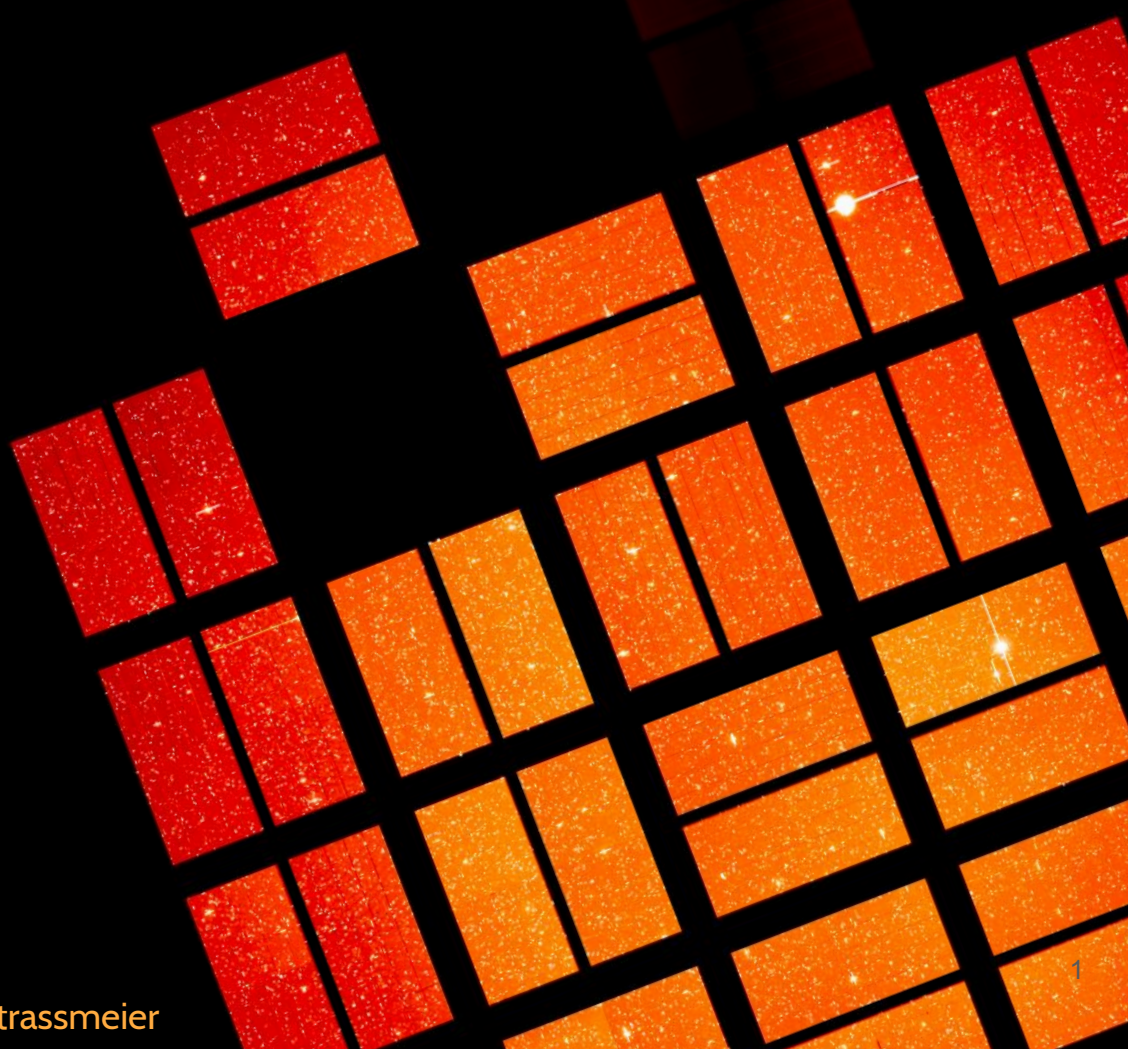
Stellar activity in cool stars: time series analysis

How to tell a star's age from its flaring activity



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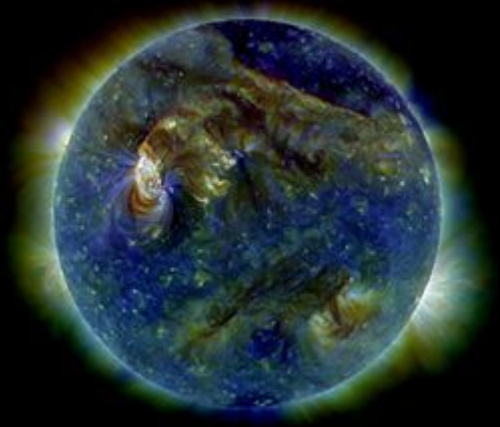
Advisors: Dr. Sarah J. Schmidt, Prof. Dr. Klaus G. Strassmeier

By NASA/SDO/AIA - NASA Image of the Day, Public Domain

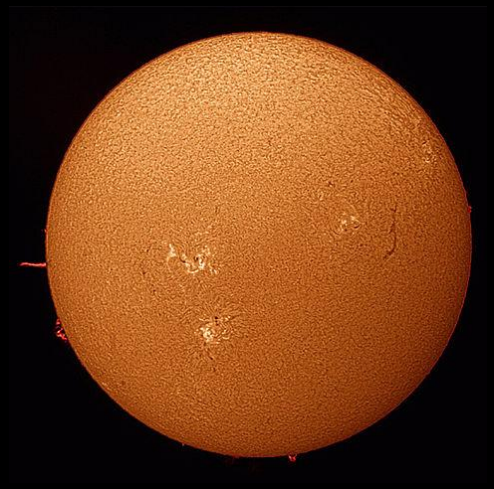
Big picture: stellar activity



As the star ages its magnetic activity evolves.

A magnetic dynamo is believed to be at work in stars with outer convection zones.

Magnetic activity phenomena include star spots, CMEs, chromospheric emission … and flares!



Sufficiently energetic flaring can be observed in: hard and soft X-ray, UV, visible (white light), line emission, IR, and radio bands.

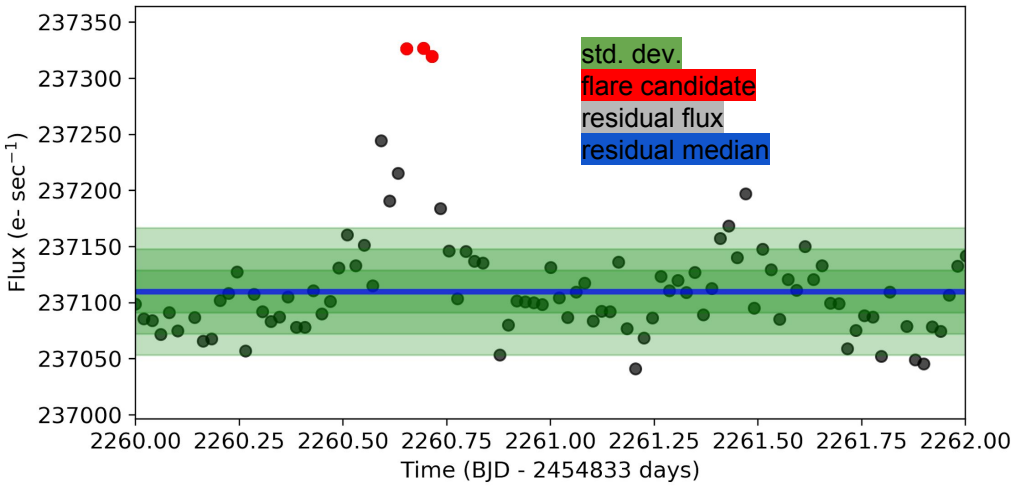
flaring activity = flaring activity (mass*, age)

***effective temperature, spectral type**

Origin: StephanPsy (GNU-FDL).
Uploaded by Birgit Kremer, Marbella, Spain, CC BY-SA 3.0,

How to establish a flaring clock

1. Detect flares as brightenings in stellar **light curves**.
2. Infer the **energy** released by each flare.
3. **Count** all the flares!
4. Relate results to **age and mass.**



time series analysis

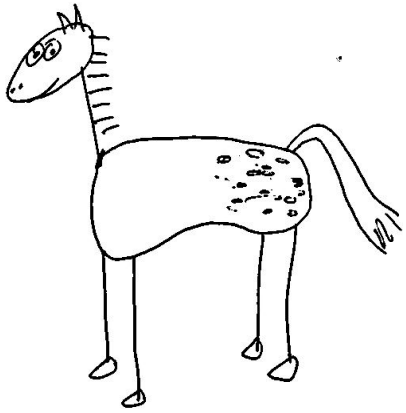
Automated flare detection

Appaloosa

- **automated flare finding pipeline**
  - takes raw light curves (LC) and fits a model LC
  - detection criteria: noise threshold, min. duration

Appaloosa enhanced

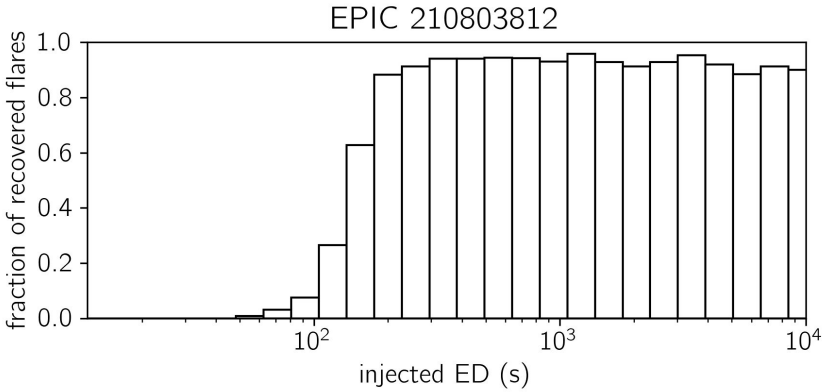
- **flare finding + synthetic flare injection/recovery**
  - account for recovery probability (synthetic flare detected or not?)
  - correct flare energies (injected energy > recovered energy)

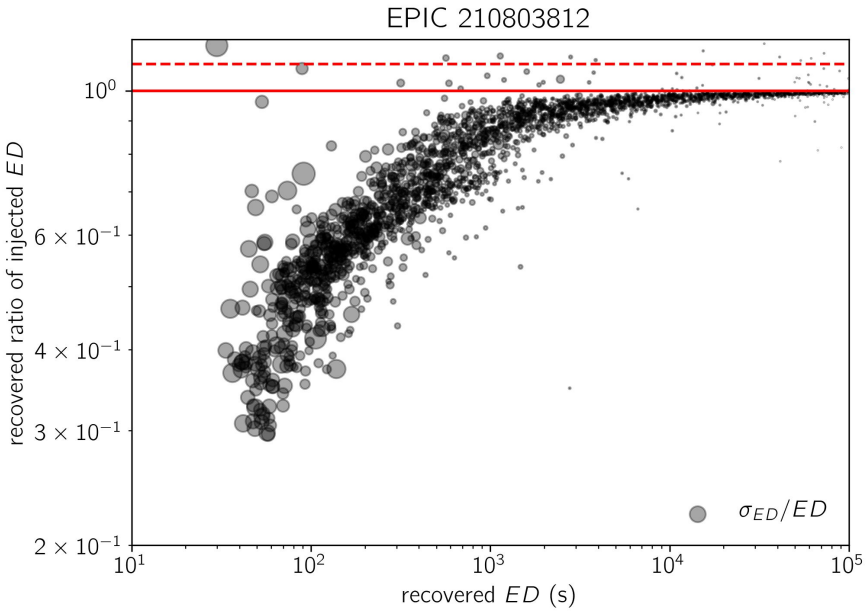


Davenport (2016)
https://github.com/jradavenport/appaloosa

Synthetic flare injection and recovery

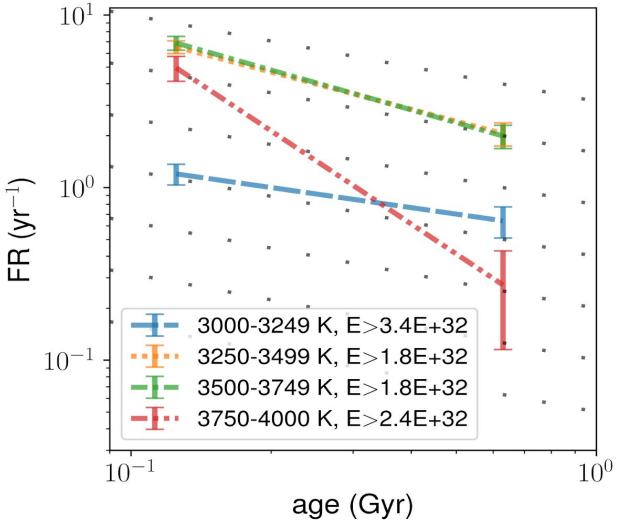
time series analysis



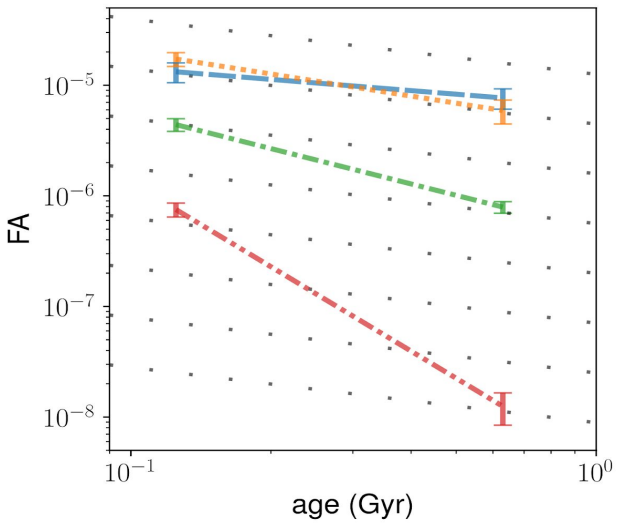


cool stars

flare rate (FR)



total energy released in flares relative to stellar luminosity (FA)



Flare frequency distributions in late-K to mid-M dwarfs

cool stars