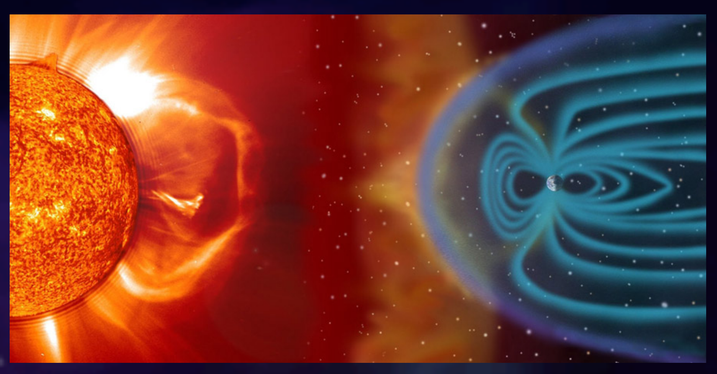
Stellar Flares on M-Dwarf stars

Dennis Afanasev

Exoplanets and Stellar Astrophysics Lab (Code 667)

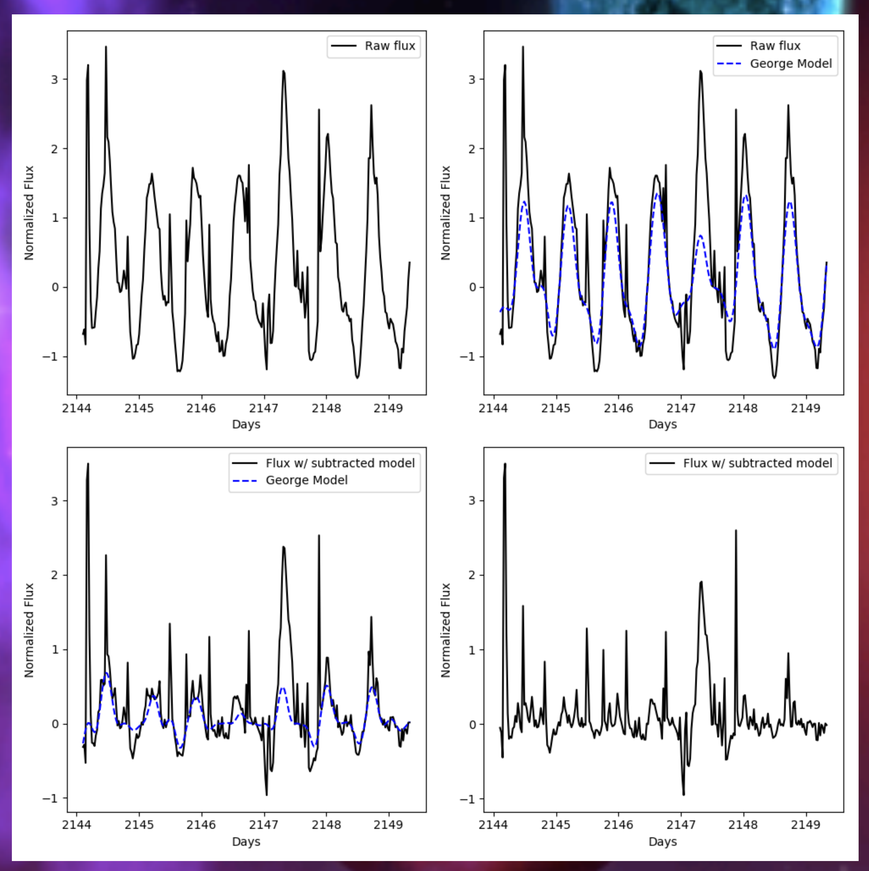
Abstract

Flares are observed as sharp increases in brightness from a star. They occur due to a sudden release of magnetic energy in the stellar region known as the corona. This release of energy triggers an outburst of charged particles, which have the potential to strip planetary atmospheres. Flares are common in young stars such as M-Dwarfs, which are also known hosts to most discovered planets in the habitable zone. I model and analyze known flare stars to better understand their occurrence rates.



Modeling Stellar Rotation

Stellar rotation is visible in data from the K2 mission and makes it difficult to analyze flares. This may be reduced by iteratively modeling and subtracting the rotation by modeling with a covariance function:

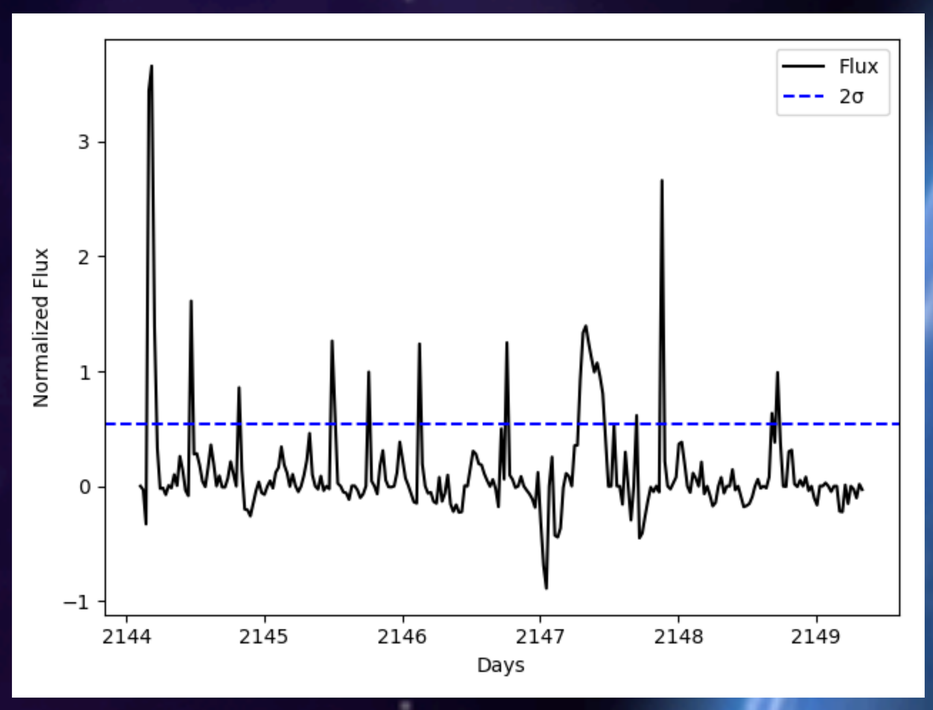


Covariance function used:

$$k(\mathbf{x}_i,\ \mathbf{x}_j) = \exp\left(-\Gamma\ \sin^2\left[\frac{\pi}{P}\,|x_i - x_j|\right]\right)$$

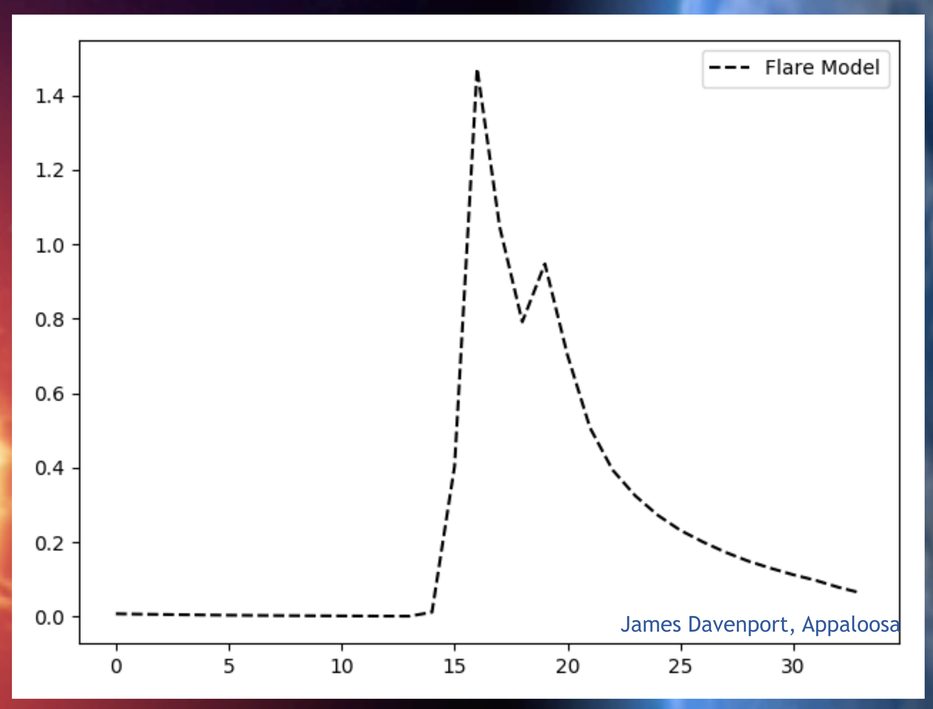
Flare Detection

Flares are identified as the peaks of brightness spikes above a 2σ threshold:



Flares may exhibit mini-flares before fully decaying. A spike in a larger flare is classified as a mini-flare if it exceeds the noise threshold, which is the average of a set:

$$noise = \{|\ x_n - x_{n+1}\ ||\ x_n, x_{n+1} \in F \wedge x_n, x_{n+1} < 2\sigma\}$$



Future Flare Star Analysis

The Transiting Exoplanet Survey Satellite (TESS) will observe many M-dwarf stars. My models will allow us to constrain flare rates and stellar rotation for a wide range of M-dwarf masses and ages. Our ultimate goal is to understand stellar environments and their impact on exoplanet habitability.