Evolution of Surface Structure on Chemically Peculiar Stars

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We propose K2 monitoring of two magnetic chemically peculiar stars to measure precise photometric rotational phase curves and search for temporal evolution of phase curves. Precise K2 light curves with 30 minute sampling covering at least 10 to 19 rotation periods will:

- Test for surface structures down to scales of a few degrees in longitude, indicating high-order magnetic fields not detectable by spectroscopy.
- Test for temporal evolution of surface structure on a time scale of months, identifying the rotational phase and magnetic location of any such evolution.
- Provide a precise photometric constraint for Zeeman Doppler analyses based on existing and future spectropolarimetry.

Chemically peculiar stars have anomalous surface abundances due to radiation pressure "levitating" elements with high absorption cross-sections (e.g. Si, Cr, Sr) and gravity "settling" elements with low mass (e.g. He). According to existing theory, these diffusion processes operate on time scales comparable to the stellar lifetime.

Radial mixing would tend to tend to homogenize abundances in the star, so the assumption is that surface mixing is negligible in chemically peculiar stars. On the other hand, spectroscopic analyses (e.g., Korhonen et al. 2013, A&A, 553, A27) report temporal evolution of spectral line depths and hence spot properties on time scales of a few months, after removing rotational modulation. Such changes should be detectable with a precise K2 light curve spanning 70 days.

Zeeman Doppler imaging of magnetic stars requires extremely high S/N. Slicing a spectroscopic time series into smaller phase bins compromises robustness of the reconstructed surface image. A precise K2 time series will provide a simple way to test for the existence of surface features on scales down to a few degrees. Having 10 to 19 rotational periods will allow us to robustly detect inflections in the light curve down to the 30-minute sample time, corresponding to 4 to 7 degrees of longitude.

Finally, Balona (2013, ASP Conf. Series, 479, 385) claims magnetic flares exist on a small number of A/B stars. While an undetected M dwarf companion seems more likely, the K2 time series would also be sensitive to very large flares.

Our two targets are members of the young Sco-Cen association:

HD	Spectral Type	Vsini km/s	Period day	Var Code	Bz kG
147010	B9 Si Cr Sr	20	3.9207	SLM	-4.4/-1.8
148199	B9 Si Sr He wk	15	7.7	LM	-1.8/1.5

Variability codes: S=spectroscopic, L=luminosity (vs. phase), M=magnetic