Exoplanets Around Flare Stars

James R. A. Davenport
NSF Astronomy & Astrophysics Postdoctoral Fellow, Western Washington University
DIRAC Fellow, University of Washington

jradavenport
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Casey Reed/NASA
See poster Adam Schneider:
The UV Evolution of Mid-Type M Dwarfs with GALEX
so many flares!

GJ 1243, M4
300 days of 1-min data
$P_{\text{rot}} = 0.59$ days
+6100 flares!
find every flare in Kepler: **appaloosa**

http://github.com/jradavenport/appaloosa

*why “appaloosa”? Ask me later*
find every flare in Kepler: **appaloosa**

3 steps to find flares in Kepler:

1. Detrend – iterative removal of “noise”
2. Detect – find “significant” peaks
3. Distrust – artificial flare injection and recovery
Flare Frequency Distribution (for 1 star)

Cumulative Flare Rate

Cumulative Flare Freq (#/day)

$10^{-3}$ $10^{-2}$ $10^{-1}$ $10^{0}$ $10^{1}$

$30.5$ $31.0$ $31.5$ $32.0$ $32.5$ $33.0$ $33.5$ $34.0$ $34.5$

log Flare Energy

68% Completeness Test Limit

individual quarters of data

Davenport 2016
A break in the powerlaw?  
(talk with Dave Soderblom)
Fit with powerlaw

\[ \log \nu = a \log \varepsilon + b \]

- flare rate slope
- specific flare rate

Add terms for **mass** and **age**

\[
\begin{align*}
a &= a_1 \log t + a_2 m + a_3 \\
b &= b_1 \log t + b_2 m + b_3
\end{align*}
\]

*Age from gyrochronology model*
Flare Rate vs. (Mass, Age)

Davenport et al. (2017 in prep)
Proxima

Alpha Cen A&B

Proxima b

P = 11.186 days
m sin i = 1.27 M☉

habitable zone!

transit?

ESO

@jradavenport
MOST

Microvariability and Oscillations of STars

2014 & 2015
37.6 days on Proxima
~1min cadence
Proxima Cen  Over 60 flares found

Flares!

gaps due to orbit
Proxima: Flare Rate vs. Energy from \textit{MOST}

66 per day, Amplitude \approx Transit of Proxima b

Cumulative Flares per Day

log Flare Energy (erg)

See poster: Ward Howard
Stellar Activity for Every TESS Star in the Southern Sky
No conclusive evidence for a transit from MOST data

\(~1.5\%\) chance of a Transit

Flares really hurting us
Need more continuous data

Go to infrared?

Kipping+2016
Flares in the Optical & IR
Observations

Flares in the Optical & IR

Models

Davenport et al. (2012)

Tofflemire et al. (2012)
Gillon et al. (2017) ~20 days

Luger+2017 ~79 days
BIG flare(s)

K2 light curve
TRAPPIST–1

K2 light curve

Flare

Barycentric Julian Date − 2,457,700 [day]

Normalized Flux

Luger+2017
Flares from Spitzer

TRAPPIST–1
Flares from Spitzer

Similar K2 flare

TRAPPIST–1
Comparable rates between optical & IR
Incredible - flares overlapping 2 transits!

TRAPPIST-1
Flares *may* be bad for habitability!

Flares make transit searches hard(er)

Flare rates change with stellar age!

Flares are visible in the IR!