# VARIABILITY ACCORDING TO KEPLER

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## NASA Kepler Mission

- The Kepler mission consists of a 1m telescope and CCD camera, designed to measure Earth-like transiting planets orbiting solarlike stars.
- Kepler stares at one 115 sq. degree field of view in Cygnus/Lyra for 4-6 years, collecting light curves for >100,000 stars.
- Kepler light curves consist of 1 or 30 min samples with ~10 ppm precision (best).



#### Launch – 6 March 2009









# Kepler First Light Image



## Zoomed image

- Open cluster NGC 6791
- Note defocus
  & square-ish stars.
- Int time =6 sec
- Pixel = 4''
- FWHM = 6.5″
- Star Aperture
  = ~30+ pixels



### CCD Focal Plane Assembly

### Note curvature and CCD pairs





## Kepler "V+R" bandpass



# CCDs covered with coated field flattener lens (FFL)



## Exo-Planet Hat-P-7b





## Light Curves not without Instrumental/other effects





## Bright G dwarf stars

~50% of solar-like stars are more active then the active sun -- 1/3 for G type, >>50% for mid-K and cooler



From Koch et al. 2010 Basri et al. 2010







#### Mighell and Howell 2010

## Kepler Phot. Prec. vs. ~r mag



## **Best Photometric Precision**

History of Photometric Precision



## **Best Photometric Precision**

History of Photometric Precision



## Kepler Photometric Precision r ~ 8.5 to 19



## V344 Lyr - Cataclysmic Variable r~18 at minimum, 14 at max



## Quiescent Light



## Superoutburst humps



## Detailed analysis of Periods and Amplitudes

Period Stability



**Amplitude Stability** 



### Can Nothing Escape? A r=18.8 White Dwarf showing 0.08 mag humps, rotation?



From Kepler Calibration and Science program (Holberg, Howell, Mighell)

## SUMMARY

- 4 year time span providing >100,000 light curves of stars from r~10-16
- Additional thousands of light curves from GO programs (r~10-20)
- Instrumental and blending effects involved, getting worked out
- Precision 0.00002 0.00060 mag !! (r~ 8-13)
- Variability >50% of all stars are variable (will likely increase as we refine light curve analysis)
- Hundreds of new / odd variables Need follow-up (phot + spec) observations. Relatively easy, but need (lots of) telescope time.
- New detailed phenomena observed The more you