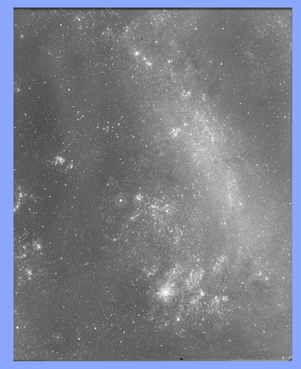
DASCH: Digital Access to a Sky Century@Harvard
Explore Variables over 100 Years

Sumin Tang, Jonathan Grindlay, Edward Los, Mathieu Servillat and Robert Kurucz
Harvard-Smithsonian Center for Astrophysics



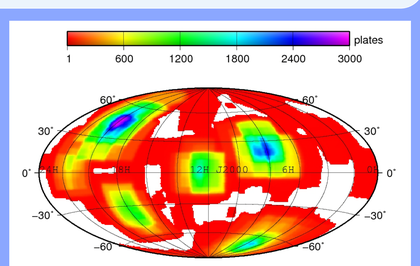
Abstract: DASCH is a project to digitize and analyzethe scientific data contained in the ~550,000 Harvard College Observatory (HCO) plates taken between the 1880s and 1990s, which is a unique resource for studying temporal variations in the universe on ~10-100 yr timescales. We have developed the astrometry and photometry pipeline, scanned ~14,500 platesin several selected fields. Here we describe our variable search algorithms and present a few examples of variables we discovered, including a group of new type of variable K giants with 10-100 year dips, a group of Be variables showing ~1 mag variations over years, a new symbiotic nova, a 5-yr dust accretion event in KU Cyg around 1900, and a nova in 1914.

I. Introduction to DASCH:

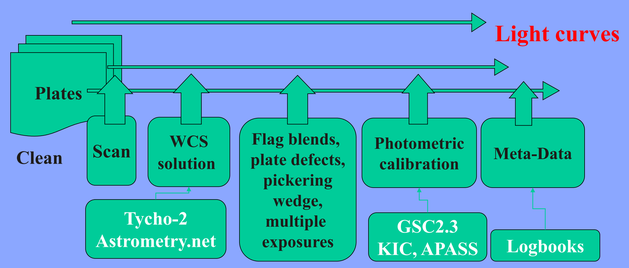
Digital Access to a Sky Century at Harvard

- The Harvard College Observatory (HCO) maintains a collection of **~550,000** photographic plates between **1880s-1980s** covering the whole sky (*Grindlay et al. 2009*).
- **~500-1500** measurements for each object with B<14-15 (up to 19 mag in some regions)
- Study temporal variations of a wide variety of objects (stars to AGNs)
- Astrometry: **0.8-3 arcsec**, Photometry: **0.1-0.15 mag** (*Laycock et al. 2010*).
- **~14,500** plates scanned so far, in several different fields, including the open cluster M44, Baade's Window near the Galactic center, 3C 273, the Kepler field, and partial coverage of LMC (in progress).

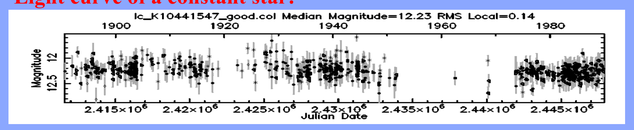
Exposure map of ~14,500 scanned plates



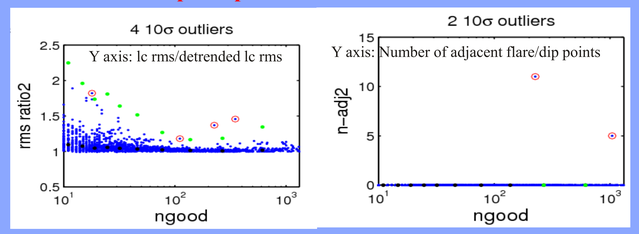
DASCH Pipeline



Light curve of a constant star:

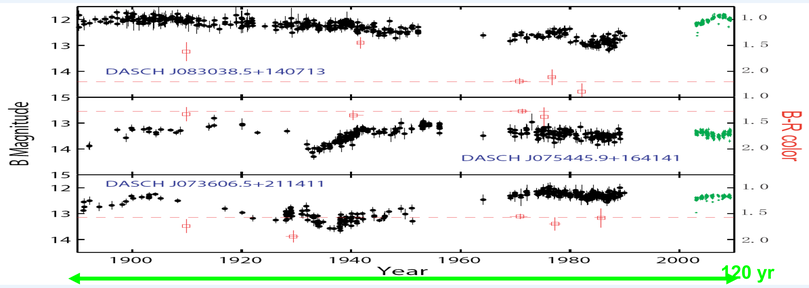


Variable Search: pick up outliers via different statistics

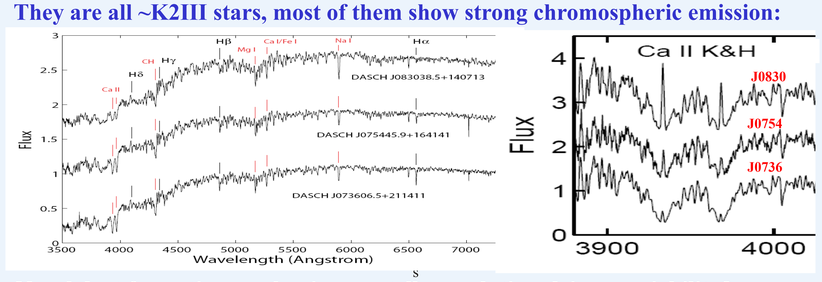


II. A New Type of Long-Term Variables: ~20 K giants with ~1 mag dips over 10-100 yr

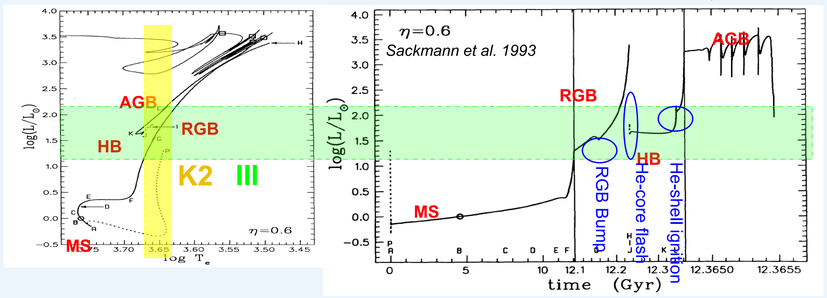
Tang et al. 2010



They are all ~K2III stars, most of them show strong chromospheric emission:

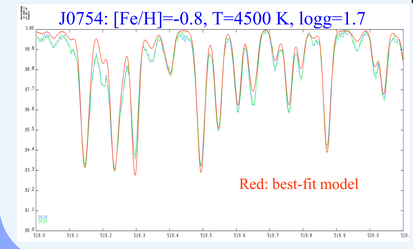


Novel dust formation mechanism or stellar evolution-driven variability?

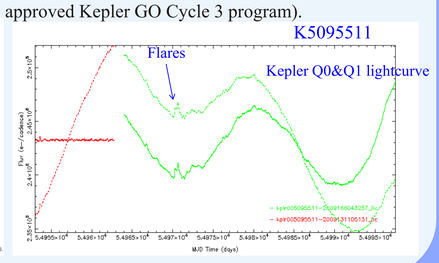


Two approaches to tackle the mystery:

1. Atmosphere fitting to derive stellar parameters using high resolution echelle spectra (MMT Hectochelle & Magellan MIKE):



2. Five of them are in the Kepler FOV, so we will use the Kepler data to study their stellar activity and possibly stellar structure by asteroseismology (via an approved Kepler GO Cycle 3 program).



III. More examples of variable stars and AGNs

Be variables which might be X-ray binaries (Be stars with neutron star companions)

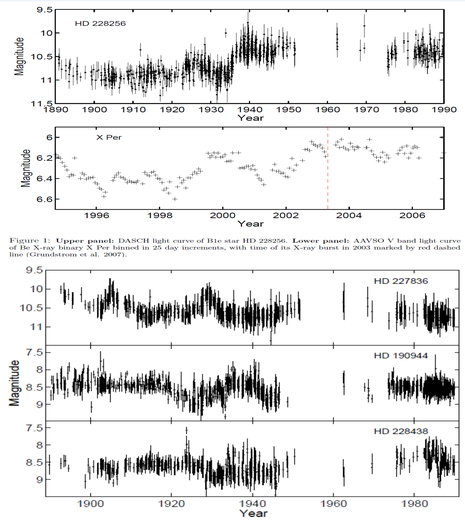
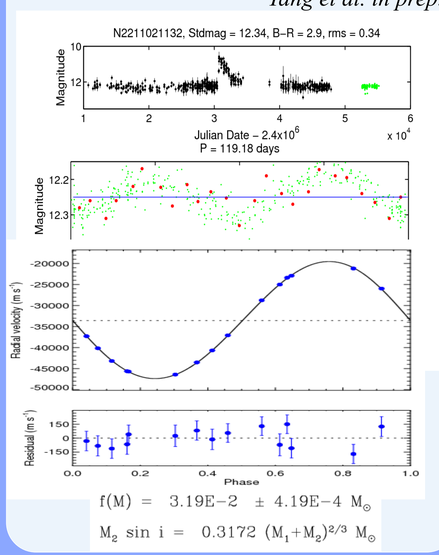


Figure 1: **Upper panel:** DASCH light curve of B1e star HD 228256. **Lower panel:** AAVSO V band light curve of Be X-ray binary X Per binned in 25 day increments, with time of its X-ray burst in 2003 marked by red dashed line (Grundstrom et al. 2007).

Further observation need: X-ray (Chandra); binary orbit (TRES).

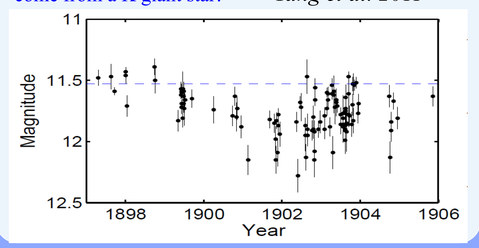
A new symbiotic nova with M1III+WD, only 9 other are known

Tang et al. in prep.

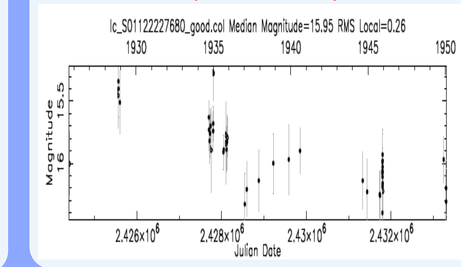


KU Cyg: a 5-yr dust accretion event in ~1900

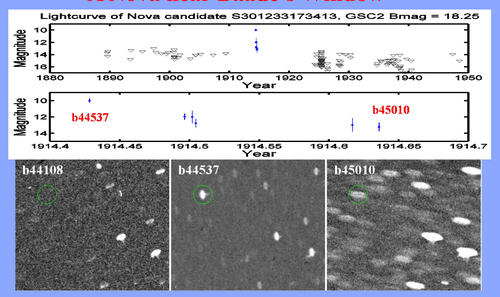
An Algol system with transfer of material that maybe come from a K giant star! *Tang et al. 2011*



An independent re-discovery of a 16 mag Z=0.38 AGN by its variability



A Nova near Baade's Window



Summary

- DASCH: **100 yr** light curves of B<15 objects.
- **14,500 plates** scanned so far are only **2.6%** of the whole Harvard plate collections.
- Huge potential in **exploring long-term variability for known variables** and **discovery of exciting new types of variables**.

For more details see DASCH website:
http://hea-www.harvard.edu/DASCH/