DASCH Variables in the Kepler Field

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And the DASCH team:

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AAS 217th Meeting, Seattle, Jan. 11, 2011
DASCH (Digital Access to a Sky Century @ Harvard) to Digitize and Measure the Harvard Plates to Open the $\sim$100yr Time Domain Window

- $\sim$530,000 photographic plates between 1880s-1980s (Grindlay et al. 2009).
- 500-1500 measurements for each object with B$\sim$10-14 (up to 18 mag in some regions)
- study temporal variations of a wide variety of objects (stars to AGNs)
- Astrometry: 0.8-3 arcsec (but up to 6” near edge of low-res plates)
  Photometry: 0.1-0.15 mag (Laycock et al. 2010).
~3000 plates each covering all or part of the Kepler field:

Long-term **DASCH** coverage + short-timescale **Kepler** data.

Open cluster NGC 6819 in Kepler Field (Plate MC 36426, taken in 1949)
100 yr DASCH lightcurve of **Kepler-10**
Variable Search:
1. divided into local $2\degree \times 2\degree$ bins
2. calculate lightcurve statistics for each star
3. pick up outliers (variable candidates)
4. Visual examination of plate images
Different types of Variable Candidates

Red giant variables: Mira, LPV

RR Lyr, EB, CV

MISC, including some unusual long-term variables

Visual validation still in progress… Only ~30 most interesting candidates have been done so far
K Giants with 10-50 yr variation: An unknown phase of RGB/AGB evolution? similar to what we found in the M44 field (Tang et al. 2010)

\[ \text{Teff \sim 4400-4500 K, log g \sim 2-3 \, \text{cm/s}^2, R \sim 6-15 \, R_\odot \text{ in the KIC 5630212: also a K giant according to its spectra} \]
K5095511: a long term variable and active/spotted Giant?

Over-fitting of co-trending

The new Bayesian approach co-trending results (Jenkins 103.02; VanCleve 140.08) will be great helpful

Flares

Kepler Q0&Q1 lightcurve

Strong Ca K&H emission lines: indicate strong magnetic activity

MMT Hectochelle spectrum
A few more examples

Carbon star: dust obscuration?

K dwarf (KIC), Chandra X-ray source, 2-3 mag flares: active binary?

Long-term A star variable: 1.5 mag rising

FAST spectrum

lightcurve
Combining DASCH

• 100yr lightcurves for B<15 mag objects in the whole sky
• Discovery of exciting new types of variables
• Explore long-term variability for known variables

with the high-cadence great accuracy Kepler data

• Short-term variability (flares, dimmings, oscillations)
• Magnetic activity, star spots and rotation
• Asteroseismology: derive stellar parameters, pin down their position in the evolutionary track. Compare the stellar parameters derived from atmosphere fitting (MMT Hectochelle/Magellan MIKE spectra).

Enables a unique study of stellar variability on the widest range of timescales. We have applied for the Kepler Cycle 3 GO program for ~20 of our most interesting DASCH variables.