A Coordinated Approach to K2/Campaign 9: Microlensing Data Reduction and Analysis.

Rachel Street
Las Cumbres Observatory Global Telescope Network, Inc.

The phenomenon of microlensing offers us a glimpse of dark and otherwise unexplored populations within our galaxy. It is capable of finding and characterizing objects of all masses even if no light is received from them at all. K2/Campaign 9 (K2/C9) will observe dozens of microlensing events and its near-continuous lightcurves will pick up even the shortest events due to so-called free-floating planets. K2/C9 therefore offers an unparalleled opportunity to gather a much larger and well observed sample of these events, something that is extremely challenging from the ground. But unlike purely ground-based surveys, K2's separation from Earth provides an extraordinary chance to measure the properties of all the events within the field of view. The same microlensing events observed simultaneously from Earth and K2 will display distinctive lightcurve features from which the parallax to the event can be measured. This parameter is the key to derive the masses and distances of the lensing objects.

To make the most of the K2/C9 opportunity, there are a number of challenges to be met. We propose to focus on the specific areas below, and to support complimentary programs by other teams.

K2 Data Reduction and Analysis
The pixel scale of K2 is strongly under sampled. Combined with the excessive crowding of stars in the Bulge this presents a major, but not insurmountable, factor limiting the achievable photometric precision. The rapidly-changing brightness of the lensed star combined with systematic noise caused by K2's pixel drift means that additional work is needed to deliver good photometry. Drawing on our team's experience with Difference Image Analysis, detrending and photometric noise analysis, we propose to extend our existing data analysis packages to reduce the K2 data and analyze the systematic noise which can masquerade as planetary signatures.

Ground-based observations
Both optical and NIR observations are required through-out Campaign 9 to ensure all events are properly characterized. Ideally, these will be provided by a set of ground-based survey facilities, including DECam and UKIRT, but at this stage their availability is unclear. We propose to send one of our team's experienced observers to support these programs if they go ahead. If not, then we propose to take advantage of LCOGT's telescope network and provide red-optical (SDSS-r,i) and NIR (Pan-STARRS-Z,Y) lightcurves of all alerted events in the field.

Data Modeling
The data for a large number of microlensing events (>85) will need to be modeled. The (non-linear) models for binary lensing events have a large number of parameters so properly exploring the full parameter space is a usually a time-consuming, manual process with multiple degeneracies. Our team has developed the only automated analysis package, which will use to deliver a self-consistent catalog of event parameters.

Public Data Products
We will make all our data products and applicable software available to the public as soon as reductions are complete. They will be disseminated through NASA's Exoplanet Archive and will include extensive documentation.

Coordinating Analysis Efforts
Expertise in microlensing is worryingly sparse worldwide but markedly within the US. There is strong benefit in fostering the free exchange of results and ideas and in collaboration between teams. We propose for funds to host a workshop at LCOGT, CA, open to the whole community, with the goal of expediting the timely reduction, analysis and publication of K2/Campaign 9 results. In particular, we request funds to support students to attend and hence develop future microlensing expertise.

This proposal is highly responsive to the aims of the Exoplanet Research Program to detect new exoplanets and understand their origins and will significantly enhance the interpretation of observational data. This is vital for both the K2 mission and also to lay ground-work for WFIRST-AFTA.