K2 Guest Observer - Cycle 1
Abstracts of selected proposals
(NNH14ZDA001N)

Below are the abstracts of proposals selected for funding for the K2 Guest Observer - Cycle 1program. Principal Investigator (PI) name, institution, and proposal title are also included. 93 proposals were received in response to this opportunity. On January 29, 2015, 27 proposals were selected for funding.

Charles Beichman/Jet Propulsion Laboratory
A K2 Search for Planets Transiting Bright M Dwarf Stars

This program continues an ongoing effort (Campaigns 0-3) to survey a large sample of M stars to identify new transiting systems, emphasizing small planets (1-4 REarth) near the Habitable Zones of nearby M stars. By observing ~1800 sources per field in Campaigns 4 and 5 we anticipate being able to find ~45 planets orbiting stars with spectral types from M0-M6. An emphasis is placed on rapid follow-up to ensure timely validation and characterization to support early observations with JWST.

Tabetha Boyajian/Yale University
Testing asteroseismology with bright red giants using K2 timeseries and interferometry

We propose to observe a small number of bright nearby red giant stars taken from the Hipparcos catalogue, for which we will obtain additional ground-based interferometric observations and high-resolution spectra to determine precise values of the angular diameter 0, T eff, log (g), and surface composition. These additional constraints, coupled with the oscillation spectrum derived from K2 observations and the available parallax information,
will provide the most stringent tests possible of the asteroseismic techniques used to determine masses, radii and ages of stars, as well as the physical processes governing the evolution of red giants and the Galaxy.

Patricia Boyd/NASA Goddard Space Flight Center
New Swift X-ray Sources in K2 Rigorously Probing Active Galaxy Accretion and Stellar Variability

We request K2 monitoring of new X-ray sources in the Campaign 4 field discovered with our ongoing Kepler-Swift Active Galaxies Survey (KSwAGS). The first phase of the KSwAGS uncovered 93 bright X-ray sources in the original Kepler FOV (Smith et al., in preparation). Approximately half of these sources were indeed active galaxies while the remainder were active stars of various type (pulsating stars, rapid rotators, close binaries, flaring M-stars). High-precision optical follow-up would have been scientifically useful on all newly-discovered X-ray targets, however the fourth Kepler reaction wheel failed before we could propose monitoring of these sources.

All existing archived AGN light curves in the Kepler database were thus selected using near-infrared photometric methods (e.g., Edelson & Malkan 2012). These methods preferentially select AGN with high black hole masses (MBH e 108 MSUN), since the method fails if the continuum is dominated by starlight, instead of AGN light. Fortunately, X-ray selection uncovers low-MBH, low luminosity, and low accretion-rate AGN. These types of AGN have predicted variability timescales short enough to be constrained by a 75-day K2 campaign. Indeed, narrow-line Sy 1 objects (NLS1) are expected to vary on timescales of days to weeks. This science is complimentary to what we are conducting in the original field with high-MBH objects, since the accretion physics is expected to differ between these types of objects (i.e., low-accretion rate objects may have advection dominated accretion flows or other scenarios instead of the canonical optically-thick, geometrically-thin accretion disk).

Swift will begin surveying the K2 Campaign 4 FOV in 2014 Sept. We anticipate ~50 sources from this survey, based on the original KSwAGS, which discovered 93. The photometric precision and high duty cycle of K2 will be more than adequate for our purposes. Our objectives cannot be met using archival Kepler data because these AGN targets were selected with techniques that are biased toward high MBH objects.

Matt Burleigh/University of Leicester
Eclipses, transits and variability of white dwarf stars with the K2 Mission

Matt Burleigh(1)(PI), Francesca Faedi(2)(Collaborator), Jay Holberg(3)(Co-I), Ian Braker(1)(Graduate Student), Sarah Casewell(1)(Co-I), Katherine Lawrie(1)(Collaborator),
Mike Goad(1)(Co-I), Martin Barstow(1)(Co-I)

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(3) Lunar and Planetary Laboratory, Sonnett Space Sciences Bld., University of Arizona, Tucson, AZ 85721, USA

This proposal is to obtain high precision photometry of White Dwarfs within the two proposed fields of K2 Cycle 1 to search for planets, brown dwarfs and stellar variability.

Such a survey (combined with the other K2 fields) would allow for the monitoring of statistically significant numbers of White Dwarfs to be able to put constraints on the existence planets in short period orbits around White Dwarfs. Any transiting objects that are detected could be prime targets for follow up observations by the JWST (Loeb & Maoz 2013). Such a survey would also be able to detect brown dwarfs around White Dwarfs allowing further constraints on the smallest object that can survive common envelope evolution. In addition any unexpected variability would also be detected such as the Kepler mission found in BOKS 53856 (Holberg and Howell 2011).

Douglas Caldwell/SETI Institute
Variability and Dynamics of Young Stars

We seek to understand the conditions and dynamics of the earliest stages of planetary system formation through a study of the variability of young stars in the K2 Campaign-4 field of view. We propose to observe at long cadence ~50 young stellar objects, T-Tauri stars, pre-main sequence stars, and flare stars selected from the literature and associated with the Pleiades and Hyades star clusters. The objects range in age from tens to hundreds of million years and in spectral type from late-F through mid-M. We will analyze the variability of these objects on timescales ranging from hours to months in order to model the accretion onto the star, detect disk density variations, measure rotation rates, and search for eclipsing/transiting companions. The results of our analysis will lead to a better understanding of the range of conditions under which planetary systems form. The proposed work uses the unique capabilities of K2 to collect data with the precision, duration, and duty cycle needed for such a study.

Michael Carini/Western Kentucky University
Rapid Optical Variability in Infrared and Optically Bright Blazars

Blazars are extreme examples of the phenomena known as Active Galactic Nuclei (AGN). The defining characteristics of blazars are a featureless (or nearly featureless) optical continuum, large amplitude and highly variable polarization, and large amplitude continuum variability at all wavelengths. Their weak or completely absent discrete spectral features leaves us with only continuum variability as a diagnostic of the emission mechanisms at work in these objects. Long cadence observations of a sample of optical and IR bright blazars identified in the F4 and F5 field of the K2 mission are proposed. The source sample will be comprised of blazars with Kep magnitude < 17 which are either already identified as blazars or sources in the fields found on the Wise blazar strip that are not previously identified blazars. The continuous, highly sampled light curves that will be obtained in the K2 mission will allow a detailed exploration of blazar variability on timescales of minutes to several months that is not possible with

ground based observations. In particular these observations will allow: the determination of the minimum timescale of the variability, the determination of the slope of the power spectral density (PSD) on timescales from minutes to several months, searches for breaks in the high frequency PSD which indicate the presence of characteristic variability timescales and searches for quasi-periodic oscillations in the optical light curves of blazars. Bright blazars are being chosen so that they can continue to be monitored from the ground post K2 in order to extend the time series and characterize the PSD across a wider range of frequencies.

William Cochran/University Of Texas, Austin
PICK2: Planets In Clusters with K2

We propose to obtain high precision K2 photometry of the members of four open stellar clusters to be observed fields 4 and 5 in order to search for young, newly formed planets. Open clusters provide a homogeneous sample of stars in which the major independent variable is the stellar mass. The different ages of the clusters will help us to understand the early dynamical evolution of planetary systems. We have assembled a large, diverse and highly experienced international team. We will search the light curves for planetary transit signatures. We will conduct extensive followup observations including ground-based photometry, high precision RV measurement, and high resolution optical and near-IR spectroscopy in order to confirm the planetary candidates. We will perform detailed spectral analysis in order to derive stellar parameters and chemical abundances, and will perform Doppler tomographic analysis of rapidly rotating planetary candidates. These results will provide important new constraints on the physics of planetary system formation and early dynamical evolution. We will address the Kepler mission goals of obtaining an inventory of the diversity of planetary systems around sun-like stars. We will also obtain data very complementary to the goals of the TESS program, and help guide planetary system science for JWST studies.

Saurav Dhital/Embry-Riddle Aeronautical University, Inc.
Gyrochronology of Stars in Wide Binaries in the Kepler K2 Fields

We propose to obtain time-series photometry of ~400 wide main-sequence binary stars with Kepler on Two Wheels (K2) and determine their rotation periods. This will allow for calibrating the rotation age relationship for main-sequence stars older than ~1 Gyr for the first time. Such rotation-based ages are precise to ~10%, which exceeds any other current method of determining ages of stars in the Galactic field. We will expand on our ongoing work to characterize and quantify the limitations of both Kepler and K2 data.

Based on the underlying premise that stars are born with an initial distribution of rotation periods and slow down over time as they shed angular momentum, Barnes et al. have have suggested an empirical framework for measuring stellar ages from their rotation periods. This paradigm, gyrochronology, works well for solar-type stars in young clusters and, apart from asteroseismology, is the most precise way to measure stellar ages of individual stars. Binary (or multiple) star systems are essentially small open clusters, albeit with just two members. While not able to provide the statistical power of the dozens of stars typical in an open cluster, an ensemble of binary systems in the Galactic field can be even more powerful as they span a range of ages, metallicities, and evolutionary histories that provide a truly heterogeneous population. Past the age of <1 Gyr, binaries are also much closer and brighter than open clusters. As all but the most massive open clusters, which are further away and fainter, become unbound after <1 Gyr, their utility is limited as lower-MS dwarfs tend to escape first, limiting their availability as age benchmarks. Lastly, components of wide binaries with semi-major axes s500 AU are coeval and evolve independently with no discernible effect on each other. Therefore, to test and calibrate gyrochronology for older stars, binary and multiple systems represent powerful keystones.

Rick Edelson/University of Maryland, College Park
AGN Variability Studies with Kepler K2 Campaigns 4 and 5

Kepler is revolutionizing the study of optical variability in AGN, with light curves having unprecedented precision, sampling and duty cycle. This led to the first observation of a break in the optical PSD of a Seyfert 1 galaxy and clarification of the nature of microvariability in blazars. We propose continued Kepler LC monitoring of 127 AGN and AGN candidates in Campaigns 4 and 5 as part of our program to observe hundreds of AGN throughout the K2 mission. This will vastly improve the statistical leverage for characterizing optical variability and assure Kepler's legacy for AGN studies. The most important AGN on Kepler silicon in this round is the bright, rapidly-variable blazar OJ 287. We request SC monitoring of this source in order to assure adequate temporal sampling for this unique observing opportunity.

Patrick Gaulme/New Mexico State University
Solar-like Oscillations in Eclipsing-Binary Systems

We propose to use K2 unique capability to detect solar-like oscillations of main-sequence and red-giant stars that belong to well-known eclipsing binaries. Binary systems hosting at least one star with detectable solar-like pulsations are becoming important astrophysical targets because they provide a way to calibrate asteroseismology. Indeed, eclipsing binary systems allow for accurate determination of masses and radii of both stars by combining photometric and radial-velocity measurements, which can then be compared with asteroseismic estimates. Eclipsing binaries are also interesting for the physical processes resulting from tidal interactions, which may influence their evolution when the stars are close enough. So far, all the published stars known to both display solar-like oscillations and belong to eclipsing binaries are red-giants, and all have been detected by the Kepler mission (Hekker et al. 2010, Gaulme et al. 2013 & 2014, Beck et al. 2014). The purpose of this GO proposal is to observe a small set of eclipsing binaries, including either a red-giant or a main-sequence solar-like star, that are already well characterized in terms of physical parameters (orbits, masses, radii). Doing so present two main advantages. Firstly, observing well-known systems helps predicting the likelihood of detecting solar-like oscillations. Secondly, the objective is to reduce the burden of ground-based follow-up, which is very time-consuming when radial-velocities need to be measured.

Mark Giampapa/Association Of Universities For Research In Astronomy, Inc.
The Suns of M67

The solar-age and solar-metallicity open cluster, M67, is a benchmark cluster for understanding stellar evolution and the nature of solar-type stars. Önehag et al. (2011, A&A, 528, A85) find that solar twins in M67 have photospheric spectra that are virtually indistinguishable from the Sun s at echelle resolutions. Therefore, K2 data would enable for the first time a high-precision comparison of the variability characteristics of solar analogs to that of the Sun, which is characterized by cycle-related variability at the level of about 0.1% (1 mmag) and a superimposed rotational modulation by spots with amplitudes in the 1 3 millimag range. Our primary observational objective in this proposal is to obtain estimates of rotation periods of solar-type stars in M67 with previous Ca II activity measurements from Giampapa et al. (2006, ApJ, 651, 444). The results from this program will provide important constraints for (1) the relationship between activity and rotation at solar age and (2) the angular momentum evolution in sun-like stars.

The solar counterparts in M67 have an apparent brightness of V ~ 14.5. Therefore, the benchmark precision of 170 ppm for V=12 G2 V stars in one long cadence (LC) observation can be attained in 5 hours or the equivalent of 10 LC observations.

Alternatively, a precision of 0.5 mmag needed to resolve rotational modulation in the 0.1% 0.2% range could be achieved in about 0.6 hours or two LC sequences. Approximately 2.8 solar-like rotation periods (~ 27d) could be observed in the ~ 75-day duration of K2 Field 5 observation. Our approach will be to analyze sequences of 2 10 LC observations for rotation measures and single LC sequences for transient activity. The K2 data will be augmented by a contemporaneous survey of the program targets using Lowell Observatory's new 4.3-m Discovery Channel Telescope (DCT).

While the specific objective is to obtain rotation measures of solar counterparts in M67, K2 observations of M67 will yield additional perspectives on the variability of its many solar-type stars at precisions that are unattainable from the ground for the M67 solar analogs (V ~ 14.5). The frequency of occurrence of superflaring (Notsu et al. 2013; Maehara et al. 2012) in sun-like stars at solar age could be investigated for the first time in addition to other forms of transient activity, each of which could impact the conditions in exoplanetary systems. In summary of one important application, the K2 data-set for M67 would be an indispensible first step towards the characterization of the conditions of the habitable zones in sun-like stars at solar age. Finally, transits of super-Earths and larger exoplanets could be detected. These goals are scientifically and technically compatible with the K2 mission while scientifically relevant to NASA programs such as Habitable Worlds and Living With A Star.

John Gizis/University of Delaware
Ultracool Dwarfs: Clouds, Flares, and Exoplanets

We propose to observe nearby ultracool dwarfs using the Kepler K2 mission to characterize their cloud/weather properties, measure their flare rates, and detect their planetary companions. Like gas giant planets, very-low-mass stars and brown dwarfs form condensate clouds in their atmospheres. K2 can unique characterize variability due to these clouds, both rotation modulation on a timescale of hours and weather evolution of the clouds on timescales from days to months. Magnetic activity changes dramatically at the stellar/substellar hydrogen-burning limits, but some ultracool dwarfs are known to flare. We will measure the white light flare rate in well-defined statistical samples as a function of effective temperature, rotation rate, and age. Flares are tied to magnetic reconnection rates and the energy budget. We also aim to detect transiting exoplanets by continuing to monitor each available ultracool dwarf in K2 campaigns; brown dwarfs, gas giants, and even large rocky planets are detectable. The K2 Campaigns 4 and 5 targets include nearby field late-M and L dwarfs.

John Johnson/Harvard-Smithsonian Center for Astrophysics
Characterizing the Cooler KOIs: Studying the Planet Population around Mid-M Dwarfs

The Kepler science team has identified M dwarfs as a vital set of targets for the K2 mission. While Kepler and K2 have combined to observe nearly 10,000 M dwarfs to date, nearly 85% of these have been M0 and M1 dwarfs. Here, we propose observations of 3,548 mid-M dwarfs, enabling us to extend our knowledge of planet occurrence rates to the most abundant stars in the universe, a class almost entirely unstudied during the primary Kepler mission.

Steven Kawaler/Iowa State University
Search for sub-kilogauss magnetic fields in white dwarfs with K2 photometry

A surface magnetic field on a white dwarf is currently detectable via spectroscopy when the field approaches 1 MG; such a magnetic field is hard to understand originating from a normal main sequence progenitor. As a result, we have little information on the evolution of the magnetic field of main sequences stars in this final stage of evolution except for those with anomalously strong fields. This program will use very sensitive photometric observations of white dwarfs by Kepler/K2 to search for rotational modulation of the flux from low-magnetic field white dwarf stars caused by magnetic phenomena (such as starspots and plages). On the expected white dwarf rotation periods (about 1 day, generalizing from nonradially pulsating white dwarfs), the low amplitude of the expected variations renders them extremely difficult to detect using ground-based photometry. K2 will be able to observe many well-studied field white dwarfs and many in the Pleiades, Hyades, and M44. Measurement of rotation modulation (or even upper limits to photometric amplitude variations) will further exploit those data to teach us about magnetic fields in these stars that are otherwise inaccessible observationally. In the case of ZZ Ceti pulsators, we may for the first time independently measure the rotation rate, providing a test of asteroseismic rotation periods.

Mukremin Kilic/University of Oklahoma
A Search for Habitable Planets Around White Dwarfs in Fields 4 and 5

A large fraction of white dwarfs (WDs) may hot planets in their habitable zones. These planets may provide our best chance to detect bio-markers on a transiting exoplanet, thanks to the diminished contrast ratio between the Earth-sized WD and its Earth-sized planets. The James Webb Space Telescope is capable of obtaining the first spectroscopic measurements of such planets, yet there are no known planets around WDs. Here we propose to take advantage of the unique capability of the K2 mission to perform a transit

survey that is capable of detecting the first planet in the habitable zone of a white dwarf. There are nearly 400 WDs known in Fields 4 and 5. Thanks to the large field of view of Kepler, for the first time in history, a large number of WDs can be observed at the same time, which is essential for discovering transits. This survey will maintain Kepler's spirit of searching for habitable Earths, but near new hosts.

Sebastien Lepine/Georgia State University
A search for exoplanets and close stellar/substellar companions in the local halo population

We propose to expand the scope of the original Kepler mission by conducting a search for exoplanets orbiting the old and metal-poor stars of the Galactic halo, a population that was not observed to any significant degree in the first Kepler mission. Following the recent discovery of exoplanets orbiting Kapteyn's stars, a local halo M subdwarf, the stars of the Galactic halo population are now known to harbor exoplanets as well as those of the Galactic disk. However, very little is currently known about the prevalence and properties of the exoplanets in the halo. Our astrometric and photometric analysis of the fields to be observed in campaigns 4-5 of the Kepler K2 mission have identified 1,957 high-velocity subdwarfs that are nearby members of the Galactic halo. We propose to monitor these halo stars with Kepler, to identify and characterize a statistically significant number of the first generation of exoplanets in our Galaxy. Light curves of the targeted halo stars will be searched for eclipses or transits, following the methodologies developed in the first Kepler mission. Candidates will be targeted for ground-based, follow-up observations to confirm the existence of the transit, and determine if it is from a planet of from a stellar companion. The detection of eclipsing stellar companions would also be of high interest for stellar astrophysics, as it would provide natural calibrators of the mass-radius relationship; while this relationship is critical to constrain models of stellar structure, such calibrators currently do not exist for low-mass, metal-poor stars.

Robert Mathieu/University of Wisconsin - Madison
A Comprehensive Stellar Astrophysical Study of the Old Open Cluster M67 with Kepler

M67 is perhaps the best studied of all star clusters, either open or globular. Being at an age and metallicity very near solar, at an accessible distance of 850 pc with low reddening, and rich in content (over 1000 members including main-sequence dwarfs, a well populated subgiant branch and red giant branch, white dwarfs, blue stragglers, sub-subgiants, X-ray sources and CVs), M67 is a cornerstone of stellar astrophysics.

We comprise a strong and diverse research team that will use the proposed Campaign 5 long-cadence data for M67 to yield forefront findings across a wide array of domains of stellar astrophysics. These will include:

" Searches for exoplanet signatures;

" Red giant asteroseismology;
" Stellar evolution, including non-standard evolutionary paths (e.g., blue stragglers);
" Stellar rotation and angular momentum evolution;
" Stellar activity;
" Eclipsing binaries and beaming.

The ability to observe M67 was a significant driver in motivating the K2 mission to the astronomical community and NASA. Indeed, M67 might be viewed as K2 s Goldilocks cluster; the number of stars per unit area is perfectly matched to the 4 arcsec pixels, and yet not too crowded to allow good results on very faint members. A large superaperture augmented by targeted stars outside the cluster core will comprehensively and efficiently capture some 1400 likely cluster members. Targets of interest span Kp ~ 8 to 20, the bright end being defined by evolved red giants for asteroseismology and the faint end being M dwarfs for which Hot Jupiters will still be easily detectable.

The team has strong expertise with time-series photometry and Kepler in particular. We will provide state-of-the-art time series to the community for more than 2,000 stars in the M67 field. Extractions using both simple aperture photometry and difference image analysis (the non-perfect guiding of K2 may provide data well- conditioned for the latter) will be performed, in addition to careful detrending of systematics in the time series.

This team also has assured access to a wide range of ground-based facilities, capabilities and data to follow-up K2 discoveries. The team leaders have extensive and successful experience with large international collaborations and major scientific projects.

We will make the best possible use that K2 observations of this key cluster can provide, both with targeting decisions, time series production for community use, and our own science results.

Jennifer Patience/Arizona State University
Monitoring the atmospheres of brown dwarfs

With the exceptional monitoring capabilities of the K2 mission, we propose to obtain long-cadence measurements of a set of brown dwarfs within campaigns 4 and 5. The targets span a large range of spectral types, enabling an investigation into atmospheres with temperatures overlapping with transiting and imaged exoplanets. The proposed data will provide a unique resource for the investigation of the atmospheres of substellar objects, with observations spanning more than one hundred rotation periods. The proposed data will be used to investigate the periodicity and persistence of variability linked to atmospheric processes or activity, along with the identification of potentially rare events such as flares. The proposed K2 data would be augmented with ground-based multi-wavelength infrared observations and form a key component of a student thesis.

Andrej Prsa/Villanova University
Eclipsing Binary Stars: Indispensable Astrophysical Laboratories for Studying Stellar Populations

Eclipsing Binary Stars are the cornerstone of stellar astrophysics. They provide fundamental stellar parameters (masses, radii, temperatures and luminosities) for objects across the H-R diagram. The K2 mission will probe fields along the ecliptic, thus allowing us to study inherently different stellar populations and their distributions as a function of galactic latitude. Campaigns 4 and 5 focus on some of the best studied clusters, namely the Pleiades, the Hyades, M67 and the Beehive. Because stars in clusters are coeval, share a common evolutionary path and feature the same chemical abundances, eclipsing binaries found in these clusters serve as distance calibrators and stellar population gauges. We collected all known eclipsing binary stars from available online catalogs (via Simbad and VizieR services), and performed a thorough search for binaries in the proprietary Kilodegree Extremely Little Telescope (KELT) and SuperWASP survey data to assemble a list of proposed targets for this solicitation. The reduction and analysis will be done by experienced members of the Kepler Eclipsing Binary Working Group.

Seth Redfield/Wesleyan University
Monitoring Targets Within 100 Light Years

Temporal monitoring of stars within 100 light years provides an opportunity to search for close planetary systems that are optimal for follow-up studies, as well as evaluate the stellar properties that are critical to the evolution of planetary atmospheres. A complete census of the physical properties of a star and planetary system is necessary for an evaluation of the habitability of planets. It is precisely these nearest systems that the question of habitability will be examined in greatest detail in the decades to come. I propose for consideration the sample of all nearby stars with reliable parallaxes within 100 light years (or 30.7 pc). The sample is expected to be less than 30 targets, and they may be observed with the long cadence. While the probability of a detection of a planet in such a small sample is low, given the total sample in all K2 campaigns, it is favorable that such a nearby planetary system will be detected. If so, it is likely to be one of the most heavily scrutinized systems given the relative ease of follow-up observations. This not only applies to the planetary properties (e.g., planetary atmosphere measurements, astrometry, direct imaging, spin-orbit alignment measurements), but also the stellar properties (e.g., metallicity, activity, wind strength), and even the circumstellar (e.g., debris disk, exozodical emission) and surrounding interstellar properties. For example, stellar winds are critical to the long-term evolution of planetary atmospheres, even when they are relatively weak, like those of solar-like stars. The only method of measuring such winds is through the interaction of the interstellar medium and the stellar wind, which creates an astrosphere. This requires some knowledge of the surrounding interstellar medium and stellar properties, and has only been successful for very nearby

stars. Therefore, given its proximity, a planet found in the proposed sample of nearby stellar systems has the best opportunity to be fully characterized with a comprehensive and robust suite of measurements.

Mike Reed/Missouri State University
Understanding extreme horizontal branch stars via asteroseismology

We propose to explore core structure of horizontal branch stars by applying asteroseismological tools to Kepler data of extreme horizontal branch (spectral class subdwarf B) stars. Subdwarf B (sdB) stars are the atmosphere-stripped cores of horizontal branch stars. Many happen to pulsate, and that allows us to probe their structure. From Kepler's main mission, we learned how to identify pulsation modes and to constrain structure models from period spacings and frequency multiplets.

Period spacings also help to discern internal structure and age since some stars show substantial mode trapping while in others it appears to be absent. The amount (and location) of the mode trapping sequence is a function of the core structure which evolves with time. By sampling sdB stars of different evolutionary age and envelope mass, we can use the small deviations of period spacings to constrain structure models.

Frequency multiplets also tell us the rotation period and orientation of the pulsation axis. From this information we have discovered that rotation periods are long (20-100 days), even for stars with binary period down to 0.4 days. This is a surprising result as it has been assumed that close binaries quickly tidally lock their components.

We made significant progress from the original Kepler mission. However, to fully exploit those advances, we need to complete the characterization of helium-fusing cores across their range of age (from zero-age to terminal-age on the horizontal branch) and temperature (an indicator of the envelope-to-core mass ratio). It would also be a huge benefit to have more examples of pulsators in binaries, as that allows us to further explore how angular momentum is conserved and/or transferred during envelope ejection.

To continue working toward a complete understanding of horizontal branch cores (including mass loss and post-helium-flash evolution), we are proposing that K2 obtain short-cadence (SC) observations of a selection of likely sdB pulsators and long-cadence (LC) observations of remaining sdB stars. The SC data can fully explore pulsations and short-period (1 day) binaries and while the LC data can detect some pulsations while still exploring binary sdB stars, especially the longer-period ones.

Our team has extensively explored many aspects of sdB stars, including spectroscopic characterization, binary properties, and the application of asteroseismic tools. We have been examining sdB stars since their pulsations were discovered in 1996 and have published over 20 papers from Kepler's main mission.

We have also incorporated students into our work. Many of our papers include graduate and undergraduate students as signficant contributors. Missouri State University does not have a graduate program, and as a result, undergraduate students have learned to process, analyze, and interpret NASA Satellite data to detect pulsations and signatures of binarity. They have also been involved in pre- and post-Kepler characterization studies, providing them with a broad range of training.

Ignasi Ribas/Institut d'Estudis Espacials de Catalunya/CSIC
Deciphering stellar activity with K2 photometry and ground-based radial velocities

Stellar intrinsic variability poses one of the main challenges to the discovery of the smallest terrestrial planets and the measurement of their atmospheres. Variability is often caused by magnetic activity and, as such, it has an apparently stochastic nature. This is why the impact of activity on photometry or radial velocities is often referred to as jitter and treated as a noise source. But this approach is just a consequence of our lack of knowledge of how stellar magnetic activity works. If understood in sufficient detail, one could turn the supposed noise into signal and therefore correct it out. A particularly interesting possibility is to use simultaneous photometry and precision radial velocities to break some of the degeneracy and better constrain the reconstruction of the stellar surface, as well as studying parameter correlations. This was put to practice for the active planet host star HD 189733 with relatively good success but also highlighting the need to expand the test to other stars with extended time baselines and coverage density. K2 long-cadence photometry, in simultaneous combination with radial velocities from the ground, offers a unique opportunity to contribute critical information to the better modelling of stellar activity and subsequent correction of precise photometry and RVs for exoplanet discovery and measurement.
Our strategy comprises the selection of stars with moderate activity level in the K2 fields. Field 4 is particularly interesting since it covers part of the Hyades cluster, whose GK member stars are relatively bright and have the appropriate activity levels. Using several criteria we have selected V=7.5-8.5 mag G-type stars with log R HK around -4.5 in Field 4 and Field 5. The precise photometry from K2 will be complemented with ground-based RVs from the HARPS-N, TRES, and SOPHIE instruments to which the proposers have direct access and deliver measurements with precisions better than a few m/s. This will allow us to obtain simultaneous RV measurements for the targets, at a rate of one measurement per night, and for a time baseline of about 40-50 days. This represents several rotation cycles of the targets as they are expected to rotate with periods of ~10 days. The combination of K2 data and ground-based RV measurements is key to further our understanding of stellar activity and to turning a noise component into correctable signal , thus opening the way for the discovery of smaller exoplanets (using both photometry and spectroscopy) and for the eventual measurement of the minute signature of their atmospheres. Combining precise ground-based spectroscopy and space-based photometry of bright stars will be commonplace in the near future with the TESS mission. This proposal therefore represents a case study for such upcoming investigations.

Eric Schlegel/University Of Texas, San Antonio
Cataclysmic Variables for K2's Campaign 4 and 5

Campaign 5 of the Kepler2 mission will cover the location of
the bright, eclipsing nova-like cataclysmic variable AC Cnc. The Kepler mission has studied only two eclipsing systems, both
of the dwarf nova sub-class. Eclipsing CVs are important because the observations define the system parameters and provide a probe of the accretion disk. Nova-likes are important because they exhibit the properties of high-accretion rate systems. AC Cnc will be the first eclipsing novalike to be observed. A recent model for the flickering observed in high-accretion rate CVs can be directly tested with an eclipsing system.

Aleks Scholz/University of St Andrews
Rotation periods of very low mass stars and brown dwarfs in open clusters

We propose to measure rotation periods for ~750 very low mass (VLM) stars (0.08<M<0.3 Msol)
and brown dwarfs (M<0.08 Msol) in campaign 4 and 5 of the Kepler-2 mission. The field-of-view of
these campaigns covers the three open clusters Hyades, Pleiades, and Praesepe, the only main-sequence
clusters in the Kepler-2 fields for which VLM cluster members can be monitored with sufficient precision
to measure rotation periods. At ages of 100 and 600 Myr, the Pleiades and the Hyades are the ideal targets
to constrain spindown models. In contrast to solar-mass stars, the spindown of VLM objects, especially
in the substellar domain, is very poorly understood, particularly due to a lack of empirical constraints.
Kepler-2 will help us to remedy this situation. We expect to derive hundreds of VLM periods, an improvement
by a factor of ~4 compared with the existing literature. This will enable us to derive the spindown
timescales for VLM objects as a function of mass and to provide critical constraints for wind models in this
mass domain. The lightcurves will be useful for a variety of secondary science projects, including the
search for benchmark eclipsing binaries and for the first close-in planets around brown dwarfs.

John Stauffer/California Institute of Technology
The K2 Young Suns Survey: Clues to Star and Planet Formation from Observations of Young Open Cluster Stars

We propose to obtain light curves for more than 1000 low mass members of

the Pleiades, Hyades and Praesepe open clusters in Campaigns 4 and 5 of the K2 mission. We will use these data to: (a) determine the frequency of close-in gas giant planets in these clusters (and hence determine if being born in a dense environment affects the planet formation process); (b) identify eclipsing binary stars among these cluster members,thereby providing new precision tests of stellar evolution models; and (c) determine properties of these stars related to their youth (spottedness, rotation period, flaring frequency) better than can be done from ground based observations. By combining these data with similar data we have obtained with CoRoT for the 2 Myr old NGC 2264 open cluster, we will address how these properties evolve with time. The results from this program would add significantly to our knowledge of the origin and evolution of stars and planets, thereby directly addressing one of the primary NASA astrophysics goals.

Dennis Stello/University of Sydney
Galactic Archaeology on a grand scale Campaigns 4-5

MOTIVATION: Unraveling the evolutionary history of the Milky Way has been a long-standing problem in contemporary astrophysics, and understanding this history will have significant ramifications for our insight into how other galaxies form and evolve. Success will depend on understanding the stars within our Galaxy: their role as its building blocks and the source of its chemical evolution. This demands precise measurements of the fundamental properties of stars, something we currently have achieved mainly for the solar neighborhood. Initial investigations in this new field of near-field cosmology better known as Galactic Archaeology has used Kepler and CoRoT data and shown that asteroseismic-determined radii, masses and ages of red giants have tremendous potential for expanding our view into how the Galaxy formed and evolved.
AIM: The proposal aims to observe a sizable number (about 5,000 per campaign) of colour-magnitude selected red giants to probe the Galaxy far beyond the solar neighborhood. This is a continuing program initiated during Campaign-0, and it is our intention to make similar proposals for all future K2 fields in order to probe Galactic directions not probed before, taking advantage of K2 s 360-degree view along the ecliptic. With this data we aim to build a comprehensive picture of the Galaxy s structure and evolution from its stellar populations.
METHOLOGY: The K2 data will be used to determine radius, mass, and age of each star using asteroseismology, complemented by ground-based spectroscopy and photometry from large surveys targeting both hemispheres (APOGEE, GALAH, Gaia-ESO, RAVE, and SAGA). We will use our seismic inferred stellar properties to stress-test state-of-the-art Galaxy models (Galaxia, TRILEGAL).

Ann Wehrle/Space Science Institute

Measuring the Light Curves of the Binary Black Hole Candidate OJ287 and Other Fermi Blazars

We propose to measure the K2 long cadence light curves of the blazar OJ 287 and several other Fermi gamma-ray blazars. OJ 287 may contain a close binary supermassive black hole, based on substantial evidence of a ~12-year periodicity in optical light curves. OJ 287 is visible to the K2 mission in Campaign 5 in summer 2015, a few months before a major outburst is anticipated. OJ 287 is detected strongly by the Fermi gamma-ray mission. We will compare the properties of the OJ 287 light curve to those of other Fermi blazars for which we have approved and proposed K2 observations. Seven additional Fermi blazars will be observable with high precision in K2 Campaigns 4 and 5. Our scientific goal is to determine the origin of optical emission in these gamma ray blazars at the time of K2 observations. The three candidate origins are: 1) a single dominant synchrotron-emitting region in a jet; 2) substantial contributions from multiple synchrotron-emitting regions in a jet; and 3) an accretion disk with multiple thermal emitting regions.