Galactic Archaeology on a grand scale – Campaign 1

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. Field 1 in particular, provides an invaluable look to the Galactic halo.

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 this 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 $J - K_s > 0.5$. Our top priority targets comprise about 2000 stars of which 405 are already observed spectroscopically by APOGEE and RAVE, and a sample of about 1600 which ensures we get a magnitude complete sample from $H = 7$ down to $H = 11.00$ (see Fig.1 right panel for corresponding Kp). Selecting stars further down our target list (sorted in H-mag) will ensure magnitude completeness to fainter magnitudes down to $H = 13.00$ (Fig.1, red curve, left). This will increase the diagnostic potential of our red giant sample for galactic archaeology as well as increasing the number of K and M dwarfs in the sample, which dominate each magnitude bin for stars fainter than $H = 11.00$ (Fig.1, blue curve, left).

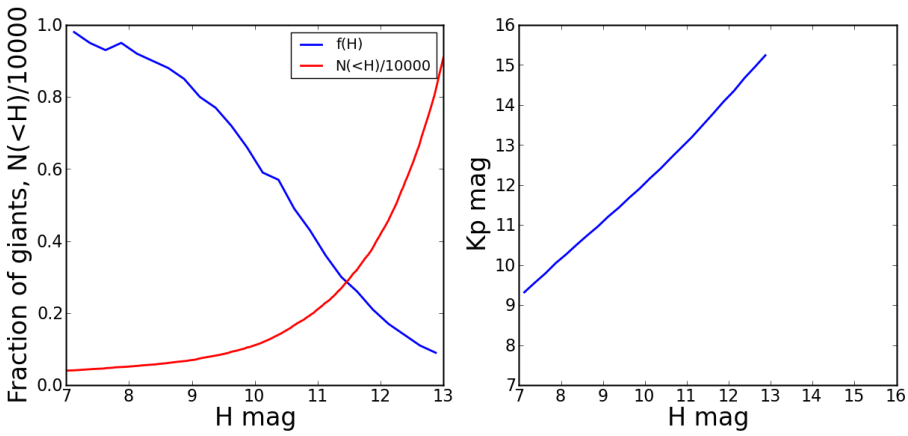

Figure 1: Left: Estimated fraction of giants per magnitude bin (blue), and accumulated number of stars at a given H band cut-off (red). Right: H vs. median Kp relation. Predictions are based on simulations using *Galaxia* (Sharma et al. 2011, ApJ, 730, 3).

SYNERGY WITH OTHER K2 GOALS: Our selection process includes, serendipitously, all K–M dwarfs cooler than $J - K = 0.5$, which will benefit the search for planets in the habitable zones around cool dwarfs – 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. Hence following this selection preserves a simple selection function while targeting stars that are useful for either Galactic or planet studies – a win-win situation for both science cases as it 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.