stars. I will also present work on the K2 Halo Survey, reviewing recent progress with the Pleiades and Aldebaran and presenting early results of a planet search and asteroseismology of the full sample.
Ragozzine, Darin	Brigham Young University	Getting more out of information-rich Kepler multis that show TTVs	Kepler opened new avenues of exoplanet discovery and characterization by identifying systems with multiple-transiting planets (“multis”) and systems showing Transit Timing Variations (TTVs). When TTVs are seen in multis, it is often possible to place constraints on the densities of planets from Kepler light curve data alone. These systems are the most information-rich exoplanetary systems and I will review some interesting cases. However, most existing analyses do not extract the maximum amount of useful planetary information available because TTVs and light-curves are not solved for simultaneously; valuable Short Cadence data is not used (as there is no homogeneous catalog); and/or TTVs cannot even be measured because individual transits have low SNR. In addition, though there are hundreds of planets with weak TTVs, these are rarely chosen for full analysis. These problems are naturally addressed by using photodynamical models that fit n-body integrations directly to Kepler light curve data, which have been successfully applied to a few individual systems. We are expanding our existing model to the PhotoDynamical Multi-planet Model (PhoDyMM, pronounced “pho dime”) that can handle the full variety of planetary systems. We describe our funded ADAP grant to apply PhoDyMM to all Kepler multis in order to produce a homogeneous catalog of high-information Bayesian posterior distributions of self-consistent planet and system properties. With these improvements, we hope to place mass constraints on ~50 new small planets. Early results of PhoDyMM on selected systems will be presented, including updates of previously analyzed systems using more Kepler data.
Reding, Joshua	University of North Carolina at Chapel Hill	The Confluence of Hardware Failures That Lead to the Discovery of the Most Rapidly Rotating Isolated White Dwarf	We present the discovery of WDJ1252-0234 (EPIC 228939929, g=17.5 mag) in K2 Campaign 10, the fastest-rotating isolated white dwarf detected to date. We targeted this candidate white dwarf based on its blue color and high proper motion, but it unfortunately fell on Module 4, which failed barely one week into observations in Campaign 10. Still, that brief long-cadence dataset showed hints of significant variability. In April 2018, more misfortune struck as the Goodman Spectrograph slit mask failed on the 4.1 m Southern Astrophysical Research (SOAR) Telescope, and so we observed this object with high-speed photometry as part of our backup plan. On this night, we discovered that the variability seen by K2 was actually caused by a magnetic spot indicating a rotation period of roughly 316 seconds, aliased off the Nyquist frequency 11 times! Follow-up SOAR spectroscopy and its position in the Gaia color-magnitude diagram confirm that this is a featureless white dwarf, possibly strongly magnetic. This object’s peculiarities offer us valuable insights into the potential of white dwarf mergers as progenitors of type-Ia supernovae, and how we may constrain the temperature topology of magnetic spots on white dwarfs, none of which would have been possible if not for a series of “unfortunate” events.

Rest, Armin	STScI	A Fast-Evolving, Luminous Transient Discovered by K2/Kepler	For decades optical time-domain searches have been tuned to find ordinary supernovae, which rise and fall in brightness over a period of weeks. Recently, supernova searches have improved their cadences and a handful of fast-evolving luminous transients (FELTs) have been identified. FELTs have peak luminosities comparable to type Ia supernovae, but rise to maximum in <10 days and fade from view in <30 days. Here we present the most extreme example of this class thus far, KSN2015K, with a rise time of only 2.2 days and a time above half-maximum of only 6.8 days. Possible energy sources for KSN2015K are the decay of radioactive elements, a central engine powered by accretion/magnetic fields, or hydrodynamic shock. We show that KSN2015K's luminosity makes it unlikely to be powered by radioactive isotopes, and we find that the shock breakout into a dense wind most likely energized the transient.
Ricker, George	MIT	The TESS Mission: Current Status and Future Plans	Successfully launched in April 2018, the Transiting Exoplanet Survey Satellite (TESS) is well on its way to discovering thousands of exoplanets in orbit around the brightest stars in the sky. In its two-year prime survey mission, TESS will monitor more than 200,000 bright stars in the solar neighborhood for temporary drops in brightness caused by planetary transits. This first-ever spaceborne all-sky transit survey is identifying planets ranging in size from Earth-sized to gas giants, orbiting a wide variety of host stars, ranging from cool M dwarfs to hot O/B giants. TESS stars are typically 30-100 times brighter than those surveyed by the Kepler satellite; thus, TESS planets are far easier to characterize with follow-up observations. For the first time it will be possible to study the masses, sizes, densities, orbits, and atmospheres of a large cohort of small planets, including a sample of rocky worlds in the habitable zones of their host stars. Additional data products from the TESS mission include full frame images (FFI) with a cadence of 30 minutes. These FFI provide precise photometric information for every object within the 2300 square degree instantaneous field of view of the TESS cameras. In total, nearly 100 million objects brighter than magnitude I=16 will be precisely photometered during the two-year prime mission. TESS's unique lunar-resonant orbit should provide opportunities for an extended mission lasting more than a decade. A deep survey by TESS of regions surrounding the North and South Ecliptic Poles is providing prime exoplanet targets for atmospheric characterization with the James Webb Space Telescope (JWST), as well as for studies by other large ground-based and space-based telescopes coming online in the next two decades. The TESS legacy will be a catalog of the nearest and brightest main-sequence stars hosting transiting exoplanets, which should endure as the most favorable targets for detailed future investigations. A summary of initial science results from the first half-year of the TESS mission will be presented, as well as an update on the plans for the remainder of the primary mission and the proposed extended mission.
Ridden-Harper, Ryan	Australian National University	Hunting transients in K2 with the K2: Background Survey	The Kepler K2 mission has provided us with a wealth of information on supernovae and other transients, most of which were detected through the Kepler Extragalactic Survey (KEGS). Although KEGS found may transients through target observations of galaxies, there may be many more undiscovered transients hidden in Kepler data that were serendipitously observed. In my talk I will discuss the K2: Background Survey, a search for unknown transients in all Kepler/K2 data, and recent results.

Rodenbeck, Kai	Institute for Astrophysics Göttingen	Revisiting the exomoon candidate signal around Kepler-1625 b	Transit photometry of the Jupiter-sized exoplanet candidate Kepler-1625 b has recently been interpreted to show hints of a moon. This first exomoon would be as large as Neptune and unlike any moon we know from the solar system. We aim to clarify whether the exomoon-like signal is caused by a large object orbiting Kepler-1625 b, by stellar or instrumental noise or by the data detrending procedure. We explore several detrending procedures including the CoFiAM method used in Teachey et al. 2018. We develop a planet-moon model and fit it to the Kepler data. We employ the Bayesian Information Criterion to assess whether a single planet or a planet-moon system is a more likely interpretation of the light curve. We carry out an injection-retrieval test by injecting simulated transits into different out-of-transit parts of the original light curve: (1) 100 sequences with three synthetic transits of a Kepler-1625 b-like planet and (2) 100 sequences with three synthetic transits of a Kepler-1625 b-like planet with a Neptune-sized moon. The statistical significance and characteristics of the exomoon strongly depend on the detrending method, the data chosen for detrending, and on the treatment of gaps in the light curve. Our injection-retrieval experiment shows evidence of moons in about 10% of those light curves that do not contain an injected moon. Strikingly, many of these false-positive moons resemble the exomoon candidate, i.e. a Neptune-sized moon at about 20 Jupiter radii from the planet. We recover 31%-46% of the injected moons, depending on the detrending method, with radii and orbital distances broadly corresponding to the injected values.
Rodriguez, Joey	Harvard-Smithsonian CfA	K2-266: A Compact Multi-Planet System With A Planet That Is "Way Out of Line"	With the recent success of the Kepler Mission combined with the ground based radial velocity and transit surveys, the field of extrasolar planets has rapidly expanded over the past decade. This has guided the transition of the field from pure discovery to the combination of discovery, atmospheric characterization, and demographics. Recently, we have discovered a compact six planet system of sub-Neptunes orbiting a nearby (78 pc) K-star. Interestingly, the system contains an 0.66 day ultra-short period super Earth that is significantly misaligned (>12 degrees) to the other five planets. As results of its close proximity to its host star, the USP does transit our line-of-sight. This provides a rare opportunity to directly compare the misaligned planet to the other five planets in the system, potentially gaining insight into how it got to its current orbital configuration. K2-266 is the most planets discovered in one system from the repurposed Kepler mission, K2. In addition, we also identify a transiting planet candidate around a nearby, co-moving companion to K2-266. I will discuss the discovery and characterization of the K2-266 system, and the key questions this system may help us answer. J.E.R. is supported by the Harvard Future Faculty Leaders Postdoctoral fellowship.

Santos, Angela	Space Science Institute	Seismic signatures of magnetic activity in solar-type stars observed by Kepler	Authors: A. R. G. Santos (1), T. L. Campante (2), W. J. Chaplin (3), M. S. Cunha (2), M. N. Lund (3), R. Kiefer (4), D. Salabert (5), R. A. García (5), C. Karoff (6), T. S. Metcalfe (1), G. R. Davies (3), S. Mathur (7), Y. Elsworth (3), R. Howe (3) (1) Space Science Institute, Colorado, USA (2) Instituto de Astrofísica e Ciências do Espaço, Porto, Portugal (3) School of Physics and Astronomy, University of Birmingham, UK (4) Centre for Fusion, Space, and Astrophysics, Department of Physics, University of Warwick, UK (5) IRFU, CEA, Université Paris-Saclay, France (6) Department of Geoscience, Aarhus University, Denmark (7) Instituto de Astrofísica de Canarias, Tenerife, Spain Properties of acoustic oscillations are sensitive to magnetic activity. In the Sun, activity-related variations in the mode frequencies have been known for more than three decades. Such variations are expected to be common among solar-type stars and encode information about the activity-related changes that take place in their interior. The unprecedented long-term photometric time-series obtained by Kepler provide a unique opportunity to detect and characterize stellar magnetic variability through asteroseismology. We analyze Kepler short-cadence data of 87 solar-type stars to search for variations, possibly activity-related, in the frequencies and amplitudes of the acoustic modes, as well as in the granulation component. Significant variations are found for more than half of the targets. For stars with available measurements from spectroscopic observations, we find that the amplitude of the frequency variations increases with the chromospheric activity level. The results are thus consistent with the observed frequency variations having an activity-related origin. Furthermore, we find that the amplitude of the frequency variations depends on other stellar properties. Frequency variations increase with effective temperature being in good agreement with the theoretical prediction by Metcalfe et al. (2007). Frequency variations are observed to increase with decreasing rotation period and stellar age, which is consistent with fast rotating and young stars being more active than old and slow rotators. We also find evidence for a relation between frequency variations and stellar metallicity, which may confirm the impact of metallicity on magnetic activity. Our results further demonstrate the potential of using asteroseismology to learn about stellar magnetism.
Schlichting, Hilke	UCLA	Observational Signatures of the Core-Powered Mass-Loss Mechanism: The Radius Valley as a Function of Stellar Mass	The assembly of planetary cores results in core temperatures of about 10,000 to 100,000 Kelvin. Furthermore, if this assembly takes place in the presence of a gas disk, planetary cores not only accrete H/He atmospheres, but they are also prevented from cooling significantly since the optically thick H/He envelopes act like thermal blankets regulating the heat loss from both the core and envelope at the radiative-convective boundary. As a result. the cores and envelopes take Gyrs to cool. We have recently shown that cooling luminosity of the core (core-powered mass-loss) can play an important role in the thermal evolution of the super-Earths and sub-Neptunes and that it yields a bimodal distribution in exoplanet radii consistent with observations. I will explain what physical process gives rise to the bimodality and show that slope and location of the radius valley depend, to first order, only on the planet properties and the bolometric luminosity of the host star. I will show that this results in a shift of the radius valley to larger planet radii as a function of stellar mass. I will conclude with discussing what these findings imply for observed correlations of planet size and stellar mass and highlight the value of combining photoevaporation and core-powered mass-loss models when interpreting the observations.

Schwab Abrahams, Ellianna	UC Berkeley	The Fundamental and Magnetic Characteristics of M Dwarfs in the Kepler Field	M dwarfs have much longer main sequence lifetimes than the Sun and provide stable habitable zones for tens of billions of years, perhaps making M dwarf planets some of the most habitable in the galaxy. Additionally, the smaller radii of M dwarfs allow us to more easily detect transiting Earth-analog planets, due to the higher planet/star radius ratio of the system than of FGK stars. We seek to better understand the M dwarfs (previously known and new characterized) in the Kepler field, using the wealth of information provided by the Kepler. We confirm a sample of M dwarfs using the crossmatch between the Kepler target and the second Gaia data release. We calculate the spectral energy distributions (SEDs) of these objects, using distances from Gaia and available archival photometry (e.g., AllWISE, 2MASS, SDSS, and PANSTARRS). We use the SEDs to measure updated luminosities, temperatures, masses and radii using empirically based calculations for these stars, rejecting those that don't qualify as M dwarfs. We find that model-independent masses and radii are systematically larger than the measurements in the latest Kepler Stellar Properties Catalog (DR25). Using Kepler light curves, we calculate rotation rates of these stars and compile hα and flare rate information from archival surveys. We show that white light (Kepler bandpass, Kp) flare strength is highly correlated with rotation rate for M dwarfs and that M dwarfs with fast rotation rates and higher flare strengths in the initial Kepler dataset do not have any confirmed exoplanet detections. While the majority of the stars that we investigate have no confirmed exoplanet detections, a small subset are known to host transiting exoplanets. We measure updated planetary radii and equilibrium temperatures for these transiting exoplanets. Comparing stellar populations with and without confirmed planets will allow us to assess the impact of M dwarf magnetic strength and activity on planetary habitability.
Sestovic, Marko	University of Bern	The occurence rate of planets around ultracool dwarfs	Recent discoveries such as TRAPPIST-1 have spurred interest in finding planetary systems around ultracool dwarfs. Such systems present a good chance to characterise the atmospheres of earth-like planets, and potentially to find biomarkers with current and upcoming technologies, such as JWST. There are several ongoing and planned observational programs intended to find further examples of such systems, such as SPECULOOS and SAINT-EX. However, the occurrence rate of such systems is currently an unknown quantity. Over its lifetime, K2 has observed nearly 700 ultracool dwarfs, with spectral type M6 and above. This data-set, with its long observing periods, represents our best opportunity to place constraints on the occurrence rate of planets around such stars. We use a custom pipeline to detrend the individual lightcurves using Gaussian Process regression, and perform an automatic transit search on the detrended lightcurves. We find the completeness of our search by injecting and recovering simulated signals on each target, parametrised by planet radius and semi-major axis. We model the occurrence rate as a Poisson process over the whole population of targets, allowing us to place new upper limits on the occurrence rates of super-Earth and sub-Neptune planets, and a lower limit on the occurrence rate of earth-sized planets. The results of this will help upcoming programs such as SAINT-EX in determining target yields and may serve to direct future efforts in finding such planets.
Shallue, Christopher	Google Brain	Can deep learning help find Earth analogues?	Kepler was tremendously successful at identifying small planets orbiting close to their host stars. However, identifying Earth-like habitable planets proved more challenging because their signals are primarily in the long period, low signal-to-noise regime where false positive detections are most likely. Measuring the occurrence rate of these planets requires both a detection system that is sufficiently sensitive to low signal-to-noise transits, and an automatic classification system that is sufficiently accurate at separating real planets from false positive detections. In this talk, I will discuss our work to automatically classify detected signals using deep learning, a cutting-edge machine learning technique. I will also discuss our work developing a detection pipeline that is more sensitive to Earth-like planets. I will present our discoveries of new planets in both Kepler and K2 data, including the first system with eight exoplanets.

Shaya, Edward	U. of Maryland	A Tidal Disruption Event in a Seyfert 2 Observed with K2	A transient event, initially appearing to be a supernova event, in the nucleus of galaxy 2MASX J08565098+2107380 (z=0.0817) occurred in the K2 Campaign 16 field. It was first noticed by PS1 and was followed up spectroscopically and photometrically by several ground based telescopes. K2 monitored it continuously for 79.5 days at 30 minute intervals, starting 15 days before the flux began to rise until more than a month past maximum light. The shape of the light curve (LC) does not match any supernova template, although the luminosity was within the SN range. The time to rise from 1 magnitude below maximum to maximum, ~24 days in the rest frame (~26 days observed), was longer than in any reported SN event. And, the smoothly varying flux that appears to be gradually returning to pre-event non-varying levels is not typical of an active galactic nuclei outburst. However, the LC does closely resemble those of previous tidal disruption events (TDE, when a star is tidally disrupted by a black hole and part of the tidal debris gas gradually falls into the black hole), including the diagnostic $t^{-5/3}$ fall after maximum, for at least 100 days after maximum. A Sloan spectrum of the host galaxy from 2005 suggests the host was a Seyfert 2. However, spectra after the start of the event show broad emission lines typical of a Seyfert 1, which means that this is also Changing-Look event. The extremely smooth light curve obtained by K2 indicates that It must be a Changing-Look event caused by the tidal disruption of a star rather than an instability in the accretion disk.
Stello, Dennis	UNSW Sydney	The K2 Galactic Archaeology Program – revealing the jigsaw puzzle one campaign at a time.	Recent space missions have transformed our ability to use asteroseismology on vast numbers of stars, providing a powerful way to obtain precise estimates of stellar bulk properties such as radius, mass, and age. This advance has opened up for exploration of the structure and evolution of the Galaxy using oscillating red giant stars as distant tracers of stellar populations including the halo, the bulge and the thin and thick disks. Backed by a large international collaboration, including large spectroscopic surveys such as APOGEE and GALAH, the K2 mission's Galactic Archaeology Program has been observing tens of thousands of red giants along the ecliptic covering all main constituents of the Galaxy. In this talk I will give an overview of how seismology can aid the study of the structure and evolution of the Galaxy, with a status review of the K2 Galactic Archaeology Program. This includes recent breakthroughs in artificial intelligence analysis methods that has now resolved previous bottle necks and issues of detection bias, sparking a slew of investigations currently in preparation. Our K2-based results show a clear need for changes to the standard Milky Way synthesis model; changes that also resolve previous mismatches between observed and predicted stellar populations in the Kepler field.
Stelzer, Beate	University of Tuebingen, D	The rotation-activity-age relation of M dwarfs in the era of Kepler and K2	The rotation-activity-age relation can be used as a proxy for magnetic fields -- which are difficult to measure in M dwarfs -- and is, therefore, key to studies of (i) the predicted dynamo transition at the fully convective boundary (SpT ~M3), (ii) differences in angular momentum loss through magnetized winds with respect to solar-type stars, and (iii) the evaporation of planet atmospheres, especially relevant for M dwarfs because of the small separation of their planets' habitable zones where they are strongly exposed to the stellar high-energy emission. I present results from a comprehensive approach to calibrating the rotation-activity and the activity-age relation employing different samples of field M dwarfs. Data from both the Kepler and the K2 mission are central to this project, providing both rotation periods and activity diagnostics from the photometric lightcurves. Additional activity measures are obtained from X-ray (Chandra, XMM-Newton) and UV (GALEX) data. Ages are available for a small subset of stars from the cooling history of their White Dwarf companions. Finally, simultaneous Kepler and X-ray coverage is used to study the coincidence between photospheric and coronal flaring. Among the most notable results is unprecedented evidence for an abrupt change of optical photometric activity (flares and rotation cycle amplitude) at P_{rot} ~ 10d, and an unexpectedly steep decline of X-ray activity in the unsaturated regime of slow rotators. An outlook on the potential of TESS and PLATO for these studies will be given.

Szabo, Robert	MTA CSFK, Konkoly Observatory	Classical pulsating variables in the Kepler/K2 era	Classical pulsating variables in the Kepler/K2 era I will give an overview of the results Kepler and K2 delivered about RR Lyrae and Cepheids. The unprecedented photometric precision and quasi-continuous observations unveiled an unexpected richness of dynamical phenomena in these objects. The results reinvigorated the field and attracted young researchers, as well. Nonradial modes found in these otherwise radially pulsating stars open the possibility to start to exploit their astroseismic potential. Through the modulations, period doubling, resonances, cycle-to-cyle variations and other discoveries we even got a closer to solving the century-old Blazhko-mystery. RR Lyrae and Cepheids are excellent tracers of the Galactic structure, hence I'll discuss the K2 RR Lyrae and Cepheid survey and its implications in Galactic Archeology studies.
Szkody, Paula	University of Washington	Insights into Accretion in Cataclysmic Variables Gleaned from Kepler	Cataclysmic variables exhibit many different timescales for the accretion of material from a late type main sequence or brown dwarf star onto a white dwarf. This can range from flickering (minutes) to orbital timescales (hours) to dwarf nova outbursts or high/low state changes (days to years). Kepler and especially K2 have provided the first continuous series of observations in order to study all of these timescales, resulting in a much better understanding of the mass transfer process and the resulting impact on the accretion disk. This includes the development of an eccentric disk during superoutbursts, the precursors to outbursts, and the general activity level that preceeds outbursts compared to post-outburst levels. The data analyzed so far include periodicities associated with an accreting pulsating white dwarf, several dwarf novae systems with normal outbursts and superoutbursts and a magnetic system undergoing a transition state.
Van Eylen, Vincent	Princeton University	Understanding planet formation through asteroseismology	Almost everything we know about exoplanets has been inferred indirectly through their host stars, making it crucial to understand stars if one hopes to learn about planetary systems. Asteroseismology provides the current gold standard of stellar characterization. In this talk, I explain how asteroseismic studies provide important new insights into the formation and evolution of small close-in planets, which were discovered in great numbers by the Kepler and K2 missions, and are the focus of the TESS survey. I show how asteroseismology can be used to detect and investigate the radius gap, which separates super-Earths and sub-Neptunes, with greater clarity than any other method - even allowing the determination of the exact location of the radius gap as a function of orbital period. This new measurement provides several key physical insights: 1) the slope of the radius gap is inconsistent with late gas-poor formation, but matches photo-evaporation models; 2) the complete lack of secure planet detections inside the gap is a result of homogeneous planet core compositions; and 3) these cores have a terrestrial composition, implying in situ formation rather than planet migration from beyond the ice line. I further explain how asteroseismology has been used to measure orbital eccentricities of small planets. Systems with a single transiting planet have significantly higher eccentricities than flat, multi-planet systems. I relate these findings to obliquity measurements for multi- and single-planet systems, and compare various planet formation and evolution models that can potentially explain this. I conclude with a forward look to the TESS mission.
Venuti, Laura	NPP Fellow, NASA Ames Research Center	A dynamical view of star-disk interaction processes in the Lagoon Nebula with Kepler/K2	High-precision time series photometry provides a unique window into the dynamics of the inner disk regions (< 1 AU) around young stars (< 5-10 Myr). Exquisite surveys carried out with CoRoT and Kepler have revealed a bewildering variety of photometric behaviors that young stars with disks may exhibit. These bear the imprints of variable mass accretion onto the star, of stellar magnetic activity, of rapidly evolving inner disk structures, all filtered through the geometric angle of view to the sources. In this talk, we present a preliminary view of photometric variability for pre-main sequence stars in the Lagoon Nebula cluster (2 Myr). The region was monitored with Kepler during the K2 Campaign 9 for 80 days, which corresponds to a dozen rotation periods for typical disk-bearing stars, a few Myr-old. We implement a well-tested metrics to categorize light curve types based on the degree of (a)periodicity and (a)symmetry of the brightness variations (spotted, quasi-periodic, stochastic, bursters, dippers). We then compare our morphological classification with a number of disk, accretion, and activity indicators to corroborate our physical interpretation of the different variability classes. The Lagoon

			Nebula cluster is comparatively younger, and hosts a comparatively higher-mass population, than many clusters and star-forming regions that have been the target of extensive variability censuses over the past few years. This study is therefore pivotal to understand how the picture of star-disk interaction evolves with age and as a function of stellar mass/spectral type.
Wang, Sharon Xuesong	Carnegie DTM	RVxK2: Using Simultaneous Kepler Photometry to Mitigate Stellar Jitter	Stellar jitter is the current bottleneck for achieving < 1 m/s radial velocity (RV) precision, and the RVxK2 project (rvxk2.com) addresses this issue with simultaneous RV and photometry with the best cadence and precision available today, provided by a suite of ground-based RV instrument and Kepler. We introduce the data that were collected during our program with Kepler/K2 Campaign 16 last winter, which are available upon request and will be made public on our website in the near future. We present our first results on modeling the RV jitter of a subgiant from its stellar oscillation, as observed with Keck/HIRES with a ~5 minutes cadence over the course of 3 hours.
White, Timothy	Australian National University	Testing asteroseismic ages of red giants with the Hyades	The K2 Mission has provided a wonderful opportunity to detect the oscillations of stars in the ecliptic plane. Development of the halo photometry method has enabled this to be extended to the brightest stars, stars that are so bright that the saturation of the CCDs they cause makes traditional aperture photometry impossible. These bright stars are particularly valuable targets as they are most amenable to follow-up observations with complementary techniques. Among the most interesting targets targeted with halo photometry are the four red giants in the Hyades cluster, which were observed in Campaigns 4 and 13. In this talk, I will present our asteroseismic results from the K2 campaigns, as well as precise interferometric radii measured using the CHARA Array. Using these observations as constraints for stellar modelling, we ask the question: do the stellar model ages agree with the age of the Hyades cluster determined from isochrone fitting?
Yu, Jie	The University of Sydney	Ensemble asteroseismology of 20,000 oscillating red giants observed by Kepler	High-accuracy and long-baseline Kepler data provides us with great opportunities to perform ensemble asteroseismology of red giant stars at the phases from the base of red giant branch, helium core burning, through asymptotic giant branch. We compiled a homogeneous catalog of global seismic parameters, masses, and radii for over 16,000 red giants with the frequency of maximum power > 5muHz. Our findings show that both oscillation amplitude and granulation power depend on metallicity and mass, in that metal-rich and higher-mass stars exhibit the larger variation. In addition, we systematically investigated pulsations of 4700 M-type Kepler giants with periods from a few days to over a year. Our results deliver strong evidence to addressing three open questions in M-type giants. (1) Excitation mechanism: semi-regular variables are proved to be stochastically excited as solar-like oscillators, instead of self-excited like Mira variables. (2) Radial order assignment: our collapsed power spectrum for the M-type giants reveals unambiguous ridges and clearly tells radial orders, quantitatively well consistent with theory. (3) Dominant mode: We find l=1 modes are dominant modes, rather than l=0, 2 modes. Our catalog would be useful for performing the Galactic archaeology. The measured pulsation amplitudes and periods for the 4700 M-type giants permit the studies of the pulsation effect on mass loss.
Zhu, Wei	Canadian Institute for Theoretical Astrophysics	Many Kepler planets have distant companions	Kepler has told us the distributions of planets within 1 AU, but what about the region beyond that? In the nebula phase, the outer region dominates the mass and angular momentum budget, and therefore likely it has played a critical role in shaping the distribution and architecture of the close-in planet population. In this talk, I will show that, from RV follow-ups of Kepler systems as well as searches of single transit events in Kepler, majority of the Kepler systems also have outer cold companions, and that the architectures of the inner and outer regions are strongly correlated. This suggests that the formation and evolution of planetary systems is a global behaviour. Information from ongoing and future missions that target for specific separation scales, such as TESS, Gaia, and WFIRST, must therefore be integrated together in a clever way, in order to optimize our understanding of this global process.

Contributed Poster Abstracts

Name	Institution	Title	Abstract
Barclay, Thomas	NASA GSFC / UMBC	Simultaneous, multi-wavelength flare observations of nearby low-mass stars from Earth and space	Low-mass stars are the most common stars in the Galaxy and have been targeted in the tens-of-thousands by K2. The intrinsic magnetic activity of these convective stars is manifested in part by stochastic, short-term brightenings; flares. In addition, these low-mass stars are prime targets to search for and characterize small, Earth-like planets. The magnetic activity driving flares is critical to planetary atmospheres and habitability. High-energy radiation and energetic particle emission associated with activity drive photochemistry, can erode atmospheres, and impact habitability. We are collecting simultaneous, multi-wavelength observations to characterize flares on nearby, low-mass stars. I will present results from our campaign to obtain simultaneous flare observations in the optical, UV, X-ray, and radio of the very nearby late-M dwarf Wolf 359 (CN Leo) using K2, Swift, and ground-based radio observatories. I will also describe our campaign to observe a large sample of low-mass stars with TESS that span a wide range of masses and ages, and our goal of understanding their impact on the potential habitability of exoplanets.
Barna, Tyler	Rutgers University-New Brunswick	The Search for Exoplanets Within the Open Cluster M67 by Means of Image Subtraction Analysis	The K2 mission is based on data from the Kepler Space Telescope, orbiting in a heliocentric orbit above the earth and covering 116 square degrees of the sky. This project uses data from the K2 mission and focuses on the open cluster M67, also known as The King Cobra Cluster. In particular, campaigns 5, 16, and 18 are used. The Kepler Space Telescope and K2 mission provide invaluable data in the search for exoplanets due to the nature of open clusters, like the beehive cluster, where there is a dense multitude of stars that make analysis difficult in most cases. We are able to use an image subtraction photometric analysis method to determine potential sources from the data provided by the K2 mission and determine exoplanet candidacy thereafter.
Beatty, Thomas	University of Arizona	The Curious Case of CWW 89Ab: a Brown Dwarf With a Measured Mass, Radius, and Age	The transiting brown dwarf CWW 89Ab was recently discovered using K2 observations of the open cluster Ruprecht 147. As a cluster member, this makes CWW 89Ab one of two brown dwarfs with an independently measured mass, radius, and age. The brown dwarf is on a relatively long orbit about its host star, and thus has a correspondingly low irradiation temperature -- comparable to the predicted temperature from internal heat. Observations of CWW 89Ab are thus one of the only ways in which we can directly test model predictions of brown dwarfs' mass-radius-luminosity evolution. These evolutionary models underly all estimates for the physical properties of both brown dwarfs and directly imaged planets, and are rarely directly tested using objects with known properties. Using dual-band Spitzer/IRAC eclipse observations of CWW 89Ab we have measured the luminosity and color of CWW 89Ab's dayside, and we find that they are both significantly discrepant from predictions from evolutionary models and from models of irradiated brown dwarf atmospheres. This overluminosity cannot be explained by either an inaccurate age determination, nor additional stellar heating, nor tidal heating. Instead, it is likely that the anomalous luminosity of CWW 89Ab is caused by a dayside temperature inversion -- though a significant error in the evolutionary models is also a possibility. Importantly, a temperature inversion would require a superstellar C/O ratio in CWW 89Ab’s atmosphere. If this is indeed the case, it implies that CWW 89Ab is a 36.5 MJ object that formed via core accretion processes and thus represents the high-mass tail of traditional planet-formation processes. Observations designed to specifically test this scenario are currently underway using Spitzer/IRAC.

Bieryla, Allyson	Center for Astrophsyics | Harvard & Smithsonian	Follow-up of K2 Validated Planet Candidates from TFOP-SG1	Using the resources of the TESS Follow-up Observing Program (TFOP) time-series photometry subgroup (SG1), we undertook a project to observe previously published K2 candidate and validated planets while practicing observing techniques that are now being applied to follow-up TESS planet candidates. Our primary scientific goal was to classify the K2 targets as false positives or "SG1 certified" candidate or validated planets using two main strategies. The first method applies to K2 events that are deep enough to be detected (for a given host star brightness) with our ground-based resources. For these cases, SG1 certification required the detection of the transit within the follow-up target star aperture and furthermore that no photometric false positive (FP) scenarios exist within the follow-up aperture. The second method applies transit events that are too shallow to be detected using our ground-based telescopes. For these cases, SG1 certification required the elimination of all potential sources of eclipsing binaries (NEBs) down to a delta magnitude that could cause the K2 detection, as well as best efforts to rule out the well known Kepler/K2 column anomaly (Coughlin et al. 2014). We later expanded our project using the Tillinghast Reflector Echelle Spectrograph (TRES) on the 1.5-m telescope at the Fred Lawrence Whipple Observatory (FLWO) to obtain reconnaissance spectra, and when possible, to search for additional false positive scenarios or to attempt to confirm a candidate as a planet. We report the SG1 certified planet candidates and confirmed false positives from this work.
Boisvert, John	UNLV	Radial Velocity Model Comparison Near the 2:1 Degeneracy	We present a state-of-the-art model comparison code that uses modern Bayesian statistics to measure the Bayes factor between two competing models. The Bayes factor is the ratio of the probability of the data given one model to the probability of the data given a competing model. There is a degeneracy in the radial velocity exoplanet signal between a single planet on an eccentric orbit and two planets with a period ratio of 2:1. Our code constrains the rate of mischaracterization by analyzing a sample of sixty non-transiting systems orbiting main sequence stars from the NASA Exoplanet Archive. We find that fifteen systems (25% of our sample) show compelling evidence for the two-planet case with a confidence level of 95%. This implies that there could be hundreds of missing planets in the entire archive. The Automated Planet Finder obtained additional data for seven of the best candidates. Our pipeline finds that six systems continue to show strong evidence for the two-planet case. We show an observational strategy that breaks the 2:1 degeneracy by using two thousand synthetically generated sixteen-year timeseries. They are comprised of a thousand single planet systems with eccentric orbits and a thousand two planet systems with circular orbits. Each system starts with an initial ten years of data, but the remaining six years are different depending on the observational strategy. We find that focusing on taking observations at phases when the degeneracy is at its weakest decreases the ambiguity between the models more than simply taking observations at random phases. We also explore three data gathering schemes. This method may be useful for planning efficient observational campaigns aiming to identify the architecture of the system with a higher level of confidence.

Bryson, Steve	NASA Ames Research Center	Bayesian Computation of Kepler DR25 Vetting Completeness and Reliability	Exoplanet occurrence rates based on Kepler's final exoplanet catalog (DR25) are of great interest to the exoplanet community. Several occurrence rates have been published in the literature with widely varying results, particularly for long-period, small planets at the Kepler detection limit. Previous occurrence rate computations have typically accounted for detection completeness (the fraction of true planets that are detected), but to date few have taken full advantage of the DR25 products to compute vetting completeness (the fraction of detected true planets that are vetted as planet candidates) or reliability (the fraction of planet candidates that are true planets). The DR25 release includes several data products that support the computation of vetting completeness and reliability, including synthetic transit injection to provide a population of "true" planets, and scrambled and inverted data to provide a known population that mimics false positives. Using these products to compute vetting completeness and reliability is challenging, presenting issues of small statistics and sensitivity to data gridding. We present a new Bayesian approach to computing both vetting completeness and reliability. This approach is based on casting both problems as binomial point processes with selection probabilities that depend on several parameters, fitted via MCMC to appropriate DR25 synthetic data. We find that this approach can detect small signals, and is robust against small statistics and data gridding. We discover that there is a significant dependence of a planet candidate's reliability on where that candidate falls on the focal plane due to instrumental systematics. We briefly discuss how our results are used in an occurrence rate calculation.
Buzasi, Derek	Florida Gulf Coast University	An Unprecedented Asteroseismic Data Set for the Oscillating Massive Star Spica	Spica (Alpha Vir) is an eccentric double-lined spectroscopic massive binary system (P = 4.0145 d) which shows ellipsoidal variability, and whose more-evolved primary is an oscillating Beta Cep star with a primary radial oscillation period of approximately 5.75 days. As one of the brighest stars in the sky (V = 0.97), Spica is an ideal laboratory for the study of the structure and evolution of massive stars. We have collected 14 years of space-based high-precision photometry on Spica from WIRE (2005), MOST (2007), and K2 (Campaign 6 in 2015 and Campaign 17 in 2018). The data from each experiment are of roughly comparable quantity, and span a total of 194 days. Spectroscopic binary stars allow determination of precise dynamical masses for the components, and the addition of asteroseismic data permits further refinement of these and other parameters. Previous analysis of the MOST data (Tkachenko et al. 2016) has revealed the presence of two photometric modes not previously detected, and ground-based spectroscopy hints at the presence of several more. We will make use of our uniquely extensive temporal baseline to search for new oscillation frequencies and to explore the stability of this system over time.
Carmichael, Theron	Harvard University	Exploring the Brown Dwarf Desert: Short-period substellar companions from the Kepler and K2 missions	The brown dwarf desert describes the lack of observed brown dwarfs orbiting in short periods (less than on the order of 30 days) around main sequence stars. Using data from the Kepler spacecraft, we have found two new short-period companions to main sequence stars. The light curves from the Kepler and K2 missions indicate Jupiter-sized, short-period companions that were followed up with radial velocity measurements using the Tillinghast Reflector Echelle Spectrograph (TRES) in 2014 and 2018. In addition to the spectra and light curves, we use parallaxes from the Gaia mission to more precisely model the parameters of the host star. The first new object is a low-mass star of approximately 90 Jupiter masses orbiting a solar twin. The second object is a brown dwarf of approximately 50 Jupiter masses orbiting a late F-type star. Both of these stellar companions have 5 day periods and are eccentric. The brown dwarf is interesting as it occupies the sparsest region of the brown dwarf desert. The low-mass star is right on the mass boundary separating brown dwarfs from stars. Also shown is another previously discovered brown dwarf that orbits a star in a well-studied cluster.
Carpenter, Kenneth	NASA GSFC	HST's Evolving Role in the Study of Exoplanets	K. Carpenter, T. Barclay, G. Barentsen, P. Boyd, K. Colon, Jessie Dotson, C. Hedges, E. Quintana, and J. Wiseman Ever since the Hubble Space Telescope's pioneering spectroscopy of an exoplanet atmosphere nearly two decades ago, the telescope's role in the study of exoplanets has

			been expanding in scope and sophistication. In the early years, observing programs concentrated on simple studies or confirmation of new exoplanets, and included one of the first direct images of a possible exoplanet. Later it became possible to more thoroughly examine the atmospheres of select planets and assess the “layer-cake” structure of such, and to look for a wider range of specific elements or molecules, including helium, water, and even an organic molecule, methane. As searches expanded, a case of a star consuming an exoplanet was found, and recent observations even show evidence for a moon around an exoplanet (an “exo-moon”)! HST has also measured the mass of the oldest known exoplanet, found a planet orbiting a binary star, and indirectly detected planets by the perturbations they make in stellar disks and by the shadows they cast on those disks. More recently, Hubble has used microlensing to search for planets and to confirm planets found by other microlensing studies. With the launch of TESS, there should be innumerable candidates, covering a wide variety of planetary types and environments, for Hubble observations. The Hubble Space Telescope is now being used in innovative ways to harness the fullest understanding possible of the nature of newly detected exoplanets. Future missions will provide exciting opportunities to complement and build upon Hubble’s unique observational capabilities, which are anticipated to be powerful and available well into the 2020’s.
Ceja, Alma	University of California, Riverside	The Search for Extraterrestrial Life: An Astro-ecological Modeling Approach for Characterizing Exoplanet Habitability	The field of astrobiology aims to determine whether life exists elsewhere in the Universe. A necessary first step in this endeavor is investigating the habitability of known exoplanets. We define the habitability of an exoplanet by its potential to sustain life. Here, an integrative approach is applied to explore the relationship between alien environments and terrestrial life. A probabilistic astro-ecology model is implemented in which the survivability of an organism is determined by its thermal response to local and global exoplanet temperatures. Exoplanet thermal environments are simulated using the climate model, Resolving Orbital and Climate Keys of Earth and Exoplanet Environments (ROCKE-3D). ROCKE-3D is a fully-coupled 3-dimensional oceanic-atmospheric general circulation model (GCM, NASA-Goddard Institute for Space Studies). The GCM features interactive atmospheric chemistry, aerosols, the carbon cycle, vegetation, and other tracers, as well as the standard ocean, sea ice, and land surface components. It has been used to model Earth, Mars, ancient Venus, and the exoplanet Proxima Centauri b. The GCM output is coupled in the astro-ecology model with empirically-derived thermal performance curves of 1,627 cell strains representing extremophiles from all six Kingdoms, termed the biokinetic spectrum for temperature (Corkrey et al. 2016). The spectrum arises from a meta-analysis of cellular growth rate as a function of temperature. This work quantifies aspects of exoplanet habitability using terrestrial-based thermophysiology. Life, however, is dependent upon multiple variables including the presence of liquid water, nutrient content, and an energy source. Caveats of the methodology and application of our results are discussed with implications for extraterrestrial evolution. These results can be further applied to target selection for future missions designed for detecting biosignatures.

Chang, Heon-Young	Kyungpook National University	On Width of Power Excess and Evolutionary Status	Ki-Beom Kim1, 2, Heon-Young Chang1, 2 1 Department of Astronomy and Atmospheric Sciences, Kyungpook National University, Daegu, Korea 2 Research and Training Team for Future Creative Astrophysicists and Cosmologists (BK21 Plus Program), Kyungpook National University, Daegu, Korea With long time series of high-precision photometric data observed by Kepler and CoRoT Missions, we characterize oscillations in solar-like stars which provide information on the internal structure and evolutionary status of stars. We have reexamined asteroseismic scaling relations for the Gaussian width of the mode envelope (δv_env) in terms of the frequency maximum power (v_max), the large frequency separation (∆v). For the current investigation we have analyzed Kepler short-cadence data of 129 stars, including evolved stars and Main Sequence stars, extracted from KASOC Wg1 data. We have demonstrated that the δv_env-v_max and δv_env-∆v relations have a different slope in the power-law at v_max ≈ 1000μHz and ∆v ≈ 60μHz, respectively. We have also investigated relation between δv_env and stellar evolutionary status with the distribution of δv_env in the seismic H-R diagram. We have repeated our analysis using a few background models due to granulations with different scales and compared for the statistical tests. We conclude by briefly discussing implications of our findings on the stellar structure and evolutionary status.
Childs, Anna	University of Nevada, Las Vegas	The Importance of High Resolution Collision Models in N-body Studies	As numerical studies are becoming more popular and computational power is growing, it is important to continually increase the resolution of the models used in these studies. N-body models are commonly used to study planet formation, but majority of them use simple collision models. In 2016, John Chambers implemented a “fragmentation code” into his N-body integrator Mercury. This collision model was the first of its kind in N-body studies as it expanded collisional outcomes from elastic or inelastic to more dynamic outcomes such as fragmentation. Since Chambers’ fragmentation code there have been no other updates in collision models used in N-body studies, until now. We have developed a fragmentation code for the popular N-body integrator REBOUND using the analytic prescription for collision outcomes as described by Leinhardt & Stewart (2011). Here we analyze and compare the results of our collision model to previous models. We find that high resolution collision models are important when modeling the bulk composition of the planet. Constraints on planet composition may hold implications for atmospheric models which can be tested with spectroscopy measurements of exoplanet atmospheres from the upcoming James Webb Space Telescope.
Clarke, Bruce	SETI	Dynamic Black-Level Correction and Artifact Flagging in the Kepler/K2 Pipeline	Instrument-induced artifacts in the raw Kepler/K2 pixel data include time-varying crosstalk from the fine guidance sensor (FGS) clock signals, manifestations of drifting moiré pattern as locally correlated non-stationary noise and rolling bands in the images which find their way into the calibrated pixel time series and ultimately into the calibrated target flux time series. Using a combination of raw science pixel data, full frame images, reverse-clocked pixel data and ancillary temperature data the Kepler/K2 pipeline models and removes the FGS crosstalk artifacts by dynamically adjusting the black level correction. By examining the residuals to the model fits, the pipeline detects and flags spatial regions and time intervals of strong time-varying black-level (referred to as “rolling bands”) on a per row per cadence basis. These flags are made available to downstream users of the data since the uncorrected rolling band artifacts could complicate processing or lead to misinterpretation of instrument behavior as stellar. We discuss the implementation of this dynamic black correction and artifact flagging (referred to as “Dynablack”) in the Kepler/K2 data pipeline and present results regarding the improvement in calibrated pixels as a result of including FGS corrections in the calibration. We also discuss the effectiveness of the rolling band flagging for downstream users and illustrate with some affected light curves. Funding for the Kepler Mission has been provided by the NASA Science Mission Directorate.

Colon, Knicole	NASA Goddard Space Flight Center	Sharing is Caring: Identification of Targets Observed by both K2 and TESS	Last year, 2018, was momentous for (at least) two reasons. First, the Kepler spacecraft officially ceased operations and retired. Second, its pseudo-successor TESS launched and successfully began science observations. While the missions only overlapped in their operations for a short period of time, the synergy between the two is strong. By virtue of its wide field of view and nearly-all-sky survey, TESS sky coverage dips ever so slightly into fields that were covered by the K2 mission. Here, we present an overview of the variety of targets that have been observed by K2 and have been (or will be) observed by TESS.
Coughlin, Jeffrey	NASA Ames / SETI Institute	The K2 Mission Global Uniform Reprocessing Effort	Since early 2018, the Kepler/K2 mission has been performing a uniform reprocessing of the C0–C14 K2 data using an upgraded version of its data processing pipeline — the same version used for C15 and subsequent campaigns. This includes several new features and improvements, such as more sophisticated pixel-level calibration, better identification of spacecraft pointing, improved cosmic ray correction, and production of short-cadence lightcurves, along with several other minor improvements. This effort should enhance the scientific return of the K2 mission by providing users with a high quality, uniformly processed and documented K2 dataset — examples include exoplanet detection and occurrence rate calculation, galactic archeology and comparison of stellar populations, and supernovae/transient detrending and detection. The newly processed data is made available at the Mikulski Archive for Space Telescopes (https://archive.stsci.edu/k2) as each campaign is reprocessed. See https://keplerscience.arc.nasa.gov/k2-uniform-global-reprocessing-underway.html for details!
Coughlin, Jeffrey	SETI Institute / NASA Ames	Lessons Learned and Fascinating Finds from a Manual Vetting of Conflicted KOIs	Over the course of the Kepler mission, a total of 9,564 Kepler Objects of Interest (KOIs; astrophysical transiting or eclipsing objects) were identified via eight KOI catalogs. Each catalog examined a different initial set of transiting planet search detections, and each catalog utilized a different vetting procedure to distinguish valid planet candidates from false positives --- manual vetting in early catalogs, and fully automated vetting in later catalogs tailored for exoplanet occurrence rate studies. As a result, many KOIs were vetted multiple times, with over 1,400 KOIs having conflicting dispositions, being labeled 'planet candidate' in at least one catalog and 'false positive' in at least one other. An effort was undertaken by the Kepler False Positive Working Group (FPWG) to manually and individually review each of these conflicted KOIs, using the latest Kepler data, diagnostics, and follow-up observations available. In this talk, I will present the findings from this manual FPWG review, which include insights on potential pitfalls in automated vetting, a check on statistical planet validation, and possibly overlooked, scientifically unique planet candidates and variable stars.
Curtis, Jason	Columbia University	K2-231 b: A Sub-Neptune Exoplanet Transiting a Solar Twin in Ruprecht 147	We identify a sub-Neptune exoplanet (Rp = 2.5 Earth radius) transiting a solar twin in the Ruprecht 147 star cluster (2.65 Gyr, 300 pc, [Fe/H] = +0.1 dex). The 81 day light curve for EPIC 219800881 (V = 12.71) from K2 Campaign 7 shows six transits with a period of 13.84 days, a depth of 0.06%, and a duration of 4 hr. Based on our analysis of high-resolution MIKE spectra, broadband optical and NIR photometry, the cluster parallax and interstellar reddening, and isochrone models from PARSEC, Dartmouth, and MIST, we estimate the following properties for the host star: M = 1.01 ± 0.03 solar masses, R = 0.95 ± 0.03 solar radii, and Teff = 5695 ± 50 K. This star appears to be single based on our modeling of the photometry, the low radial velocity (RV) variability measured over nearly 10 yr, and Keck/NIRC2 adaptive optics imaging and aperture-masking interferometry. Applying a probabilistic mass-radius relation, we estimate that the mass of this planet is Mp = 7 +5 -3 Earth masses, which would cause an RV semi-amplitude of K = 2 ± 1 m/s that may be measurable with existing precise RV facilities. After statistically validating this planet with BLENDER, we now designate it K2-231b, making it the second substellar object to be discovered in Ruprecht 147 and the first planet; it joins the small but growing ranks of 23 other planets and three candidates found in open clusters.

Dalba, Paul	UC Riverside	Transit Ephemeris Refinement of Long-period Exoplanets with Substantial TTVs	The four-year baseline of the primary Kepler mission enabled the discovery of transiting exoplanets with orbital periods on the order of hundreds of days. Given the relatively short observational baselines of current and upcoming transit surveys, the Kepler exoplanets will remain the best targets for long-period transit investigations (including transmission spectroscopy of cold atmospheres) into the foreseeable future. However, some of Kepler's long-period exoplanets are plagued by imprecise transit ephemerides due to significant transit timing variations (TTVs). These exoplanets require transit recovery observations, which are often high-risk-high-reward endeavors, to avoid being lost in their orbits. I will present observations from a ground-based transit recovery effort at multiple observatories spanning 150 degrees of longitude across the Earth. The target was a potential Saturn-size exoplanet orbiting KIC 9413313 with a 440-day orbital period. The Kepler observations of KIC 9413313 show a 30-hour TTV, which prevented the Kepler pipeline from classifying this object as an exoplanet candidate. The Kepler transit light curves also exhibit curious bumps that are consistent with starspot crossings or exomoon mutual eclipses. The observations to recover a transit of this object span more than 3.2 days in an attempt to account for the uncertainty in the transit ephemeris. Still, the full data set of 2,900 photometric exposures yields a non-detection of the transit of the potential exoplanet orbiting KIC 9413313. I will quantify the confidence in this non-detection as well as the constraints that the data place on the system's orbital ephemeris. This effort demonstrates that processing and follow-up of Kepler's longest-period exoplanets and candidates is not yet complete. It also highlights the importance of transit ephemeris refinement for the longer-period exoplanets to be discovered by TESS.
David, Trevor	NASA JPL	Age Determination in Upper Scorpius with Eclipsing Binaries	The Upper Scorpius OB association is the nearest region of recent massive star formation and thus an important benchmark for investigations concerning stellar evolution and planet formation timescales. We present nine EBs in Upper Scorpius, three of which are newly reported here and all of which were discovered from K2 photometry. Joint fitting of the eclipse photometry and radial velocities from newly acquired Keck-I/HIRES spectra yields precise masses and radii for those systems that are spectroscopically double-lined. The binary orbital periods in our sample range from 0.6-100 days, with total masses ranging from 0.2-8 solar masses. At least 33% of the EBs reside in hierarchical multiples, including two triples and one quadruple. We use these EBs to develop an empirical mass-radius relation for pre-main-sequence stars, and to evaluate the predictions of widely-used stellar evolutionary models. We report evidence for an age of 5-7 Myr which is self-consistent in the mass range of 0.3-5 solar masses. and based on the fundamentally-determined masses and radii of eclipsing binaries (EBs). Evolutionary models including the effects of magnetic fields imply an age of 9-10 Myr. Our results are consistent with previous studies that indicate many models systematically underestimate the masses of low-mass stars by 20-60% based on H-R diagram analyses. We also consider the dynamical states of several binaries and compare with expectations from tidal dissipation theories. Finally, we identify RIK 72 b as a long-period transiting brown dwarf (M = 56.1 +/- 7.7 Jupiter masses, R = 3.06 +/- 0.32 Jupiter radii, P ~ 97.8 days) and an ideal benchmark for brown dwarf cooling models at 5-10 Myr.

Daylan, Tansu	MIT	Recharacterization of previously known exoplanets in multi-sector TESS data	We analyze archival and recently collected Transiting Exoplanet Survey Satellite (TESS) data of previously known exoplanets (e.g., WASP-62b, WASP-100b, WASP-119b, WASP-126b) in the southern continuous viewing zone of the TESS mission. These exoplanets are in the TESS field of view (i.e., camera 4) over many sectors, resulting in more than a hundred observed transits for some of them. By jointly modeling radial velocity and long-baseline photometric data, we update posteriors on their orbital epoch and periods, which allows precise transit time predictions for James Webb Space Telescope (JWST) follow-up. We also probe the systems for companion planets, potential secondary eclipses, transit times variations, orbital decays and phase modulations. The information gain on these exoplanets accomplished by TESS is quantified by comparing the models fitted with and without the TESS data and those previously reported in the literature.
Dhara, Atirath	West Windsor Plainsboro High School South	Using Image Subtraction to Search for Planets in M67	The search for extra-solar planets in dense open clusters has so far proven to be challenging due to the blending of various stellar lights. The use of image subtraction, however, can attenuate some of these concerns. In this poster, I discuss the potential of image subtraction in finding exoplanets in the dense open cluster M67. M67 was chosen in particular because of the number of sun-like stars it contains. In addition, the density of M67 allows the usage image subtraction to produce sharper and more precise light curves of M67's constituent stars, enhancing any previous studies done for this cluster.
Dholakia, Shashank	University of California, Berkeley	Mind the Gap 2: Period Constraints for Long-Period Planets in Overlapping Fields	Photometric datasets with significant spatial overlap present an opportunity to search for planets with longer periods than the baseline of each individual campaign. However, the significant gap in time between the observations presents a challenge to period constraints, ephemerides, and future follow-up for these planets, as often only one transit is observed in each campaign with an unknown number of transits in the gap. As a result, the distributions for period are multimodal, with discrete spikes at integer divisions of the time between the two observed transits. In this contribution we describe a general solution to constrain the period of long-period planets in datasets with large gaps and apply it to 7 planet candidates found in K2's C5, C16 and C18 (see contribution: "Mind the Gap 1: New Constraints for Six Planet Candidate Systems in K2 C5, C16, and C18 data"). We describe the difficulties and benefits of follow up observations in further constraining the period. Lastly, we note the applications of this work to the TESS mission, which also will return to reobserve regions of the sky like K2.
Dholakia, Shishir	University of California Berkeley	Mind the Gap 1: New Constraints for Six Planet Candidate Systems in K2 C5, C16, and C18 data	Due to the shorter, 75-day observation baseline of K2 photometry, most planet discoveries by K2 are restricted to periods shorter than 75 days. However, significant on-sky overlap existed between Campaigns 5, 16, and 18 of K2. We search from a pool of single-transit candidates reported in LaCourse and Jacobs (2018) for additional transits in subsequent campaigns. We find 6 systems in which we observe additional transits, one of which is an apparent multiplanet system with four planets. Because the TESS mission's observing strategy closely parallels these gapped datasets, this work serves as a useful dress rehearsal for period constraints and follow-up of many similar yet-to-be-discovered systems. Also see contribution: "Mind the Gap 2: Period Constraints for Long-Period Planets in Overlapping Fields" for further details on period constraints and applications to follow-up observations.

Eisberg, Joann	Chaffey College	New Astronomy Reviews Special Issue: History of Major Kepler Exoplanet Discoveries	Kepler was a watershed for exoplanet science. The majority of exoplanets currently known, including the vast majority of small exoplanets, are Kepler discoveries. Although Kepler's primary mission was to conduct a statistical census of the exoplanet population, along the way it found dozens of especially novel and interesting types of exoplanets and exoplanet systems, many with characteristics scarcely imagined when Kepler was launched. To mark the tenth anniversary of launch, New Astronomy Reviews is publishing a Virtual Special Issue containing articles that describe the stories behind several of Kepler's major exoplanet "firsts", written by the researchers who led these key discoveries. The styles of the articles are as diverse as the planets whose discoveries are describe, with many focusing on personal stories related to the work done for the discovery papers and others more on updates to our knowledge of these watershed planets and systems. All articles have been refereed by experts in the specific topics of the discoveries and reviewed by a historian of astronomy to ensure high quality and relevance to a diverse audience. Specialists and non-specialists alike will be interested by themes including: detailed insight into the practices of modern astrophysical research, the opportunity and constraints of big data sets and the analysis thereof, the tension between the primary mission of Kepler to conduct a statistical census and the prestige of discovery of individual planets and planetary systems.
Endl, Michael	Univeristy of Texas at Austin	Characterization of the stellar population in the Kepler field with the VIRUS array at the Hobby-Eberly Telescope	Authors: Michael Endl, David Aguado, Karl Gebhardt, Carlos Allende Prieto, William D. Cochran, Matthew Shetrone We present first results of a spectroscopic deep survey of the original Kepler search field. For this purpose we use the VIRUS Integral Field Unit array at the 10 m Hobby-Eberly Telescope (HET) at McDonald Observatory. The goal of our investigation is a detailed characterization of the stellar population in which the ~4500 candidate Kepler planetary systems are embedded. In particular, we aim to determine the fraction of thick- versus thin-disk stars along the line of sight to these systems. We focus on Kepler target stars fainter than V~14.5, which are - so far - poorly covered by other spectroscopic surveys. We present the results of our initial 2017 campaign, where we used 26 VIRUS units in 22 HET visits to the Kepler field. We measure stellar spectroscopic properties (radial velocity, log(g), [Fe/H], and if possible [alpha/Fe]) from our VIRUS spectra. We will use the stellar parameters obtained from spectroscopy, along with the best current photometry and astrometry from Gaia, as priors for a Bayesian inference of the intrinsic stellar properties and of its fundamental underlying stellar population in the Kepler field. This will allow us to establish the Galactic context of the sample of small Kepler planets in the habitable zone of their host stars.
Estrela, Raissa	JPL/Caltech	Two terrestrial planet families with different origins	The important role of stellar irradiation in envelope removal for planets with diameters of $\lessapprox$ 2 R$_{\Earth}$ has been inferred both through theoretical work and the observed bimodal distribution of small planet occurrence as a function of radius. We examined the trends for small planets in the three-dimensional radius-insolation-density space and find that the terrestrial planets divide into two distinct families, one of which merges with terrestrial planets and small bodies in the solar system and is thus Earth-like. The other terrestrial planet family forms a bulk-density continuum with the sub-Neptunes, and is thus likely to be composed of remnant cores produced by photoevaporation. Based on the density-radius relationships, we suggest that both terrestrial families show evidence of density enhancement through collisions. Our findings highlight the important role that both photoevaporation and collisions have in determining the density of small planets.

Feigelson, Eric	Penn State University	AutoRegressive Planet Search: A new statistical approach to exoplanet transit detection	While space-based photometric surveys of normal stars for exoplanet transits have revealed many exoplanets, the effort is limited by non-Gaussian stellar variability typically arising from magnetic activity. Most treatments of this extraneous noise use nonparametric techniques, but we have found that low-dimensional parametric stochastic autoregressive models, widely used in signal processing and econometrics, are often very effective. The AutoRegressive Planet Search (ARPS) analysis of Kepler lightcurves proceeds in three stages: ARIMA or ARFiMA modeling of PDC lightcurves; applying a new Transit Comb Filter to find periodic transits in the model residuals; and identifying exoplanet candidates with a Random Forest machine learning classifier trained to DR25 Gold confirmed planets. Application to the full Kepler mission 4-year data set shows considerable success in recovering confirmed planets, and dozens of new exoplanet candidates are identified, including UltraShort Period planets. The ARPS methodology is also being used for planet discovery in TESS lightcurves, and can be applied to irregularly spaced ground-based transit surveys when the observing cadence is sufficiently dense.
Fetherolf, Tara	University of California Riverside	Stellar Properties of KIC 8736245: A Sub-Synchronous Kepler Eclipsing Binary with a Solar-type Star Leaving the Main Sequence	There exists a well-known discrepancy in the mass--radius relationship of low-mass (<0.8 Solar masses) stars between theory and observations, in that the observed radii and temperatures are often larger and cooler than predicted by several percent. We examine the Kepler eclipsing binary KIC 8736245, a circular, eclipsing binary whose 5.07 day binary period is longer than most low-mass binaries with precise mass and radius estimates. The longer period means the stars are more widely separated, and thus the main suspect for inflating the radii---tidal synchronization and spin-up---is not as important as it is in shorter period systems. Therefore, the radii should not be significantly inflated. By pairing the Kepler light curve with ground-based multicolor photometry from Mount Laguna Observatory and spectroscopy from the Hobby-Eberly Telescope, we are able to constrain the stellar masses to be 0.98 and 0.78 Solar masses and radii to be 1.31 and 0.79 Solar radii. These radii estimates account for the significant systematic noise induced by the 1--3% fluctuations in the light curve caused by starspot activity on the primary star. We find that the primary star is beginning to evolve off the main sequence and the secondary star's radius is consistent with main sequence isochrone models. However, neither star's rotation is synchronous with the orbital period or with each other, a puzzling result given the estimated ~8 Gyr age of the system.
Fleming, Jordan	UC Berkeley	A Refined Transit Measurement for K2 Planetary Candidate EPIC 206061524.01 Orbiting an M Dwarf	EPIC 206061524.01, a planetary candidate from K2 Campaign 3, is a sub-Saturn-sized planet with a radius of $6.92 \pm 0.61\ R_\oplus$ orbiting an M0.7V dwarf. The host star is characterized by infrared spectra from the 3.58 m European Southern Observatory (ESO) New Technology Telescope (NTT), and has a stellar companion 0.43” away as determined from Keck AO imaging. We present new Spitzer/IRAC photometry (GO 11026, PI Werner) and perform a joint fit to the transit data from Spitzer/IRAC and K2 to refine the planet radius, orbital period, and equilibrium temperature. Accurately determining the ephemeris is essential for scheduling efficient follow-up observations with the James Webb Space Telescope (JWST). Atmospheric characterization with JWST would be valuable as sub-Saturns (4.0–8.0 $R_\oplus$) make up a small fraction of all confirmed exoplanets, and there is no representation of these planets in the Solar System. We assess the suitability of EPIC 206061524.01 for future RV measurements--a nontrivial task due to the observed lack of correlation between the mass and size of sub-Saturns.

Fridlund, Malcolm	Leiden Observatory and Chalmers university of Technology	The KESPRINT collaboration	Having its origin in exoplanetary work on the CoRoT and Kepler missions, and with the promise of having access to large amounts of exoplanetary transit data from K2, two groups with the same objectives, were formed independently in 2013.The two teams joined in 2016,as KESPRINT, with the objective to utilize the light curves from the K2 mission in order to identify suitable exoplanetary candidates for follow-up with the resources available (photometry, AO-Imaging, and radial velocity observations) was formed. KESPRINT has members around the world, access to major observatories and instruments and today a large fraction of the exoplanets that have been detected with K2 have been confirmed and characterized by our team. Also, the first exoplanet detected using data from the TESS mission have already been characterized and the results published. The scientific goals of KESPRINT is that after confirmation of exoplanets detected in the light curves of space missions, the planetary parameters should be determined with the highest possible precision. Our first goal have been to study the distribution of planet sizes and orbital properties with the long term objective of connecting this data with general formation processes. In the era of TESS data we now aim as our immediate objective to study the radius gap in planets with sizes smaller than about 4 Earth radii. In this paper we describe the methods and organisation of KESPRINT and give examples of past and current work and how it relates to the next two major space missions providing transit light curves, TESS and PLATO. We put emphasis on the mechanism required to feed the results of the light curve analysis to the sub-teams carrying out the photometry, AO-Imaging, and radial velocity observations, and then to the interpretation groups and finally to the sub-team tasked with documenting the results.
Gaidos, Eric	University of Hawaii	From Building-blocks to Boil-off: Kepler/K2 Observe the Life Cycle of Planets	Kepler and K2 observed almost 2000 square degrees and roughly half a million stars. These included stars and their planetary systems in a wide range of evolutionary states, from pre-main sequence young stellar objects to highly evolved red giants and white dwarfs. We describe cases where continuous and precise photometry from the Kepler/K2 mission, combined with ground-based follow observations, has opened new windows on planet formation and evolution. ``Dippers" are T-Tauri-like disk-hosting low-mass stars with episodic dips in brightness caused by intervening circumstellar dust: although there disks and dips are highly correlated, the physical mechanism is unclear; three different scenarios considered here (dusty vertical structures in the disk, a dusty circumstellar wind and infalling planetesimals) illuminate different aspects of planet formation. The existence of exceptional (older) "dippers" that lack detectable disks (e.g., EPIC 205718330 and 235240266) means that icy planetesimals or "exocomets" do occur; triggered follow-on spectroscopy and multi-bandpass photometry allow us to probe the constituents of these objects that may represent the building blocks (or leftovers) of planet formation. Once planets form and disks dissipate, planets become relatively inaccessible objects, but transiting exoplanet surveys of young clusters, e.g. Zodical Exoplanets in Time will allow us to constrain some aspects of dynamical and atmospheric evolution. Finally, for planets that are very close to their host star or around a star that is rapidly evolving, silicate evaporation and condensation will produce a "tail" that can be probed spectroscopically; here we present a search for planet-associated Na I in spectra of Kepler-1520 and K2-22b. TESS picks up where K2 left off with its all-sky survey, and as an example of promise fulfilled, we present a "dipper" star discovered by this successor mission.

Ganesh, Abhinav	Caltech	Project PANOPTES: Detecting Transiting Exoplanets with a Low-Cost Robotic Observatory	There are multiple methods of detecting planets beyond the solar system, and one of the most prolific in detection yield is the transit method. For the transit method to work the planet/star plane must be aligned with the direction of the Earth, reducing the probability of capturing such a system. Therefore, to most effectively detect planets via the transit method, wide field cameras that monitor 10s of thousands of stars simultaneously are the ideal choice. Project PANOPTES aims to do just this and survey a large portion of the sky by building a functional telescope unit out of cost-effective, off-the-shelf parts. The system exploits high-performance DSLR cameras and an amateur astronomy mount to track the field precisely. The robotic observatory minimizes costs by eliminating the need for a dome: it sits outside and makes use of very basic weatherproofing techniques. The goal of my project was to build a new version of the unit and obtain a transit curve within 10 weeks. We will outline the build process for the PANOPTES unit which included the construction of hardware, electronic circuitry for control and implementation of control software to drive the observatory. Once polar aligned, this unit was able to image target stars and obtain a transit curve for the planet HD189733, despite the light pollution from LA. We will describe the build and how such a unit can play a critical roll in TESS followup studies.
Gonzales, Erica	University of California, Santa Cruz	K2 Candidate Star Companions: Revealing and Confirming Diluting Companions with Adaptive Optics High Resolution Imaging	The K2 mission has excelled at continuing the Kepler legacy by finding and validating hundreds of planets for detailed characterization and population studies. The use of adaptive optics high-resolution imaging (AO HRI) to reveal unresolved diluting companions has been vital to validating the existence of a transiting planet and determining accurate planet properties. Though the planet-hunting torch has been passed down from the Kepler to the Transiting Exoplanet Survey Satellite (TESS) mission, there remains a significant number of extremely high-value K2 candidates that require ground-based follow-up. We focus on candidates from K2 which surveys the ecliptic and allows for an order of magnitude larger sky coverage relative to the Kepler mission and yields detection of planets orbiting brighter and closer stars. Planet radius is determined through Kepler/K2 transit measurements. Previous imaging of Kepler systems has revealed that 40% of candidate hosts are in a multiple star system. AO HRI reveals nearby stars that contribute flux to the photometric aperture and dilute the transit. Knowledge of such objects is crucial to quantifying the likelihood that the signal is due to a planet versus a background or companion star. Moreover, failure to correct for flux dilution results in systematic biases of the planet radii and subsequent mass and bulk density estimates. Our K2 follow-up team has imaged several hundred K2 candidate targets and find the adjusted planet radii is in agreement with previous Kepler studies. In addition, our program has identified ~100 planet candidates lacking AO HRI follow-up to date. We present results from new observations and objectives for further increasing our sample size of K2 candidates with companion stars.
Gosnell, Natalie	Colorado College	K2 M67 legacy field signals spots as cause of sub-subgiant underluminosity	Sub-subgiant stars populate an otherwise-isolated region of the color-magnitude diagram below the subgiant branch, where stars are too faint to be subgiant stars and too cool to be main sequence stars. Found across a variety of open and globular clusters, the existence of sub-subgiants challenges simple stellar evolutionary models. K2 Campaigns 5, 16, and 18 targeted the M67 sub-subgiant S1063, providing 205 days of time series photometry segmented into three continuous windows over 1162 days. We combine the high precision K2 lightcurves with sparse ground-based photometry from ASASSN and Pan-STARRS to construct the photometric variability over the last 4+ years. We find a rotation period of 23.5 days, with significant harmonic structure at ~12 days. We attribute the lightcurve structure to starspot modulation, further supported by the presence of chromospheric and coronal activity indicators. The ~10% peak-to-valley photometric variation requires a longitudinal asymmetry in the starspot distribution, with starspot coverage differing by at least 10% between the two projected hemispheres. We assess the total coverage fraction by direct detection of starspot emission in high spectral resolution (R=45000), high bandwidth (H- and K-band) near-infrared echelle spectra from IGRINS. These results are consistent with predictions that sub-subgiants are magnetically active subgiants that appear underluminous due to the starspots inhibiting

			convective energy transport. We predict future observations of sub-subgiants will share similar spot characteristics, resolving their historically anomalous position in the HR diagram.
Gratia, Pierre	Northwestern University	Eccentricities and the Stability of Closely-Spaced Five-Planet Systems	We report on the stability of planetary systems containing five closely spaced identical, Earth mass planets. We reproduce the log-linear relationship of Obertas et al. (2017, Icarus 293, 52) for zero eccentricity systems, before considering nonzero initial eccentricities of exactly one planet, with eccentricities as large as 0.05 being considered. Larger initial eccentricity generally leads to shorter system lifetime for a given initial orbital separation, regardless of which planet is initially on an eccentric orbit, despite the fact that the initial angular momentum deficit is larger when the outermost planet is eccentric. The log-linear relationship is reproduced for all considered eccentricities, and the monotonically increasing log-linear regression lines have decreasing slopes as we consider higher initial eccentricities. Mean motion resonances also tend to destabilize these systems, although the decreases in system lifetimes are not as large as for initially circular orbits. Our results can be used to estimate how near Kepler's closely-spaced multi-planet systems with known planetary parameters are to maximal packing and can provide upper limits to the masses and eccentricities of closely-spaced systems whose planets have not been characterized.
Greklek-McKeon, Michael	University of Maryland, College Park	Revealing the Variability of Naked-Eye Ecliptic Stars with K2 Halo Photometry	Using the technique of halo photometry, we analyze the brightest stars observed by K2 in campaigns 11-14, searching for previously unidentified variability. We correct and detrend the lightcurves, calculate power spectra for each star, and perform frequency analysis to extract the dominant oscillation modes, if any. Of 75 total targets, we discover seven new classical pulsators, 28 new significant pulsation modes for previously known pulsators, and 24 new oscillating red giants. We also find evidence for granulation-like signatures in the power spectra of the classical pulsators in the sample, suggesting a possible thin convective envelope at the outermost layer of these A and B-type stars. Additionally, we inject modeled transits to set constraints on the radii and orbital period of potentially observable exoplanets around the bright K dwarf 36 Ophiuchi, finding typical lower limits of 0.8 RE radius and 40 day period.
Gupta, Akash	UCLA	Understanding the Radius Valley in the Distribution of Small, Close-in Exoplanets: Relevance of Core-Powered Mass-Loss Mechanism	Recent observations have revealed a ‘valley’ in the radius distribution of small, short-period exoplanets. In this talk, I will discuss the effect of a planet's own cooling luminosity on its thermal evolution and atmospheric mass-loss (core-powered mass-loss), and its observational consequences for the radius distribution of small, close-in exoplanets. Using simple analytical descriptions and numerical simulations, we can demonstrate that planetary evolution based on the core-powered mass-loss mechanism alone (i.e., without any photoevaporation) can produce the observed valley in the radius distribution. I will discuss our results which show that we can reproduce the valley's location, shape and slope in planet radius-orbital period parameter space, and the relative magnitudes of the planet occurrence rate above and below the valley. We find that the slope of the valley is, to first order, dictated by the atmospheric mass-loss timescale at the Bondi radius and get an estimate of -0.11 for the slope in a logarithmic planet size-orbital period space. This indirectly attests to the significance of internal compression for planetary cores more massive than Earth. We further find that the location of the valley depends on the core composition and that the observed planet population must have predominantly rocky cores with typical water-ice fractions of less than ~ 20%. Furthermore, we find that the relative magnitude of the planet occurrence rate above and below the valley is sensitive to the details of the planet-mass distribution but that the location of the valley is not. It is likely that both core-powered mass-loss and photoevaporation have been active in sculpting the radius valley observed today but more work needs to be done to understand their individual contributions.

Hamann, Aaron	University of Chicago	K2-146: Discovery of Planet c, Masses from Transit Timing, and Observed Precession	K2-146 is a mid-M dwarf observed in Campaign 5, 16, and 18 of the K2 mission. In Campaign 5 data, a planet was discovered with an orbital period of 2.6 days and large transit timing variations due to an unknown perturber. Here we analyze new data from Campaigns 16 and 18, detecting the transits of planet c, a planet with an orbital period of 4.0 days, lying in a 3:2 resonance with planet b. Large, anti-correlated timing of the two planets is measured due to the resonance. The planets have a mutual inclination which torqued planet c more closely into our line-of-sight. The planet was grazing in campaign 5 and thus missed in previous searches; in Campaigns 16 and 18 it is fully transiting and its transit depth is three times larger. We improve the stellar properties using data from Gaia DR2, finding the two planets are sub-Neptunes: their masses are 5.5 and 7.1 $M_\oplus$ and their radii are 2.0 and 2.2 $R_\oplus$, respectively. We discuss possible compositions and evolutionary histories of these planets.
Hasegawa, Yasuhiro	JPL/Caltech	Core accretion and the composition of exoplanets observed by the Kepler telescope	The advent of Kepler space telescope has revolutionized exoplanetary science twofold. The first one is a statistical confirmation that super-Earths with 1 to 4 Earth radii are ubiquitous in the galaxy. The second one is a shit in exoplanetary science from the discovery stage to the stage of characterization. Indeed, better measurements of mass and radius of exoplanets enable estimation of the bulk density in exoplanets. In this presentation, we discuss how core formation and subsequent gas and solid accretion determine the mass budget of heavy elements in observed exoplanets. Making use of the existing semi-analytical formulae of accretion rates of pebbles, planetesimals, and gas, our analysis shows the followings: 1) Gas accretion begins with planetary cores that are about 4 Earth masses. In other words, planets with these masses or lower can be regarded as rocky (super-)Earths. 2) Planets with 100 Earth masses or larger are gas giant planets. While their masses are controlled by gas accretion, their heavy-element masses are determined by planetesimal accretion at their final formation stage. 3) Planets with the mass in between these two values are viewed as mini-gas giants. The presence of these planets are currently most mystery and needs more investigations. Finally, we discuss the relation between the total heavy element in planets and their atmospheric metallicity. Our findings are broadly consistent with those of previous studies, yet we explicitly demonstrate how planetesimal dynamics and its spatial distribution around planets are crucial for better understanding the composition of observed exoplanets.
Howell, Steve	NASA Ames Research Center	Speckle Interferometric Time-Series Transit Observations of Kepler-13	Steve B. Howell, Nic Scott, Rachel Matson (ARC), Elliott Horch (SCSU), Andrew Stephens (Gemini Observatory) Kepler-13b (KOI-13) is a large, short-period Hot Jupiter orbiting one star of a close binary pair. The binarity of this Kepler exoplanet host star was initially discovered by our speckle observations in 2010. Since then, this bright host star pair has been studied by a few groups aiming to understand the system and determine which star the planet orbits. Literature values for the stellar and planet parameters span a wide-range as the close binary is blended in most observations, causing uncertainties and confusion as to the accurate properties of the host stars and the transit depth itself. Values listed for the primary star and Kepler-13b radii, for example, span nearly a factor of two. Using our high-resolution speckle interferometric instrument ‘Alopeke on Gemini-North, we observed Kepler-13 for four hours during transit, collecting simultaneous 60 sec observations in 562nm and 832nm resulting in over 300 GB of data. Our observations clearly show that the primary star hosts the planet, the unblended transit is deeper than that observed by Kepler (as expected) and we derive new, more accurate values for the bodies within this exoplanet system.

Huang, Chenliang	University of Nevada, Las Vegas	Revisiting the mass-radius relation of super Earth with new ice EOS measurement	The interior structure of an exoplanet, which may play an important role in determining its habitability, can be roughly constrained by comparing its mass and radius to planet models. In a broadly adopted planet model, Zeng et al. 2016 derived the mass-radius relation of terrestrial planets by considering a differentiated, two-layer planet model. We collaborate with the high-pressure physics group at UNLV, who significantly improved the measurement accuracy of the phase diagram and equation of state (EOS) of water ice under pressures up to 88~GPa using the laser heating and quenching techniques. They show that the phase transition from a newly identified ice-VII$_{\text{t}}$ to ice-X occurs just above 30~GPa and that the bulk modulus of ice-X is much larger than previously believed. In this work, we discuss the impact of these new measurements of ice on the planetary mass-radius relation and interior structure, esp. those with substantial water content, compared to the results presented in Zeng et al. 2016. The higher bulk modulus of ice-X produces larger planets for a given mass, thereby either reducing the atmospheric contribution to the volume of many exoplanets or limiting their water content. The change in planet mass-radius relation caused by the systematic differences between previous and new EOS measurements are comparable to observational uncertainties in planet sizes for several systems.
Isaak, Kate	ESTEC	The ESA CHEOPS Guest Observers Programme	CHEOPS (CHaracterising ExOPlanet Satellite) is the first exoplanet mission dedicated to the search for transits of exoplanets by means of ultrahigh precision photometry of bright stars already known to host planets. It is the first S-class mission in ESA’s Cosmic Vision 2015-2025. The mission is a partnership between Switzerland and ESA’s science programme, with important contributions from 10 other member states. To launch in 2019, CHEOPS will provide the unique capability of determining accurate radii for a subset of those planets for which the mass has already been estimated from ground-based spectroscopic surveys. It will also provide precise radii for new planets discovered by the next generation of ground- or space-based transit surveys (Neptune-size and smaller). By identifying transiting exoplanets with high potential for in-depth characterization, CHEOPS will also provide prime targets for future instruments suited to the spectroscopic characterization of exoplanetary atmospheres. The high photometric precision of CHEOPS – 20 ppm in 6 hours of integration time for a v-band magnitude 9, G5-type dwarf star and 85 ppm in 3 hours of integration for a v-band magnitude 12, K2-type dwarf star -- will be achieved with a broadband photometer covering the 0.33 - 1.1um waveband, designed around a single frame-transfer CCD which is mounted in the focal plane of a 30 cm equivalent aperture diameter, f/5 on-axis Ritchey-Chretien telescope. 20% of the observing time in the 3.5 year nominal mission will be available to the Community through the Guest Observers Programme that will be run by ESA. The call for proposals for the first year of observing will come out approximately 6 months before launch. In this poster, I give an overview of observing with CHEOPS, with a particular focus on the ESA CHEOPS Guest Observers Programme.
Jontof-Hutter, Daniel	University of the Pacific	Following Up the Kepler Field: Targets for Transit Timing and Atmospheric Characterization	Using post-Gaia stellar parameters, we estimate the minimum expected TTV signal strength of planets in Kepler's multitransiting systems and characterize planets with expected signals. With forward modeling within our posteriors, we determine which planetary mass estimates would benefit substantially from ground-based transit timing, and which planets have large enough atmospheric scale heights to be appropriate candidates for transmission spectroscopy.

Kitiashvili, Irina	NASA Ames Research Center	3D Radiative Hydrodynamics Modeling of Convection of Stars From F to M Types to Probe Their Interiors and Photospheric Properties	Dramatic increase of data flow from Kepler and K2 missions opens opportunity to significantly improve our knowledge of the solar interior and surface dynamics and structure. However, interpretation of observations is challenging task to capture tiny effects that can be done only with advance first-principles modeling. We present results from 3D time-dependent radiative hydrodynamics models of stellar outer convection zones and atmospheres, taking into account chemical composition, radiative transfer, effects of turbulence and magnetic fields and a realistic equation of state, for main-sequence stars of spectral types F-M. We will discuss properties of convection structure and dynamics, convective overshoot, effects of magnetic fields and rotation, as well as potential effects of turbulent surface convection dynamics on high-precision RV measurements.
Kjeldsen, Hans	Stellar Astrophysics Centre, Aarhus University	Accurate measurement of properties for exoplanets that orbit very close to their host stars	Authors: Hans Kjeldsen, Aarhus University, Denmark Mia Sloth Lundkvist, Heidelberg, Germany and Aarhus, Denmark Tim R. Bedding, Sydney University, Australia Global parameters (e.g. mass and radius) for a large number of stars is one of the key measurements for the asteroseismology part of the Kepler and TESS missions. In the present talk we will discuss the techniques that are being used to extract those parameters in a large number of stars observed by different space missions using the p-mode oscillations. The time series analysis is focused on data from Kepler and in the talk we will use those data to discuss how one can run automated pipeline analysis to extract stellar parameters from time series space data for thousands of stars obtained by use of the TESS mission. We will address the implications for studies of exoplanets and stellar evolution based on the rich asteroseismic data set and we will in the present talk especially focus on measurements of accurate properties for exoplanets that allow us to describe the structure and evolution of the hot super-Earths and hot rocky exoplanets. Models for exoplanets that orbit very close to their host stars predict that the strong radiation from the star will result in photoevaporation. This will result in a lack of planets with certain sizes very close to their host stars (e.g., Lopez and Fortney, 2013). The observed distribution of exoplanet sizes as a function of stellar light intensity is discussed in the papers by Lundkvist et al. 2016 and Van Eylen et al. 2018, confirming this important prediction. It is expected that the TESS mission will allow a much improved set of data that will also span a wider range of temperatures and luminosities and the length of the time series for the individual stars in the TESS mission is perfect for studying the hot exoplanets. We will report on the first findings in relation to the newly released TESS data.
Kosovichev, Alexander	New Jersey Institute of Technology	Resolving Power of Asteroseismic Inversion of the Kepler Legacy Sample	The Kepler Asteroseismic Legacy Project provided frequencies, separation ratios, error estimates and covariance matrices for 66 Kepler main sequence targets. Most of the previous analysis of these data was focused on fitting standard stellar models, and inversion for mean structure indicators. I will present results of direct asteroseismic inversions using the method of optimally localized averages, which effectively eliminates the surface effects and attempts to resolve the stellar core structure. The inversions will be presented for various structure properties, including the sound speed, density, and parameter of convective stability, and compared with similar inversions of helioseismology data. Influence of random and systematic errors on the resolving power of asteroseismology data will be discussed.

Kosovichev, Alexander	New Jersey Institute of Technology	What Sets the Magnetic Field Strength and Cycle Period in Solar-Type Stars?	Authors: A. G. Kosovichev, G. Guerrero, B. Zaire, P. K. Smolarkiewicz, E. M. de Gouveia Dal Pino, and N. N. Mansour Observations of stellar magnetism indicate that stars of types F, G and K have magnetic activity similar to that observed in the Sun. Two fundamental properties, the magnetic field strength and the magnetic cycle period, have been determined by observations for a significant number of stars. The field strength exhibits two regimes: 1) for fast rotating stars, the field strength is independent of the Rossby number (Ro), 2) for slow rotation, the field strength decreases with Ro, following a power law. For the cycle period, two regimes, the so-called active and inactive branches, have been identified. We present results of global dynamo simulations, which show that rotational shear layers at the bottom and top boundaries of the convection zone play a fundamental role in these observational properties. The power-law decrease of the field strength in slowly rotating stars is attributed to decrease of the subsurface radial shear with Ro, and to the meridional circulation. In agreement with the observations, the simulations show that the magnetic cycle period increases with the period of rotational. The simulations reveal a bifurcation around Ro~1, which separates the dynamo regimes predominantly operating in the bulk of the convection zone and in the tachocline.
Kostov, Veselin	NASA/SETI Institute	Discovery and Vetting of Exoplanets: Benchmarking K2 Vetting Tools	We have adapted the algorithmic tools developed during the Kepler mission to vet the quality of transit-like signals for use on the K2 mission data. Using the four sets of publicly-available lightcurves on MAST, we produced a uniformly-vetted catalog of transiting planet candidates from K2 listed at the NASA Exoplanet archive in the K2 Table of Candidates. All confirmed planets pass our vetting tests. We identify 60 new false positives, effectively doubling the overall number of astrophysical signals mimicking planetary transits in K2 data. Most of the targets listed as false positives in our catalog either show prominent secondary eclipses, transit depths suggesting a stellar companion instead of a planet, or significant photocenter shifts during transit. We packaged our tools into the open-source, automated vetting pipeline DAVE (Discovery and Vetting of Exoplanets) designed to streamline follow-up efforts by reducing the time and resources wasted observing targets that are likely false positives. DAVE will also be a valuable tool for analyzing planet candidates from NASA's TESS mission, where several guest-investigator programs will provide independent lightcurve sets—and likely many more from the community.
Li, Min	University of Nevada, Las Vegas	Disk evolution and chemical compositions in the rocky planets/planetesimals	Partial condensation of the Solar nebula is thought to be responsible for the diverse chemical compositions in the rocky planets/planetesimals in the inner Solar system. Here we present a forward physical-chemical model to study the chemical evolution of a protoplanetary disk, and the chemical compositions of possible planetesimals that may form. We model the evolution of protoplanetary disks and the condensation of the dust within those disks. To calculated the condensation, we minimize the Gibbs free energy of the materials at each radius in the evolving disk. We show that the chemical compositions in the condensed materials change with time and radius. The final trends of compositions of planetesimals with 50% condensation temperature are consistent with that of CM, CO, and CV chondrites. We expect to put some constraints on the chemical compositions of some rocky exoplanets. The results can also explain the chemical compositions of some of the terrestrial planets in the solar system.

Lisse, Carey	Johns Hopkins University Applied Physics Lab	Know Thy Star, Know Thy Planet: NIR Spectral Measurements of Primary Star Atomic Abundances in Kepler THZ Planet Systems	Since 2010 we have conducted a 100+ hr, NIR exosystem spectral survey using the SpeX spectrometer at NASA's 3m Infrared Telescope Facility (IRTF) on Mauna Kea, the Northern Hemisphere's only large wavelength grasp NIR spectrometer. Originally started to take advantage of the 1% precision, R ~ 2000, 0.8-5.0 um broad wavelength grasp of the to study debris disks, the Near InfraRed Disk Survey (NIRDS) has now observed 70+ exosystems in over 100+ hours (Lisse+2012, 2015, 2017a,b). In 2017 – 2018 we observed the absorption lines of 15 Kepler host stars selected by Kane+ (2016) as most likely to harbor habitable Earth-like planets; 3 more K2 are to be observed in Spring 2019. Five of the stars show unusual Fe/Si vs Mg/Si atomic abundance ratios, suggesting their Earth-like planets might have very different sized cores and mantles than our own. Another two have a very low C/Si ratio, suggesting that organic material needed for life might be rare on any terrestrial planets in its system. Five of the Kepler stars need to have their stellar types updated in the literature, critical for obtaining accurate planetary sizes and insolation fluxes. As a check, we performed the same study on 18 bright nearby G-star planet-hosting systems in our survey database (+ TRAPPIST-1), and found a similar occurrence rate of unusual abundances and improper stellar characterizations. In this paper, we describe these results, and how we are working with the ASU NEXSS RCAN team to supply 10 line elemental abundance estimates (Mg, Si, Fe, Ca, Al, Na, ..) for the NIRDS stars plus the 200 stars of the IRTF/SpeX library to the HYPATIA Catalogue of Hinkel+ 2014.
Littlefield, Colin	University of Notre Dame	Short-cadence K2 observations of an accretion-state transition in Tau 4, the first polar observed by Kepler	We present the 81-day, short-cadence K2 light curve of Tau 4 (RX J0502.8+1624), the first AM Herculis cataclysmic variable star to be observed by the Kepler spacecraft. The light curve covers a serendipitous jump from a low-accretion state into a high state, and the one-minute cadence of the observations provides exquisite insight into the evolution of the orbital light curve throughout this transition. During the first 71 days of the K2 campaign, the light curve consisted primarily of a 0.2-mag, double-peaked orbital waveform that lacked any sign of significant mass transfer, and we consider the possibility that this modulation was the result of localized hotspots on the WD from a previous episode of accretion. However, in the final 10 days, unmistakable signs of enhanced accretion began to emerge, with a very strong (1.7 mag) cyclotron-beaming component appearing for 70% of the 1.59-hour binary orbit. Before the onset of the high state, the system gradually increased in brightness by 0.1 mag over the course of ~20 days with no concomitant changes to the orbital waveform. We compare these observations with theories about the nature of low states in cataclysmic variable stars.

Mathur, Savita	Instituto de Astrofisica de Canarias	On understanding the non detection of acoustic modes in solar-like stars observed by Kepler	More than 2,000 stars were observed in short cadence for one month, during the survey phase of the Kepler mission. The asteroseismic analysis of those stars led to the detection of solar-like oscillations in only about 540 stars (Chaplin et al. 2011a). Chaplin et al. (2011b) explained the lack of detection in most of the other stars as a consequence of their high surface magnetic activity. However the sample of stars studied was polluted with many classical pulsators and red giants. In this work we re-visit the analysis done on those stars after cleaning the sample from stars with newly detected oscillations (solar-like pulsators, red giants or classical pulsators) based on the latest DR25 lightcurves. Then, we re-analysed the remaining main-sequence solar-like stars in terms of rotation and magnetic activity. We measure the rotation periods using the methods described by Garcia et al. (2014) that uses a time-frequency analysis (with the wavelets) and the auto-correlation function. By doing so, we retrieve the most reliable rotation periods. The magnetic activity level is assessed through the Spa, which is the magnetic activity proxy based on photometric data (Mathur et al. 2014). While close to half of this sample has an Sph value larger than the one of the Sun, we find that a large fraction of stars without oscillations detected have a low magnetic activity level, which was unexpected. We also investigate on the origin of these missing detections using new spectroscopic observations of those stars (in particular in terms of metallicity and chromospheric activity). An upper limit of Sph is also inferred as a limit above which no pulsations were detected. Understanding the non detection of solar-like oscillations is key to predict the yield of solar-like pulsating stars for missions such as TESS and PLATO where the detection of solar-like oscillations will allow us to better characterize the stars, in particular the ones hosting planets.
Mayo, Andrew	UC Berkeley	Measuring the Masses of Long-Period Planets Kepler-538 b and Kepler-37 d	Although many thousands of exoplanets have now been detected and characterized, observational biases have led to a paucity of long-period exoplanets and a corresponding gap in our understanding of these planets. We report the mass estimation and characterization of two long-period planets in the Kepler-538 and Kepler-37 systems. Kepler-538 is a 0.96 solar mass star hosting one known, transiting planet, Kepler-538 b, with a period of 81.7 days. Kepler-37 is a 0.87 solar mass star hosting four known, transiting planets with periods of 13.4, 21.3, 39.8, and 51.2 days. The 39.8 day planet, Kepler-37 d, is the only planet in the system massive enough to induce a detectable Doppler shift. For both Kepler-538 b and Kepler-37 d, we analyze radial velocity observations using a Gaussian process with a quasi-periodic kernel to characterize stellar activity. We relate our analysis of these planets to what is known about the broader population of long-period planets and discuss the implications of future ultra high-precision spectrographs and more sophisticated modeling techniques on questions concerning long-period planets.
Mighell, Kenneth	SETI Institute / NASA Ames	Kepler K2 Cadence Events: A Data Visualization and Manipulation Tool to Improve the Scientific Return of Light Curve Files and Target Pixel Files from the Kepler, K2 and TESS Missions	Since early 2018, the Kepler/K2 project has been performing a uniform global reprocessing of data from K2 Campaign 0--14. Subsequent K2 campaigns (C15-C19) are being processed using the same processing pipeline. One of the major benefits of the reprocessing effort is that, for the first time, short-cadence (1-min) light curves of K2 targets are produced by the project pipeline in addition to the standard long-cadence (30-min) light curves. Users have been cautioned that the Kepler pipeline detrending module (PDC), developed for use on original Kepler data, has not been tailored for use on short-cadence K2 observations. Systematics due to events on fast timescales, such as thruster firings, are sometimes poorly corrected for many short-cadence targets. A Python data visualization and anipulation tool, called Kepler K2 Cadence Events, is presented that identifies and removes cadences associated with these often problematic thruster events, thus producing cleaner light curves. The enhanced scientific return due to these cleaner short-cadence K2 observations is demonstrated with the analysis of short-cadence targets: the exoplanet K2-99b and EPIC-206003187, an ab-type RR Lyrae star exhibiting the Blazhko effect. Kepler K2 Cadence Events can be used to visualize and manipulate light curve files and target pixel files from the Kepler, K2, and TESS missions. We anticipate this software will be available from http://code.nasa.gov.

Mocnik, Teo	UC Riverside	K2's Short-cadence View of Transiting Exoplanets	In this poster I will present the highlights from analyzing the majority of transiting exoplanet systems observed by the K2 in the 1-min short-cadence mode within the first 14 regular observing campaigns. I detected starspot occultation events in two aligned and one misaligned planetary system and proved that detecting starspot occultation events is possible in the K2 data. I also detected optical phase-curve modulations in two systems, rotational modulations in four and γ Doradus pulsations in one planetary system. I refined the system parameters for all 10 short-cadence targets and used non-detections to provide tight upper limits. In addition, during my PhD I discovered a hot Jupiter using the long-cadence K2 data and refined the ephemeris with the WASP data of another K2-discovered planet.
Montgomery, Michele	UCF	Algols and Other EBs in Kepler & K2 - Revised and New Data	Authors: M.M. Montgomery,* R. Olenick**, J. Lacomb*, W. Bennett**, S. Garza**, C. Hassan**, P. Hedlesky**, G. Milton**, R. Ahmed**, A. Thompson**, N. Smith** * University of Central Florida **University of Dallas We performed an extensive search of the entire Kepler and K2 archives to find the eclipsing binary systems known as Algols. In this work we present light curves, periodograms, and folded light curves for several of these systems, including those from our own proposed Campaigns. For already published systems, we checked existing data such as orbital periods and we present updated values in this work. For newly observed systems, we provide new observational parameters. In our quest, we also found several other eclipsing binaries (EBs) and we present some of these results as well.
Namekata, Kosuke	Kyoto University	Lifetimes and Emerging/Decay Rates of Star Spots on Solar-type Stars Estimated by Kepler Data in Comparison with Those of Sunspots	Recently, many superflares on solar-type stars were discovered by the Kepler Space Telescope (Maehara et al. 2012). Such active stars are thought to have large star spots (Notsu et al. 2013). The emerging and decay process of such large star spots are not well understood, but important for the understanding of superflare events as well as underlying stellar dynamo. In this study, we have developed a simple method to measure temporal evolutions of star spots area with Kepler data by tracing local minima of the light curves (c.f. Hall & Henry 1994). In the analysis, a time-phase diagram (i.e. O-C diagram) of the local minima enables us to identify a temporal evolution of a single star spot group. We applied this method to a huge amount of active solar-type stars observed by Kepler, and calculated the lifetimes, emerging rates and decay rates of star spots from the obtained temporal evolution of star spot area. As a result, we found that lifetimes (T) of star spots are typically 10-350 days when spot area (A) is 0.1-2.3 percent of solar hemisphere. We also compared them with sunspots, and found that the lifetimes of star spots are much shorter than those extrapolated from the empirical relation of sunspots ($T \propto A$), while being consistent with other researches on star spots (e.g. Giles et al. 2017). The emerging and decay rates of star spots are surprisingly consistent with, or a little smaller than, those of sunspots, which may indicate the same underlying processes (Namekata et al. submitted)
Olenick, Richard	Universitiy of Dallas	Kepler Observations of the Dwarf Nova EPIC 220615486 (J011613.76+0922 15.9) in Outburst	We present results from long cadence Kepler observations covering 72.5 days in Kepler K2 Campaign 8 of the cataclysmic variables EPIC 220615486 (J011613.76+092215.9). Outburst of the cataclysmic variable is observed with a variation period P = 0.067247 day present which is 2% longer than the observed orbital period P_{orb} = 0.065837 day and indicates the modulations of the disc producing positive superhumps. Characteristics imply that EPIC 220615486 is a new U Gem-type dwarf nova.

Olenick, Richard And Thompson, Alexander	University of Dallas	Evidence of Mass Transfer and Possible Third Body from Photometric Analysis and Modeling of KIC 2708156	Analysis of photometric data for KIC 2708156 (UZ Lyr), an eclipsing Algol-type binary in the Kepler mission field, is carried out using Peranso, PHOEBE, and O-C analysis. Eighteen quarters of short and long cadence Kepler PDCSAP flux with a start date of 2 May 2009 through 11 May 2013 are analyzed. The BJD time of each observable primary minimum (708), its magnitude, and associated magnitude error are obtained from the Peranso analysis from which an O – C curve is constructed. The O-C analysis provides a refinement of the period of 2708156 as 1.8912695(2) days. The parabolic shape of the O – C curves suggests a period change P-dot/P = -1.37 x 10-6 /yr and mass transfer rate of -1.4 x 10-10 MSun/yr as well as a possible third body in the system. The PHOEBE modeling results using the O-C period indicates that KIC 2708156 is a semi-detached binary with a mass ratio q = M2 /M1 = 0.199 in which the secondary star is overfilling its Roche lobe. Keywords: stars--binaries: eclipsing—accretion discs--methods: data analysis
Owen, James	Imperial College London	Insights from the "evaporation valley"	I will discuss the theoretical interpretation of the radius gap in the Kepler planets in terms of photoevaporation of a primordial H/He atmosphere. I will present work on how this can be tied to stellar metallicity to give intriguing new insights into how planets formed, such as terrestrial planet formation is more common at lower metallicity. I will also discuss how the model can be tested by studying planets around later-type stars, where the effects of XUV irradiation are more important at a fixed level of bolometric insolation. Furthermore, I will discuss the unique role multi-planet systems have in testing the photoevaporation model. Finally, by modelling the photoevaporation and evolution of a planetary atmosphere concurrently, this can be used to place constraints on the core mass function and core composition distribution of close-in planets.
Peters, Geraldine	USC	Quadrature Light Variability in Eclipsing Binaries: What 10 Years of Kepler/K2 Observations Have Revealed	The Kepler spacecraft presented an unparalleled opportunity to investigate intrinsic light variability in the component stars of eclipsing binaries. We present our initial conclusions from a long-term study in this poster. Weak flux variability at the quadrature phases has been reported sporadically for binaries of the Algol type since the 1950s, but there has been very little information on its likely cause or whether it is transient, recurrent, or periodic. For the RS CVn systems (that often show Algol-like light curves) such behavior is commonplace and attributed to starspot activity. From the initial Kepler epoch we have characterized both long- and short-term behavior in eclipsing binaries with Algol-type light curves, while K2 observations allowed us to survey many more systems and study short-term variability. The targets are eclipsing binaries with light curve types EA mostly selected from the catalogs of Avvakumova et al.(2013), Malkov et al. (2006), and the General Catalog of Variable Stars (Samus et al. 2017). There are 20 Kepler binaries and 107 unique K2 systems. Five binaries were observed during Campaigns 5, 16, and 18 allowing longer-term variability studies. The periods of most systems are under five days. The Kepler era confirmed that several binaries display unequal brightness at their quadrature phases and the relative brightness varies from > 1 to <1 on a time scale of about 1–2 years. We call these systems L/T (leading hemisphere/trailing hemisphere) variables and the light curve behavior the L/T phenomenon. Both Kepler and K2 photometry have confirmed that short-term L/T variations (even reversals) on the order of a few orbital cycles, are also present. The prototype long-term variable is WX Dra (KIC 10581918, P=1.80d, A8V + K0 IV) with an L/T cycle of 2 years. The K2 database reveals that about 50% of the binaries with Algol light curves show L/T inequality with no preference for L/T < or > 1.0. We also observed delta Scuti-like pulsations in 8 of the Kepler binaries with SC data and in about 10 K2 systems with only LC data. As expected pulsations were generally found in binaries with A-type primaries. Detailed modeling with the Wilson -Devinney program is now underway for many of the Kepler and K2 light curves. The author appreciates support from NASA grants NNX11AC78G, NNX12AE44G, NNX16AE71G, 80NSSC18K0919, and 80NSSC19K0109.

Poleski, Radosław	Ohio State University	Photometry of K2 Bulge Data	The goal of K2 Campaign 9 was to measure the microlensing parallaxes and hence constrain masses and distances of lenses for bulge microlensing events. For the free-floating planet events, the K2 observations were a unique opportunity to constrain the microlensing parallax. However, K2 Campaign 9 observations of Bulge superstamp are arguably the most challenging K2 dataset to reduce. The large stellar density combined with large pixel scale and unstable pointing produces instrumental trends that are in most cases larger than the signal we are interested in. I will present the current status of the K2C9 reduction that uses MCPM method. The method performance on short signals (like free-floating planet events) will be discussed.
Poon, Sanson Tsun Sum	Queen Mary University of London	Formation of Kepler compact multi-systems by dynamical instabilities and giant impacts	The large number of observed Kepler multi-planet systems can provide a template for statistical studies of planetary system formation. In our study we examine whether or not the observed mutual inclinations of the Kepler systems are consistent with a formation scenario in which the planets have undergone dynamical instabilities and giant impacts. The spacings of the planets are typically ~ 20 mutual Hill radii, suggesting that such a scenario is possible. We use a selection of Kepler 5-planet systems to provide templates for generating initial conditions for N-body simulations in which the planets grow through giant impacts, similar to how the final assembly of the terrestrial planets in the Solar System is believed to have occurred. We also examined how varying the accretion algorithm from a simple hit-and-stick prescription to an imperfect accretion prescription (Leinhardt & Stewart 2012) influenced the results. We performed synthetic transit observations of the resulting planetary systems, and compared them to the Kepler systems. In particular, we examined whether or not the relative numbers of 1-, 2-, …, 5-planet transiting systems produced in the simulations agreed with the Kepler data. While the simulations provide a reasonable fit to the observed data, in general the simulations produce planetary systems in which the mutual inclinations are too small, such that the synthetically observed multiplicities are higher than found in the Kepler data. We found that this result was independent of the accretion prescription adopted.
Prsa, Andrej	Villanova University	Detrending Kepler/K2 data using strictly periodic variables	Kepler and K2 data detrending has been at the forefront of data reduction efforts, resulting in numerous schemes and algorithms suited to different types of objects. Some are generic, others specific, and they all come with a set of caveats. While the Kepler team did an outstanding job in tackling this problem generally, some systematic artifacts remain that affect the optimal mining of Kepler data for stellar astrophysics. Here we present a novel algorithm that uses strict periodicity of variable objects to disentangle the recurring astrophysical signal from the time-changing component. No assumptions on the shape or form of the underlying astrophysical signal are made. The result is a detrended signal of the variable object, along with the disentangled trend timeseries. Applying this algorithm to all known strictly periodic variables provides us with an ensemble of trendlines that can be used to detrend light curves of objects that do not exhibit strict variability in their signals. Thus, this detrending method holds major promise for improved data mining. We demonstrate the use of the algorithm on the Kepler catalog of eclipsing binary stars.
Rampalli, Rayna	Columbia University	How Long Do Bees Buzz? Examining Light Curve Evolution For Low-Mass Stars In Praesepe	Preceded by several ground-based survey observations, K2 has observed Praesepe for three campaigns. As a result, we now have light curves spanning nearly a decade for many members of this benchmark open cluster. These data are ideally suited for testing the stability of the rotation periods we have measured for these stars, and thereby investigating starspot evolution in 650-Myr-old G, K, and M stars. We present an initial analysis of period stability across campaigns 5, 16, and 18, along with metrics we are developing for quantifying changes in these light curves.
Ramsay, Gavin	Armagh Observatory	TESS observations of the asynchronous polar CD Ind.	Hakala, P. J., Ramsay, G., Potter, S. B., Buckley, D. A., Wynn, G. A.

Rebull, Luisa	Caltech-IPAC/IRSA	Rotation in Taurus with K2	K2 observed stars in the Taurus star forming region in their Campaign 13 in Spring 2017. At ~2 Myr, many of the stars still have circumstellar disks and/or active accretion, which complicate the light curves. Nonetheless, we are able to derive rotation periods for more than half of the members. We can compare USco with similar stars in Rho Oph (~1 Myr), USco (~20 Myr), the Pleiades (~125 Myr), and Praesepe (~700 Myr), all with K2 light curves.
Rice, David	University of Nevada, Las Vegas	The effect of differentiated collisions on the interiors of terrestrial planets	The densities of observed exoplanets allow for a wide range of bulk compositions. Interior models based on density are dependent on the amount of mass a planet holds in its core. Throughout formation, the core mass fraction of a planetary body evolves as differentiated protoplanets collide. The preferential erosion of mantle material during a collision has been evoked in the solar system to explain Earth's non-chondritic composition and Mercury's interior structure. To track this effect, we employ a differentiation model into N-body integrations with a collisional scheme. The core mass fraction of each body is followed throughout evolution. By making use of new composition tracking and dust condensation codes, our model can be applied to a large variety of planetary systems and constrain the range of terrestrial core mass fractions.
Rivodo Rodriguez, Vanesa	University of Central Florida	Orbital Mechanics Study of Kepler/K2 System Formations	In this work, we present an orbital mechanics study of selected multi-body K2/Kepler systems that indicate not likely formation scenarios. In this study, we use a custom vpython code that permutates possible formation scenarios, assuming no a priori order of formation. The number of possible combinations are determined by n factorial, where n is the number of planets in the system. Outcomes that are considered non-formations are those that result in ejection from the system or collision with other objects in the system.
Rogers, James	Imperial College London	A Bayesian Hierarchical Model for the Planetary Distributions in our Galaxy	The California-Kepler Survey (CKS) has released a wealth of precise planetary radii measurements that have the potential to reveal the nature of the underlying planet distribution in our galaxy. One of the key results of the CKS program was the revelation that the radius distribution of small, close-in exoplanets is bimodal. Such bimodality was expected from the photoevaporation model of close-in mini-neptunes, where some planets are completely stripped of their primordial H/He atmospheres, whereas others retain them. It has been suggested that comparisons between the photoevaporation model and observed planetary populations has the power to unveil details of the planet population inaccessible by standard observations, such as the core mass distribution and core composition. However, to date, only phenomenological work has been done to constrain these distributions, leaving large uncertainties in our knowledge of planet populations. In this work, we present a full Bayesian Hierarchical analysis on the radius distribution of close-in exoplanets using the photoevaporation evolution model. This approach is used to place key constraints on the planetary distributions for core composition, core mass, initial envelope mass fraction, cooling timescale and additional dependencies on orbital period. This new information can then be used to refine a new, effective planetary formation model.

Santos, Angela	Space Science Institute	Surface rotation, photometric activity, and active region lifetimes for Kepler targets	Authors: A. R. G. Santos (1), R. A. Garcia (2), S. Mathur (3), T. S. Metcalfe (1), G. V. Simonian (4), M. H. Pinsonneault (4), J. van Saders (5) (1) Space Science Institute, Colorado, USA (2) IRFU, CEA, Université Paris-Saclay, France (3) Instituto de Astrofísica de Canarias, Tenerife, Spain (4) Department of Astronomy, The Ohio State University, Ohio, USA (5) Institute for Astronomy, University of Hawai'i, Hawai, USA From stellar brightness variations due to dark starspots, one can learn about surface rotation and the magnetic properties of stars. Rotation itself is an important ingredient for the dynamo mechanism, and is also used as a diagnostic for stellar age. In this work, we analyze the spot modulation in light-curves for main-sequence and subgiant stars observed by Kepler main-mission. We analyze four data sets: KADACS (Kepler Asteroseismic Data Analysis and Calibration Software; García et al. 2011) time-series obtained for 20-, 55-, and 80-day filters; and PDC-MAP (Presearch Data Conditioning - Maximum A Posteriori; e.g. Jenkins et al. 2010) time-series. The rotation estimates are retrieved through a combination of wavelet analysis and the autocorrelation function of light-curves (e.g. Mathur et al. 2010; García et al. 2014, Ceillier et al. 2016, 2017). Reliable rotation periods are determined by comparing the rotation estimates obtained from the different diagnostics and for the different time-series. We recover rotation periods for more than 40% of the targets. For those, we also study the photometric activity level and lifetime of active regions. We find the rotation rate to increase with effective temperature and mass, while the photometric activity proxy increases towards fast rotators. Active region lifetimes are found to be longer with increasing rotation rate and photometric activity. In this analysis we also identify potential polluters, such as misclassified Red Giants, classical pulsator candidates, and photometric pollution of light-curves.
Saunders, Nicholas	Kepler/K2 GO Office, NASA Ames	Forward modeling pixel data: applications to Kepler/K2 and future missions	We present scope, a new open source software package to accurately simulate pixel-level data including realistic systematics. The major component of the systematic noise in K2 light curves is generated by the motion of stellar Point Spread Functions (PSFs) relative to regions of varied quantum sensitivity on the pixels of the CCD. As the fuel powering the spacecraft's stabilizing thrusters ran out during K2 campaign 19 and thruster fires began to sputter and fail, PSFs experienced more extreme and less predictable motion, generating more noise in transiting exoplanet light curves. The scope package simulates these CCD detector effects by modeling the inter- and intra- pixel sensitivity variation, shape of the PSF, and motion of the stars. Uniquely, the simulations obtained with the software package allow the performance of motion systematics removal algorithms to be characterized under different conditions. For example, I will demonstrate that current de-trending techniques would effectively capture and remove systematics from space telescopes experiencing up to ten times the motion that was experienced by K2. Additionally, I will discuss future applications for the software package, including the simulation of observations made by TESS, ground based observations with synthetic seeing, and observations of crowded fields. Scope allows the novel opportunity for the community to generate well-understood simulations as testbeds for noise-removal and data analysis techniques, providing new and interesting insights into these critical steps of Kepler and TESS science.

Schlawin, Everett	University of Arizona	Back to "Normal" for the Disintegrating Planet Candidate KIC 12557548 b	KIC 12557548 b/Kepler 1520 b is first of a growing class of intriguing disintegrating planet candidates, which lose mass in the form of a metal rich vapor that condenses into dust particles. Here, we follow up two perplexing observations of the system: 1) the transits appeared shallower than average in 2013 and 2014 and 2) the parameters derived from a high resolution spectrum of the star differed from other results using photometry and low resolution spectroscopy. We observe 5 transits of the system with the 61-inch Kuiper telescope in 2016 and show that they are consistent with photometry from the Kepler spacecraft in 2009-2013, suggesting that the dusty tail has returned to normal length and mass. We also evaluate high resolution archival spectra from the Subaru HDS spectrograph and find them to be consistent with a main-sequence Teff=4440 +/- 70 K star in agreement with the photometry and low resolution spectroscopy. This disfavors the hypothesis that planet disintegration affected the analysis of prior high resolution spectra of this star. We apply Principal Component Analysis to the Kepler long cadence data to understand the modes of disintegration. There is a tentative 491 day periodicity of the second principal component, which corresponds to possible long-term evolution of the dust grain sizes, though the mechanism on such long timescales remains unclear.
Scott, Nicholas	NASA ARC/BEARI	Diffraction-limited Imaging for Exoplanet Characterization	\`Alopeke and NESSI are two dual-channel speckle imagers located at the Gemini-North and WIYN telescopes. In 2019A they will be joined by Zorro at Gemini-South. These instruments are functionally identical and offer diffraction-limited imaging in multiple filters, high-speed broadband photometry, wide-field imaging of extended objects, and wide-field astrometry. Near the diffraction limit, they are capable of 6-10 magnitudes of contrast and reaching a faint limit of 17th magnitude at Gemini. Observations require no guiding, no laser, and have a cadence of less than 2 minutes for bright objects. The instruments are open to the community with observing support and a data pipeline is used to provide the user with final reduced data products.

Singh, Raghubar	Indian Institute of Astrophysics India	Asteroseismic and spectroscopic study of Li-rich red giants	Lithium is the light and fragile element which got synthesized during Big Bang nucleosynthesis together with deuterium and He. Due to the low dissociation energy of Li, it gets destroyed above 2.5 million Kelvin which is much lower than stellar core temperature. Therefore we expect Li only on the surface of the star. Post main sequence star faces first dredge up (FDU) and as a result, the chemical abundance of different elements gets changed in the surface. The elements synthesized during the main sequence appear on the surface of the red giant. The abundance of N, 13C, 3He increases and abundance of Li reduces post-FDU. During further evolution along the red giant branch an extra mixing has been hypothesized which is well established observationally. It is expected theoretically that Li should be low in RGB branch post FDU and it should reduce more after extra mixing. Li is supposed to be very less in red giants but there are a small fraction of red giants having Li abundance higher than ISM value. This is puzzling since the discovery of first Li-rich evolved star HD112127 by Wallerstein and Sneden in 1982. There are the different hypothesis to explain this event but the exact explanation of this phenomena always hampered by lack of precise evolutionary state determination. But now we are having multiple ways of determining evolutionary state of the star based on HR diagram, asteroseismology and spectroscopically determined CN abundances. We have selected a sample of the evolved star from GAIA dr2 catalog. Which gives a huge number of the star. Final sample contains a magnitude-limited collection of stars with available low-resolution spectra from Lamost. There is a small group of these stars which overlaps in the Kepler field for which evolutionary state based on asteroseismology can be inferred. Asteroseismology has revealed precious hidden information of the inner structure of red giants like the state of core whether He is burning (red clump hence RC) or quite (red giants branch hence RGB stars), internal rotation and magnetic field in red giants. Classification of evolved stars into the red clump and red giants is particularly helpful to identify internal physical mechanism working on them. Separation into the red clump and red giants is done based on average period spacing on the consecutive dipole modes in power density spectra of a star. Bedding et al. 2011 found that in the period and frequency separation diagram there is two distinct group of the star which corresponds to red clump and RGB. RC stars have large period spacing but small frequency separation span and RGB stars have small period spacing and large frequency separation span. For our sample, star power density spectra are available for 10 - 17 quarters. We have identified radial and dipole modes of these stars and measured their period spacing. We have also done high-resolution observation study of these sample stars to get Li abundance and other stellar parameters. In this poster, I would like to present our discovery of the evolutionary state of Li-rich giants and enhancement mechanism of Li in evolved stars.
Soares, Melinda	Princeton University	Using Image Subtraction to Search for Planets and Variables in M35, NGC 2158, M44 and M67	Stellar clusters serve as invaluable astrophysical laboratories, harboring an assemblage of coeval stars that share similar distances and chemical compositions. The blending of stellar light in these densely populated regions poses challenges to obtaining high-precision light curves. Image subtraction mitigates these concerns. In this talk I discuss the results of applying this technique to the K2 dataset in our search for transiting exoplanets, eclipsing binary stars, and other periodic variables in the open clusters M35, NGC 2158, M44, and M67.
Socia, Quentin	San Diego State University	The Discovery of a Transiting Circumbinary Planet in KOI-3152	One of the most exciting discoveries to come out of the Kepler mission was the detection of planets that orbit binary stars, known as circumbinary planets (CBP). Here we report the discovery of one more CBP, KOI-3152 b, adding to the 11 CBPs currently known. KOI-3152 is a mildly eccentric eclipsing binary (e=0.1) with a 28.2-day period and containing stars with ~0.81 and ~0.26 solar masses. Only three transits were observed in the Kepler light curve (across the primary star), despite the planet's orbital period being ~170-days. More transits were not observed due to unfortunate data gaps and the rapid precession of the CBP's orbit. The rate of precession and the radius of the planet (between Neptune and Saturn size) are consistent with the family of previously detected Kepler CBPs. The discovery of KOI-3152 b adds one more crucial member to the growing CBP population.

Stauffer, John	Grove Colony HOA	More Enigmatic M Dwarf Light Curves in Upper Sco	K2 has provided us with exquisite light curves for more than a thousand very young stars in the Upper Sco and rho Oph star forming regions. Those light curves have allowed us to obtain by far the best empirical characterization of how and why young stars manifest photometric variability due to hot and cold spots on their surfaces, variations in their accretion rate and structures in their inner disk rims that can produce periodic flux dips in their light curve if the disk is viewed near edge-on. K2 has thus allowed us to better understand the types of YSO variability that had been discovered much earlier using ground-based data. However, K2 has also provided evidence for types of YSO variability hitherto unknown. In Stauffer et al. (2017 and 2018) we have characterized the phased light curve morphologies of about three dozen low mass, very rapidly rotating YSOs with K2 light curves whose variability falls outside all previously known experience. In this poster, I highlight four additional Upper Sco low mass, rapidly rotating stars with unusual K2 phased light curves and additional ancillary data we have collected on these stars.
Steffen, Jason	University of Nevada, Las Vegas	The distribution of orbital period ratios and system architecture from dynamical sculpting	The observed architectures of planetary systems result from a variety of physical processes such as the condensation temperatures of planet-forming materials, the process of forming planets, and dynamical interactions among planets once formed. We examine the role that dynamical instability plays in producing the observed period ratio distribution of Kepler planetary systems. These results show that dynamical instability plays a primary role in shaping the period ratio distribution for orbital period ratios less than ~1.5. They also show that planet pairs form less often with period ratios larger than ~2.5 than they do with period ratios between 1.5 and 2.5. These results give a means to separate the role that dynamical instability plays with the role that planet formation plays in sculpting system architectures. They also give an improved criterion to classify systems as being "closely packed".
Stello, Dennis	UNSW	Is the (single) peer review process broken?	We seem to accept that the peer review process is an essential part of our scientific endeavor, despite the process being less than 100 years old. While prestigious journals, like Science and Nature, typically use three referees per paper, most journals (MNRAS, ApJ, AJ, A&A, etc.) use only a single reviewer. This can lead to significant randomness in the process, if editors follow the referee’s suggestions uncritically/blindly. Here we present two case studies, to highlight the significant randomness in the peer review process when only a single reviewer is used. The two papers involved (1 and 2) were submitted to two of the main astronomy journals (‘A’ and ‘B’) in Europe and the US.
Sudol, Jeffrey	West Chester University	On the Possibility of Habitable, Trojan Planets in the Kepler Circumbinary Planetary Systems	We investigate the possibility of habitable, Trojan planets in all of the confirmed circumbinary planetary systems in the Kepler catalog where a planet resides in the Habitable Zone: Kepler-16, Kepler-47, Kepler-453, and Kepler-1647. For each system, we preformed 10,000 separate N-body integrations, each with a one Earth-mass Trojan planet in a random orbit near the L4 and L5 Lagrangian points on either side of the planet residing in the Habitable Zone. The distributions of the orbital parameters for the Trojan planets mimic the distributions of Jupiter's Trojans. Total integration times were 1 Myr in increments ranging from 0.3 to 1.2 days, depending on the system. The semi-major axes of the Trojan planets remaining in orbit after 1 Myr are well constrained to a narrow region around the semi-major axis of the planet, as expected. Eccentricities are restricted to less than ~0.10 for Kepler-16 and Kepler-47, but no such restrictions appear for Kepler-453 and Kepler-1647, at least up to 0.30, the limit of the range of eccentricities studied. No restrictions appear in any other orbital parameters, except in the case of Kepler-16, which exhibits an interesting region of exclusion in inclination. Our findings suggest that the probability of detecting a Trojan planet in transit in systems like these is no different than the probability of detecting any planetary body in transit in any system. Mean transit timing variations are ~0.2 day for Kepler-16 and Kepler-1647, ~1 day for Kepler-453, and a staggering ~6 days for Kepler-47, suggesting that the detection (or rejection) of an Earth-mass Trojan from transit timing variations is possible.

Swanton, Peter	Australian National University	Analysing the Short Term Variability of 3C 273	3C 273 was the first Quasar discovered and displays properties similar to different types of active galactic nuclei (AGN). These similarities and brightness lead 3C 273 to be considered as the prototype AGN. K2's campaign 10 provided a unique opportunity to observe 3C 273 using the short-cadence mode of Kepler to classify 3C 273's variability at time-scales not previously available. We present the results of the short cadence data on 3C273, including <10 minute variability never before seen in an AGN, and provide constraints on key properties of the underlying engine of the AGN.
Taylor, Stuart	Participation Worldscope/Okapi Architecture	The Distribution of Planet Parameters Provides Essential Constraints For Understanding Planet Formation.	What could be more important to the study of planet formation and evolution than the distribution of planet parameters? Results from Kepler that show the locations of the planet-mass-dependent falloffs in the distribution of planets by period likely reveal the migration of planets into the star due to stellar tidal dissipation. Comparing the falloffs for masses of planets in the regions commonly compared to Jupiter, Neptune, and the earth are likely showing that Neptune-mass planets are subjected to decreases in radii due to evaporation. Studies of the changes in radius due to evaporation must also consider that the closest in planets are undergoing decreases in orbital period due to these planets being subjected to stellar tidal migration. TESS data will further improve the determination of these distributions by improving the statistics of short period planets. We also present features in the distribution of planet parameters at longer periods that hold surprising features that my indicate that planet formation likely follows similar patterns. The presence of a double peak separated by a gap feature may indicate that in systems as or more metal-rich than the sun that giant planet formation primarily occurs in two regions.
Thao, Pa Chia	University of North Carolina at Chapel Hill	The Young Exoplanet K2-25b: Flat Spectrum and High Eccentricity	Transiting planets in nearby young clusters offer the opportunity to study the dynamics and atmospheres of planets during their early stages. K2-25b is a close-in (P=3.48 days), Neptune-sized exoplanet that orbits a mid-M dwarf in the Hyades cluster (650 Myr). We combined photometric observations of K2-25 covering a total of > 40 transits and spanning 3 years, drawn from a mix of spaced-based telescopes (Spitzer Space Telescope and K2) and ground-based facilities (Las Cumbres Observatory and MEarth). With the data covering 0.6 to 4.6 micron, it enabled our study of transmission spectroscopy. Each dataset at a common wavelength was combined and fit with a MCMC framework, yielding consistent planet parameters. We found that K2-25b's transmission spectrum is consistent with being flat, and ruled out a solar-composition atmosphere. Further HST data are needed to determine if K2-25b's atmosphere has a high mean molecular weight or contains clouds/hazes. We also found that K2-25's orbit is eccentric (e > 0.20) for all reasonable stellar densities and independent of data source. The high eccentricity is suggestive of a complex dynamical history and motivates future searches for additional planets or stellar companions.
Thompson, Alexander	University of Dallas	Analysis of KIC 2708156	Analysis of photometric data for KIC 2708156 (UZ Lyr), an eclipsing Algol-type binary in the Kepler mission field, is carried out using Peranso, PHOEBE, and O-C analysis. Eighteen quarters of short and long cadence Kepler PDCSAP flux with a start date of 2 May 2009 through 11 May 2013 are analyzed. The BJD time of each observable primary minimum (708), its magnitude, and associated magnitude error are obtained from the Peranso analysis from which an O – C curve is constructed. The O-C analysis provides a refinement of the period of 2708156 as 1.8912695(2) days. The parabolic shape of the O – C curves suggests a period change P-dot/P = -1.37 x 10-6 /yr and mass transfer rate of -1.4 x 10-10 MSun/yr as well as a possible third body in the system. The PHOEBE modeling results using the O-C period indicates that KIC 2708156 is a semi-detached binary with a mass ratio q = M2 /M1 = 0.199 in which the secondary star is overfilling its Roche lobe. Keywords: stars--binaries: eclipsing—accretion discs--methods: data analysis

Torres, Guillermo	Harvard-Smithsonian Center for Astrophysics	The eclipsing binary EPIC 219394517 in the open cluster Ruprecht 147	Guillermo Torres (1), Jason L. Curtis (2), Andrew Vanderburg (3,4), Adam L. Kraus (3), & Aaron Rizzuto (3) (1) CfA; (2) Columbia Univ.; (3) Univ. of Texas at Austin; (4) NASA Sagan Fellow The old open cluster Ruprecht 147 was observed by K2 in late 2015 during Campaign 7. It is special in that it features five eclipsing binaries that are bright enough to be amenable to spectroscopic observation. Here we report new spectroscopic data and a full analysis of the first of these binaries, EPIC 219394517, a detached 6.53-day system with a near-circular orbit featuring two very similar G-type stars. We determine highly precise absolute masses and radii good to better than 0.2% and 1%, respectively, as well as a distance estimate consistent with that inferred from the Gaia/DR2 parallax, and a reddening estimate also similar to previous measures. Current stellar evolution models from the MIST and PARSEC series agree very well with the stellar properties at the known metallicity of the cluster, [Fe/H] = +0.10, indicating an age of 2.5-2.6 Gyr. We find that a PARSEC isochrone for this age and composition along with our own reddening estimate also fits the optical (G vs. BP-RP) and near-infrared (W1 vs. J-Ks) color-magnitude diagrams of the cluster remarkably well, considering that the fit has no free parameters as the distances to all members are known from Gaia. Signs of activity are seen in both components, particularly the primary, for which we measure a rotation period of 6.89 days suggesting slightly non-synchronous rotation. An analysis of the photometric residuals shows hints of spot evolution on one or both stars.
Tovmassian, Gagik	Institute of Astronomy, UNAM	K2 study of the magnetic pre-cataclysmic variable V1082 Sgr	We analyze the entire complex light curve of the pre-cataclysmic variable V1082 Sgr, as well as explore several sections in detail with a sliding periodogram. The long dataset allows the first detection of the orbital period in the light curve. A portion of the light curve in deep minimum reveals a clean, near-sinusoidal variability attributed to the rotation of the spotted surface of the donor star. We model that portion of the light curve assuming that the donor star grossly under-fills its Roche lobe, has cool spots similar to a chromospherically active, slightly evolved early K-star, and might be irradiated by the X-ray beam from the magnetically accreting white dwarf. The fast variability of the object in the active phases resembles the light curves of magnetic cataclysmic variables (polars).
Valio, Adriana	CRAAM - Mackenzie University (Brazil)	The effects of stellar activity on orbiting planets from transit mapping	Stellar activity manifests itself in the form of surface spots and faculae and also by flares and mass ejections from its atmosphere. When an orbiting planet transits in front of the star and occults one of these features, small signatures are imprinted in the transit light curve. These can be modeled to yield the physical characteristics of spots and faculae, such as size, temperature, location, magnetic field, and lifetime.. Monitoring of these signatures on multiple transits yield the stellar rotation and differential rotation, and even magnetic cycles for long enough time series. Flares have also been detected from active stars, the impact of the flaring UV flux on possible living organisms in close orbit planets is also discussed. Mass ejections also affect the planetary atmosphere being responsible for atmospheric erosion.

Vanderbosch, Zach	University of Texas at Austin	Pulsating Helium White Dwarfs in the Age of Kepler/K2	With recent discoveries from K2 and McDonald Observatory, the number of known pulsating helium atmosphere (DB) white dwarfs has doubled from 23 to 46. Their spectroscopic effective temperatures span 20,000 - 31,000 K, a range 4,000 K wider than what current theory predicts for the DB instability strip (22,000 - 29,000 K). While spectroscopic temperatures are often unreliable for DBs, independent relative temperatures can be obtained from a detailed asteroseismic analysis of their identifiable eigenmodes. Until now, just two pulsating DBs, KIC 8626021 & PG 0112+104, have benefited from the precision of Kepler/K2 observations. Here, we present a preliminary asteroseismic analysis of five additional pulsating DBs observed by K2, four of which are newly discovered. Clear rotational splittings in two objects allow for both a measurement of the rotation period of the white dwarf and the identification of eigenmodes. Additionally, a previously known pulsating DB, KIC 212029467, has now been observed three separate times by K2 in Campaigns 5, 16, & 18, providing a unique opportunity to analyze the evolution of its pulsations over time with high precision. We place the Kepler/K2 objects into the context of all known pulsating and non-pulsating DBs to provide an update on the empirical limits of the DB instability strip and discuss the implications of lingering discrepancies with theory.
Vissapragada, Shreyas	Caltech	Space-like infrared photometry of Kepler TTV systems with Palomar/WIRC	Ground-based measurements of transiting exoplanets around faint stars are challenging, with precisions typically limited by time-correlated noise from telescope pointing variations and changes in the shape of the point spread function. We effectively mitigate these issues by implementing sub-pixel level guiding and utilizing an engineered diffuser to control the shape of the point spread function for observations taken with the Wide-field InfraRed Camera (WIRC) on the Hale 200” telescope. Here, we use WIRC diffuser-assisted J band photometry to measure transit times for five Kepler planets in systems exhibiting timing variations: Kepler-29b, Kepler-36c, KOI-1783.01, Kepler-177c, and Kepler-90h. This technique provides a way to extend the Kepler baseline with ground-based facilities in order to better constrain the dynamical masses of long period planets in dynamically interacting systems.
Wang, Songhu	Yale	Kepler-730: A hot Jupiter with an additional, close-in transiting Earth-sized planet	The majority of currently detected hot Jupiters have no known close-in companions. The WASP-47 system has been the only known exception. In this talk, I will present the validation (statistical confirmation) of the second ‘WASP-47-like’ system: Kepler-730, a system hosts a previously known hot Jupiter with period of 6.5 day, also hosts an additional transiting planet candidate. This is an Earth-sized planet candidate with period of 2.85 day, which was not detected until Kepler DR25. We statistically confirmed the planetary nature of Kepler-730c based on Doppler velocimetry from SDSS/APOGEE spectra, Robo-AO high-contrast imaging, and Kepler photometry.
Wells, Mark	Penn. State University and Villanova University	Reconciling the observed Kepler Eclipsing Binary Sample with Population Models	The Kepler satellite observed a sample of ~3000 eclipsing binaries which have been collected in the Kepler Eclipsing Binary Catalog (KEBC). We present a general framework that forward-models the underlying population of binaries for any survey and we apply this framework to Kepler. The process takes a Galaxy model and a set of theoretical distributions that describe the underlying binary population. We construct a probability density matrix (PDM) for our parameter space that is used to generate a synthetic binary population. The selection and observation effects inherent to the Kepler mission are modeled and applied to the generated binary population. We evaluate the conditions under which the systems would produce detectable eclipses, and create a synthetic sample of eclipsing binaries. We then compare the orbital distributions of this synthetic sample of eclipsing binaries to the KEBC and iteratively apply corrections to the PDM until agreement between the two is reached. We present our most up-to-date model of the Kepler binary population.

Wittenmyer, Rob	University of Southern Queensland	Revised planetary and host parameters for K2 planet candidates from AAT/HERMES: Complete results C1-C13	Accurate and precise radius estimates of transiting exoplanets are critical for understanding their compositions and formation mechanisms. To know the planet, we must know the host star in as much detail as possible. We present complete results from the K2-HERMES survey, which used the HERMES multi-object spectrograph on the Anglo-Australian Telescope to obtain R~28,000 spectra for more than 30,000 K2 stars. We present complete host-star parameters, masses, and radii for 398 K2 candidate planets from C1-C13. We discuss the properties of the K2 planet sample as functions of age, metallicity, and abundances of key elements. Our results highlight the importance of obtaining accurate stellar parameters for ongoing planet search programs - something that will only become more important in the coming years, as TESS begins to deliver its own harvest of exoplanets.
Wolfgang, Angie	Pennsylvania State University	The Empirical Exoplanet Composition Distribution: Latest Developments and Next Steps	Kepler and K2 have left a rich legacy of exoplanet detections and an indelible mark on our understanding of the abundance of different types of planets. The next step toward exoplanet characterization is identifying likely bulk compositions for these planet populations, an effort that will come into its own during the era of TESS. Illuminated by measurements of planetary masses and radii, these composition distributions can be expressed empirically via the exoplanet mass-radius relationship. Numerous studies have analyzed this relationship using different data, models, and analysis methods. Here I present recent efforts to move beyond some common statistical modeling assumptions in order to improve predictions of mass given radius (and radius given mass). I will also describe efforts to construct a statistical TESS follow-up campaign to limit the selection and detection biases currently present in measured masses and radii. Finally, I identify several key areas for ongoing and future work, looking ahead to exoplanet compositions as a function of stellar type, metallicity, and planetary incident flux.
Yenawine, Mitchell	San Diego State University	The Apsidal Motion Constants in the Triple Star System KOI-126	KOI-126 is a triple-star system exhibiting complex, fascinating eclipses. It contains a pair of late M-type stars orbiting an F-star every 33.9 days. The M-star pair orbit each other every 1.7 days, and the syzygy eclipses of the F-star enable very precise radii and mass determinations though photodynamical modeling: MA=1.347, MB=0.2413, and MC=0.2127 M⊙; RA=2.0254, RB=0.2543, and RC=0.2318 R⊙, with uncertainties of just a few percent (Carter et al. 2011). Due to tidal interactions between the three stars, the M-star binary's orbit is slightly eccentric (e = 0.022) and is quickly precessing. This offers us a rare opportunity to measure the rate of precession, which yields the "apsidal motion constants" (k2,1 and k2,2) of the M stars; this has never been measured for low-mass stars. The apsidal motion constants in turn provide information on the internal mass distribution inside the star (akin to the polytropic index). This is important for M stars, since it could provide insight on the decades-old problem of the discrepancy between theory and observations of M-star radii. KOI-126 B and C are particularly important cases because they have fully convective envelopes. To improve upon the Carter et al. estimates and more tightly constrain the k2 values, we model all 17 Quarters of Kepler data and include 5 additional (post-Kepler) eclipse events observed with the Mt Laguna Observatory 1-m telescope. We also utilize a novel variation of the Nelder-Mead simplex minimization “amoeba” technique. The standard amoeba simplex is well known to have difficulty in parameter spaces with high dimensionality and/or local minima (the KOI-126 model has 29 free parameters). Our new approach uses an additional stochastic vertex in an attempt to overcome the limitations of a simple amoeba. This fast minimization provides an important check on the results obtained from Markov Chain Monte Carlo (MCMC) methods.

Zhang, Shangjia	University of Nevada, Las Vegas	Gaps and Rings in ALMA Observations of Protoplanetary Disks: Implications for the Young Planet Population	Discoveries over the past few decades show that planets are common. However, most discovered exoplanets are mature, so their orbital properties have gone through dynamics alteration. To test planet formation theory, it is crucial to constrain the young planet population right after they are born in protoplanetary disks. Recent high resolution imaging in millimeter interferometry reveals a variety of disk features, some of which may be imprinted by young protoplanets. Our recent ALMA Large Program, "The Disk Substructures at High Angular Resolution Project" (DSHARP), provides the first homogeneous overview of disk substructures. In this work, we explore the possibility that these gaps/rings are induced by young planets, by carrying out a grid of hydrodynamics simulations with different values for planet mass, disk viscosity and scale height. I will first introduce how our simulations can explain dust emission at DSHARP observation wavelength and how the putative planet masses are inferred. Then I will explore the potential young planet population on the planet mass-semimajor axis diagram. We find the occurrence rate of giant planet > 5 Mj is consistent with direct imaging constraints. We also probe a new parameter space of Neptune to Jupiter mass planets beyond 10 au, which are not accessible to any other planet searching techniques. In addition, I will highlight our simulation demonstrating that the intricate series of gaps and rings in the AS 209 disk can be explained by a single planet. I will also demonstrate that the angular resolution and sensitivity of DSHARP observations are able to reveal disk structures induced by giant planets in the young solar system and HR 8799 analogs.
Zhu, Wei	Canadian Institute for Theoretical Astrophysics	There is no Kepler dichotomy	Half of the Kepler planets were found in systems with only one transiting planet. This was interpreted as a signature of two distinct populations of planetary systems, one with compact configuration and the other being either multis with large mutual inclinations or intrinsically single. Such a behaviour was frequently referred to as the Kepler dichotomy. Here, we constrain the intrinsic architecture of Kepler planetary systemsy by modeling the observed multiplicities of the transiting planets and their transit timing variations (TTVs). We find that only 30% of Sun-like stars have super-Earth-like planets, and that the mutual inclinations correlate with the number of planets in the system. The former revises previous claims that more than 50% of Sun-like stars have Kepler-like planets, and the latter disproves the so-called Kepler dichotomy. Our solar system fits very well in this revised picture with both its multiplicity and the dynamical hotness.
Ziaali, Elham	Research Institute for Astronomy and Astrophysics of Maragha, Iran	The period-luminosity relation for delta Scuti stars using Gaia DR2 parallaxes	We have constructed the period-luminosity relation for 286 delta Scuti stars from the catalogue of Rodriguez et al. (2000) by using the Gaia DR2 parallaxes. We plotted absolute V magnitudes against log(period) and we can distinguish two ridges, with a period ratio near 2. The ridge with longer periods is in agreement with the relation McNamara (2011) fitted to a number of metal-rich delta Scuti stars using the Hipparcos parallaxes, and presumably corresponds to the fundamental radial mode. We also used Gaia DR2 parallaxes and Tycho V magnitudes for the period-luminosity relation of 2299 delta Scutis in the Kepler field. These show a similar distribution, also with two ridges. We discuss the possible explanations.
Zink, Jon	UCLA	Transit Multiplicity in Planet Occurrence Rates	We investigate the role that planet detection order plays in the Kepler planet detection pipeline. The Kepler pipeline typically detects planets in order of descending signal strength (MES). We find that the detectability of transits experiences an additional 5.5% and 15.9% efficiency loss, for periods <200 days and >200 days respectively, when detected after the strongest signal transit in a multiple-planet system. We provide a method for determining the transit probability for multiple-planet systems by marginalizing over the empirical Kepler dataset. Furthermore, because detection efficiency appears to be a function of detection order, we discuss the sorting statistics that affect the radius and period distributions of each detection order. Our occurrence rate dataset includes radius measurement updates from the California Kepler Survey (CKS), Asteroseismology, and the Gaia DR2 catalogs. Our population model includes an improved estimate of the multiplicity distribution. From our obtained model parameters, we find that few solar-like GK dwarfs harbor one planet. This excess is smaller than prior studies and can be well modeled with a modified Poisson distribution, suggesting that the

			Kepler Dichotomy can be partially accounted for by including the effects of multiplicity on detection efficiency.
Zinn, Joel	Ohio State University	Testing the radius scaling relation with Gaia DR2 in the Kepler Field	We compare asteroseismic radii of 500 dwarfs and 3400 giants from the Kepler mission to radii based on Gaia parallaxes. The agreement, when accounting for corrections to the Gaia parallaxes, is within 2% for dwarfs and subgiants, and 1% for giants up to 30Rsun. We have tested systematics due to temperature, bolometric correction, and extinction. We have also quantified the spatially-correlated parallax errors in the Kepler field, complementing results from the Gaia team, which constrained spatially-correlated errors using faint quasars across the entire sky. Our results indicate that the asteroseismic radius scale is more accurate than recent suggestions from eclipsing binary comparisons, which stresses the importance of vetting stellar parameters in testing asteroseismology using eclipsing binary radii.