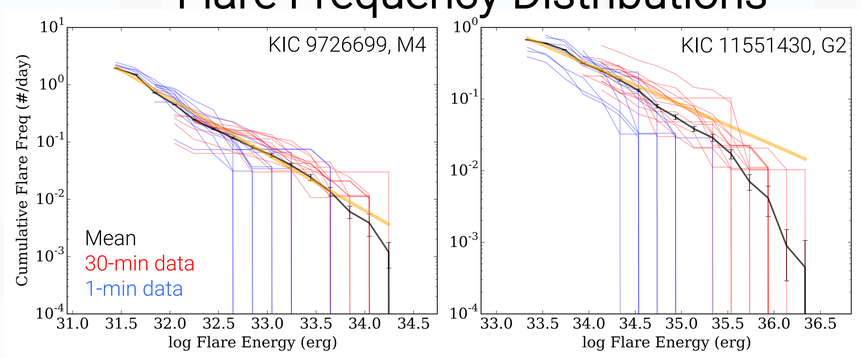
THE KEPLER VIEW OF STELLAR FLARES

James R. A. Davenport – NSF Postdoctoral Fellow – Western Washington University

ABSTRACT

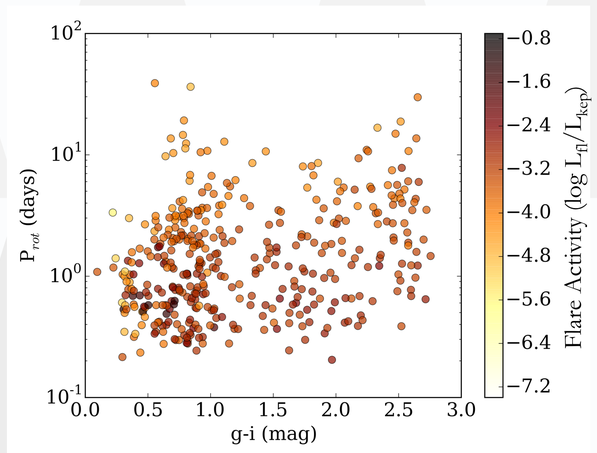
I present results from an automated survey of stellar flares using the entire Kepler dataset. This program has recovered over 1.3 million flare candidates from 4041 stars, the largest census to date. Matching these flare stars to Kepler rotation periods, we find a decline in flare activity as stars spin down. For a subset of Kepler M dwarfs with low resolution follow-up spectra, we find a correlation between Hα luminosity and the flare activity. These results give the first definitive evidence of flare activity declining over stellar lifetimes, indicating flares are a new and useful indicator of the age–rotation–activity evolution of stellar dynamos.

Flare Frequency Distributions



Long- and short-cadence Kepler data are combined to create flare frequency distributions. Completeness limits are calculated via artificial flare injection tests. Power law distributions are fit. Breaks at large flare energies are found for some stars (right).

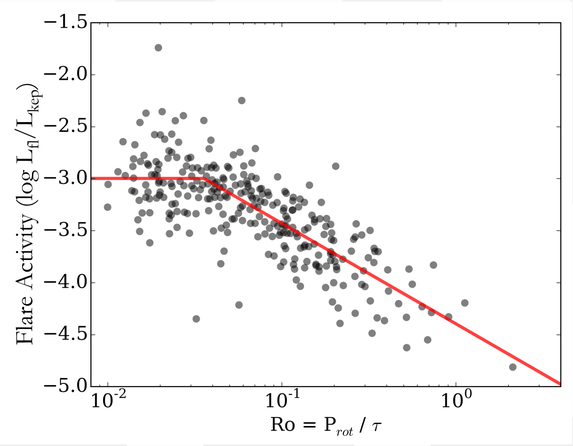
Flare Activity vs. Color & Rotation



Stronger flare activity is seen on the rapidly rotating, young stars in Kepler. Flare events are recovered on some of F stars, but no trend with rotation is seen. The observed evolution in flare activity with rotation for GKM stars will help calibrate flares to gyrochronology as an age indicator.

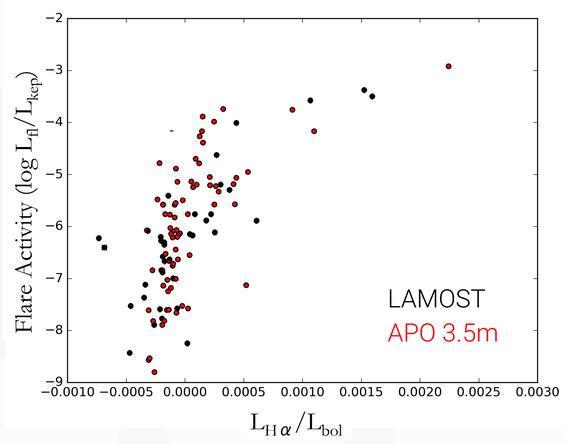
Flare Activity & Dynamo Evolution

Flare activity versus Rossby number for G8–M4 stars. A saturated regime is found for Ro<0.03, versus the typical value of 0.1 from X-ray activity. Flares appear to be sensitive to changes in rotation *before* other indicators of dynamo activity. The power law slope of β=-1 is shallower than the typical value of -2 for X-ray or UV emission. Flare activity declines *slower* than other activity indicators.



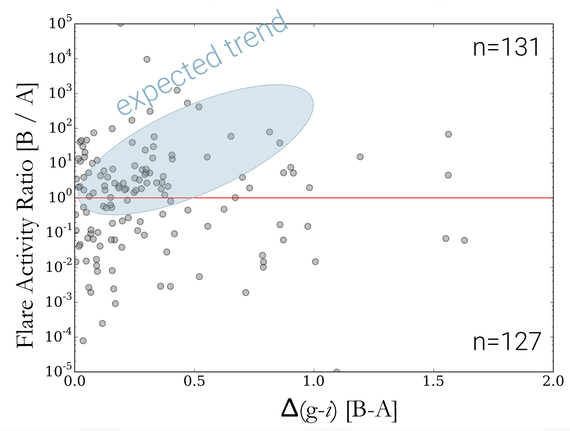
Flare Activity vs. H α

Flare activity can be compared to traditional indicators of activity, such as chromospheric H α emission. A strong correlation is seen for the most active dM's using low resolution ground-based spectra.



J. Davenport, T. Wilkinson, L. Hebb, S. Hawley, M. Agueros, et al., *in prep.*

Flare Activity in Wide Binaries



R. Clarke & J. Davenport, *in prep.*

Using known wide binary systems in the Kepler field, we are testing the age vs. flare activity relationship. Equal mass binaries ($\Delta(g\text{-}i)=0$) should have the same level of flare activity. We expect lower mass stars to have longer active lifetimes. Preliminary results show a large scatter in flare activity between coeval stars, fueling debate on the origins of these systems.

@jradavenport

http://jradavenport.github.io/preprints

http://github.com/jradavenport/appaloosa

This work is supported by an NSF Astronomy and Astrophysics Postdoctoral Fellowship under award AST-1501418.

COOL STARS - 19 -