Galactic Archaeology on a grand scale – Campaigns 2-3

K2 Target Proposal by KASC Working Group 8, the asteroSTEP and APOKASC collaborations, and the GALAH team (Point of contact: Dennis Stello, stello@physics.usyd.edu.au)

MOTIVATION: Unraveling the evolutionary history of the Milky Way has been a long-standing problem in contemporary astrophysics, and achieving this will have significant ramifications for our understanding of 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. However, it is now clear that a lack of well-described and easily reproducible selection criteria for the stellar sample hampers our ability to faithfully compare theoretical models with observations.

AIM: The proposal aims to observe a sizable number of colour-magnitude selected red giants to probe the Galaxy far beyond the solar neighborhood. 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. Campaign2 in particular, provides a high fraction of red giants at a Galactic thin disk region not probed before using asteroseismology, while Campaign3 gives an invaluable look to the Galaxy's thick disk.

URGENCY: The full potential of the data will be reached when combined with independent data such as high-resolution spectroscopy, adding radial velocity, temperature, metallicity and abundance of elements. Through the team behind this proposal, these additional data are already available for a significant fraction of our targets, and will be obtained for the remaining stars within a year by the APOGEE and GALAH surveys. The asteroseismic data from the K2 fields, which complement current observations from the *Kepler* Cygnus field and CoRoT, will form a legacy data set for Galactic Archaeology. Combined with the forthcoming data from Gaia, the results from these efforts will be a true goldmine, allowing exploration of core areas of galactic evolution theory including the age-metallicity and age-velocity relations, as well as chemical and dynamical evolution of the Milky Way.

APPROACH: We make a pure colour-magnitude based selection using 2MASS, with all stars having $J - K_s > 0.5$. To boost efficiency of future ground-based follow-up, we generally target stars in 1-degree-radius circular sub-fields centered on each CCD module.
Campaign2: Our top priority targets are 529 giants across the K2 field that are already observed spectroscopically by APOGEE, RAVE, or Gaia-ESO (with a well defined selection function) plus 2649 stars in three sub-fields at different Galactic latitude. Second priority are the remaining sub-fields. All sub-fields provide magnitude complete samples from $H = 7$ down to $H = 11.5$ ($10.9 \lesssim Kp \lesssim 14.3$) of which $\sim 90\%$ are giants.
Campaign3: Our top priority are 827 giants across the K2 field that are already observed spectroscopically plus all (2608) stars in sub-fields with $7 < H < 12$ ($9.4 \lesssim Kp \lesssim 14.0$) sorted by H magnitude (statistics in Fig.1). Second priority are the stars outside the sub-fields following the same magnitude range and sorting as our 1st-priority stars.

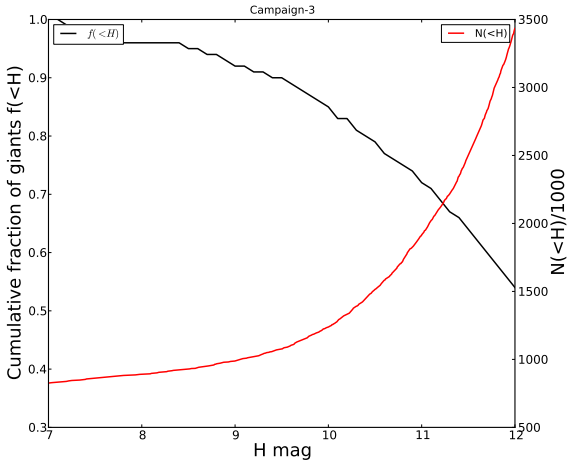

Figure 1: Estimated fraction of giants per magnitude bin (black), and accumulated number of stars at a given H band cut-off (red) for Campaign3. Predictions are based on simulations using *Galaxia* (Sharma et al. 2011, ApJ, 730, 3).

SYNERGY WITH OTHER K2 GOALS: Our selection process includes, serendipitously, the K–M dwarfs cooler than $J - K = 0.5$, which will benefit the search for planets – a key goal of K2. This purely color-magnitude selected sample of dwarfs ensures the statistically robust interpretation of the exoplanet results, and these dwarfs are likely to overlap with those of planet-focused proposals. Following our selection preserves a simple selection function while targeting stars that are useful for both Galactic and planet studies. Due to this synergy, 'going down' our priority list for Campaign3 till $H \sim 12$ can add many more 'simple-selected' stars (including many dwarfs), while in practise only adding few unique extra targets to the total K2 target budget – a win-win situation that maximizes the science from each selected star. If approved, the proposal will also provide the bulk of targets for a wealth of other science goals driven by KASC Working Group 8.