

Identifying Remote Halo Giants in High-Latitude Fields with Kepler 2

Ruth C. Peterson

SETI Institute, 189 N Bernardo Ave, Mountain View, CA 94043

Abstract. This work sketches how SDSS *ugr* colors and Kepler 2 in halo fields can identify red giants 50 – 100 kpc distant with minimal metallicity bias. For these mildly-reddened, metal-poor giants, $(g - r)_0$ yields the effective temperature T_{eff} to 100 K. K2 can detect the p-mode oscillations of red giants and measure their frequency of maximum power ν_{max} . This sets the luminosity L_{bol} and thus the distance, plus an estimate of metallicity [Fe/H].

Keywords. Galaxy: halo, Galaxy: stellar content, stars: abundances, stars: atmospheres, stars: distances, stars: Population II, techniques: photometric

Red giants are the best tracers of the remote halo. At their high luminosities they remain visible to 100 kpc, and their presence at all metallicities and ages encourages an unbiased sample of the stellar population. Here we note how Kepler (K2) and SDSS can find them.

In K2 fields in the Galactic halo, reddening is low, so the effective temperature T_{eff} of a star known to be a metal-poor giant can be determined from its dereddened $(g - r)_0$ color alone. Figure 1 shows the minimal spread in $(g - r)_0$ at a given T_{eff} at various metallicities [Fe/H], for observed metal-poor giants and for the model atmospheres of Castelli & Kurucz (2003) (CK03).

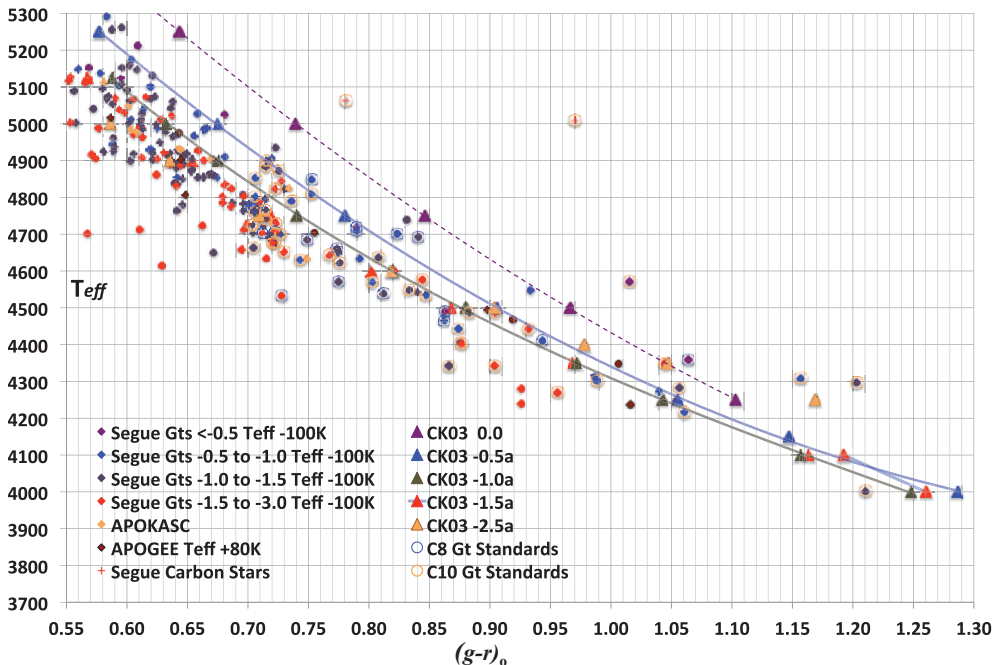


Figure 1. Temperatures from stellar SEGUE and APOGEE spectra (diamonds and circles) and CK03 giant models (triangles) are plotted vs. $(g - r)_0$. The model T_{eff} and $\log g$ values, from Yong *et al.* (2013) at [Fe/H] = -1.6, are 5125K/2.75, 4900K/2.30, 4750K/2.00, 4600K/1.60, 4500K/1.30, 4350K/1.00, and 4250K/0.75.

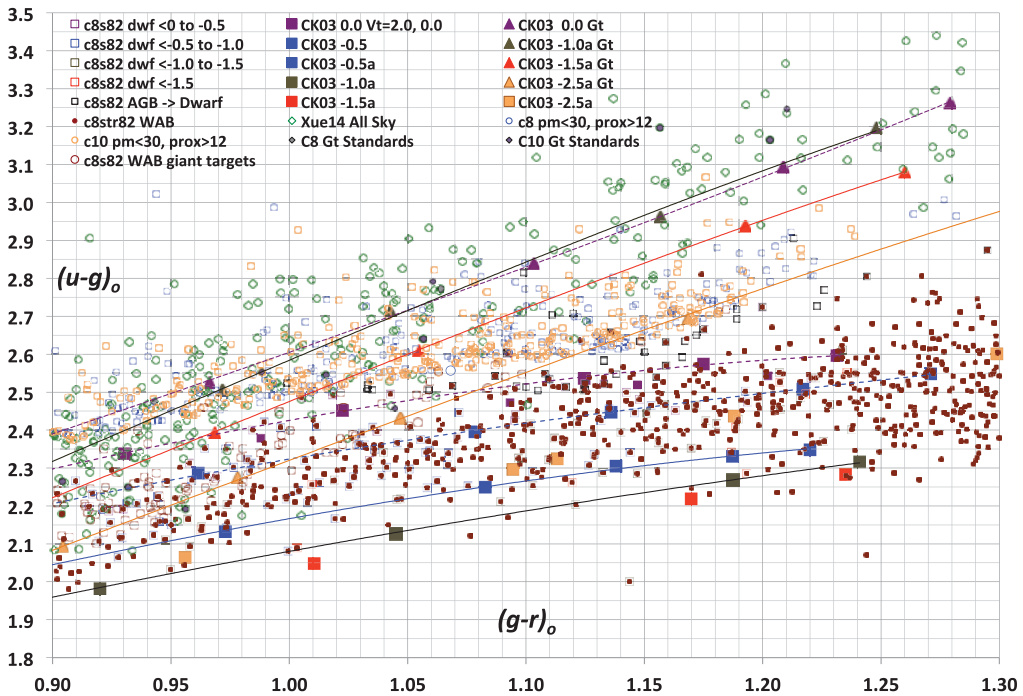


Figure 2. The dereddened colors of stars known to be giants (diamonds) or dwarfs (squares) are compared to the model colors of giants (triangles) and dwarfs (filled squares). Open circles are the dereddened colors for our proposed targets. Dark maroon circles are Bhatti *et al.* 2010 (WAB) stars, whose photometry is more precise. Note the paucity of cool giant WAB targets, hence their selection from the entire C8 and C10 fields.

K2 can identify remote giants asteroseismologically by detecting their p-mode oscillations. Those of dwarfs peak at frequencies too high to detect in long-cadence light curves, but those of cool, metal-poor giants fall within range, peaking at $v_{\max} \sim 200 - 2 \mu\text{Hz}$. Despite roll corrections, noise trials suggest K2 light curves should detect p-mode oscillations to Kepler magnitudes $K_p \sim 16.5$ for the most luminous metal-poor giants, reaching stars 100 kpc away.

In Figure 2 we show K2 targets we have proposed in the halo fields C8 and C10 (open circles). Their dereddened $(u - g)_0$ and $(g - r)_0$ colors are those of cool giants, as seen from model CK03 colors (with $u - g$ increased by 0.2) of giants (diamonds) and dwarfs (squares), and observed colors of C8 and C10 SEGUE/APOGEE giants (filled diamonds) and the all-sky Xue *et al.* (2014) giants (open diamonds). Giants are scarce: the high-quality Bhatti *et al.* (2010) (WAB) photometry (small filled circles) of Stripe 82 within C8 shows that foreground dwarfs dominate.

Applying this color selection to all SDSS + K2 halo fields should identify ~ 100 new giants. Set by stellar gravity, v_{\max} , plus T_{eff} from $(g - r)_0$, fix the giant luminosity L_{bol} . This sets its distance, and also yields an estimate of $[\text{Fe}/\text{H}]$, since giant luminosity also depends on stellar metallicity (Xue *et al.* 2014). Thus SDSS + K2 alone can characterize the remote halo population.

References

- Bhatti, W. A., Richmond, M. W., Ford, H. C., *et al.* 2010, *Ap. J. Supp.*, 186, 233
 Castelli, F. & Kurucz, R. L. 2003, *IAU Symp. No. 210*, Modeling of Stellar Atmospheres, eds. N. Piskunov *et al.*, CD-ROM poster A20; also astro-ph 0405087
 Xue, X.-X., Ma, Z., Rix, H.-W., *et al.* 2014, *Ap. J.*, 784, 170
 Yong, D., Meléndez, J., Grundahl, F., *et al.* 2013, *MNRAS*, 434, 3542