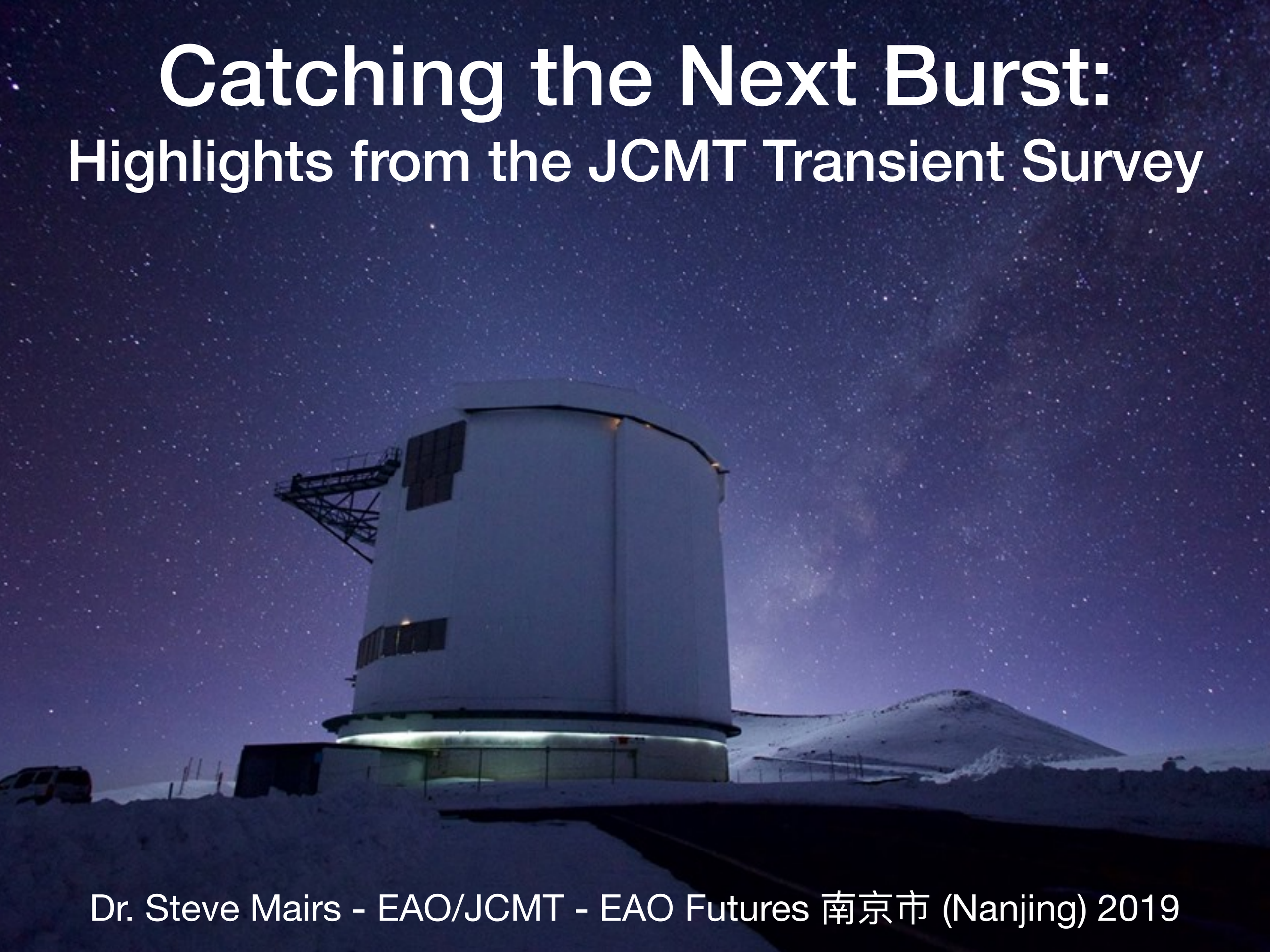
Catching the Next Burst:
Highlights from the JCMT Transient Survey



Dr. Steve Mairs - EAO/JCMT - EAO Futures 南京市 (Nanjing) 2019

Overview

The JCMT Transient Survey

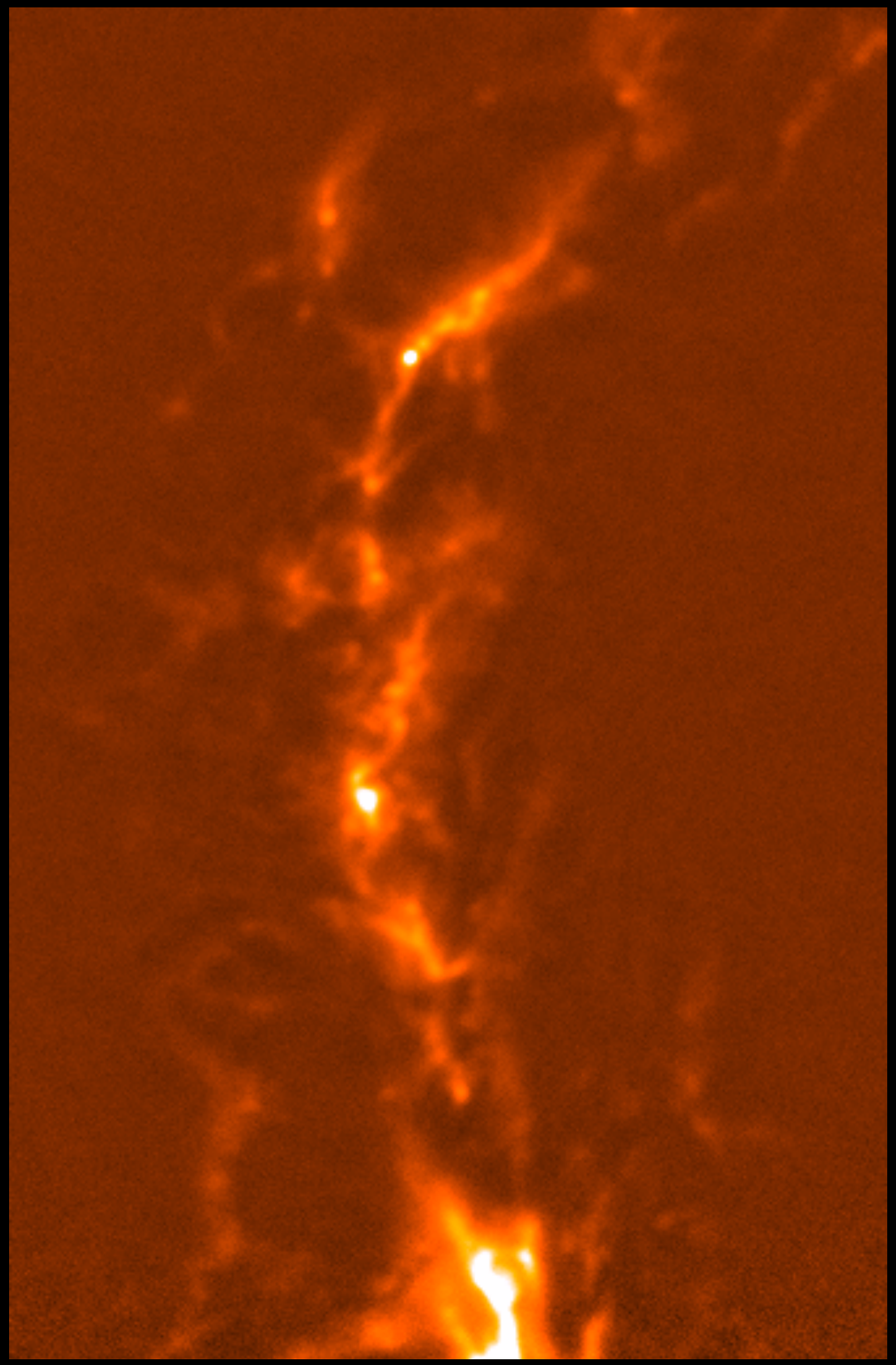
The Automated Pipeline

EC 53 (Periodic Variable)

HOPS 358 (Flux Decline)

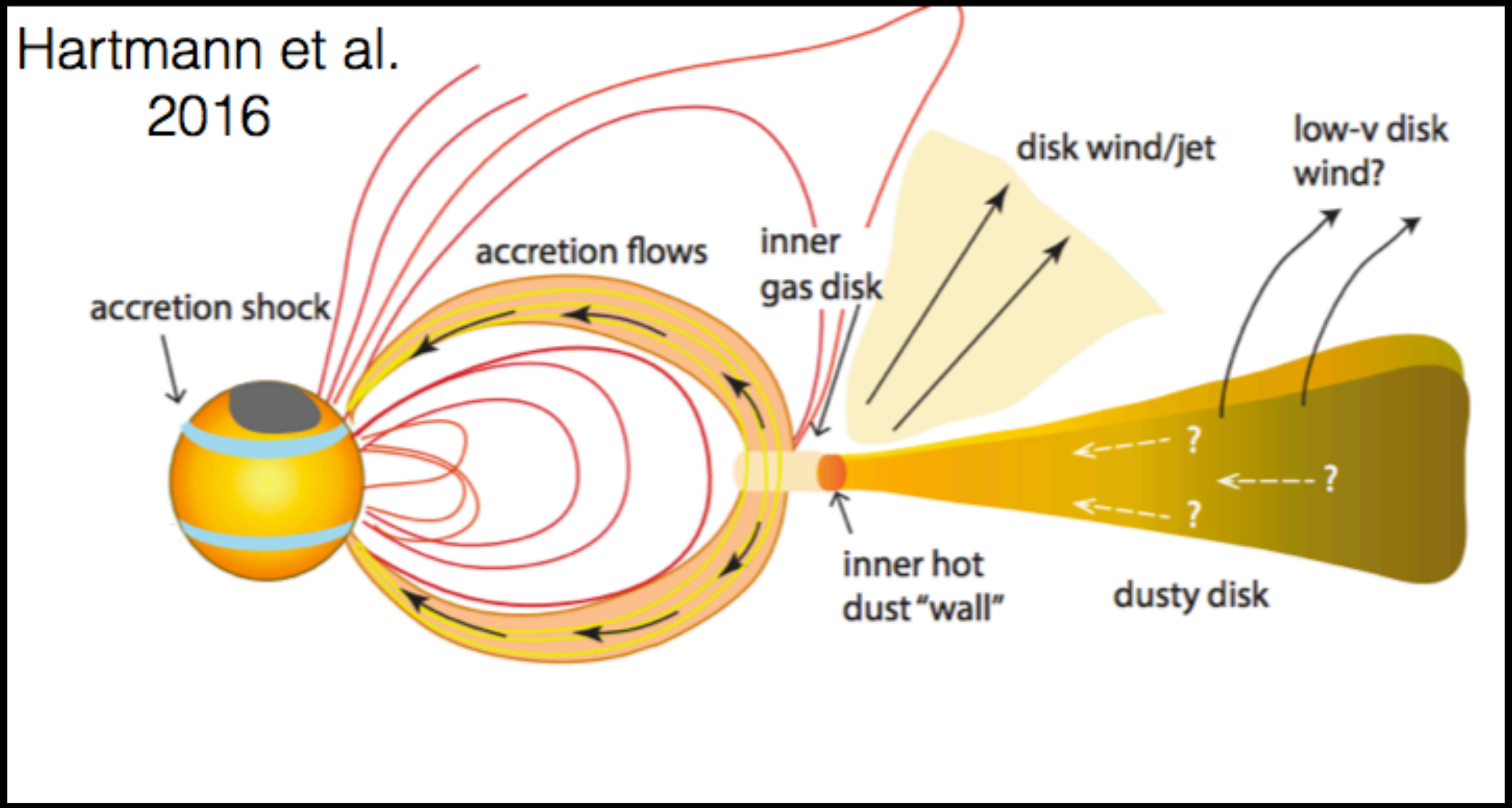
JW 566 (Flare Detection)

Paper Summary

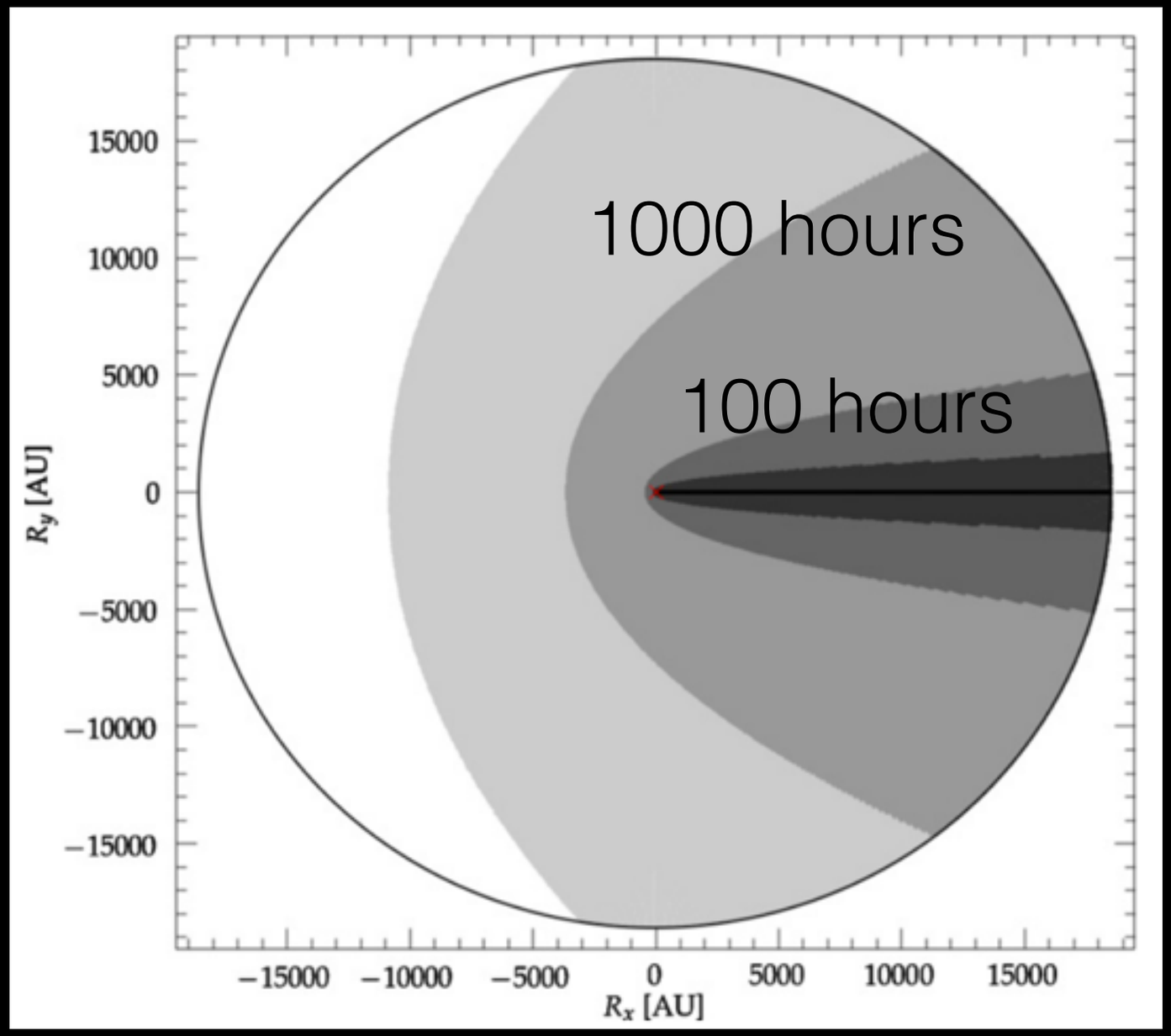


The Physical Conditions of Young Stars

Gravitational and magneto-rotational instabilities lead to clumping material and intermittent accretion bursts



Variability at Submillimetre Wavelengths



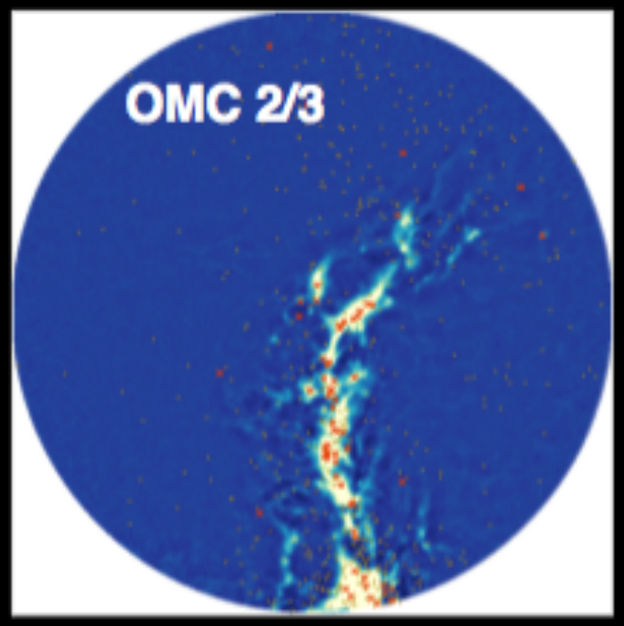
Johnstone et al (2013)
Modelled the SED of a deeply embedded Protostar undergoing an accretion burst using *DUSTY*

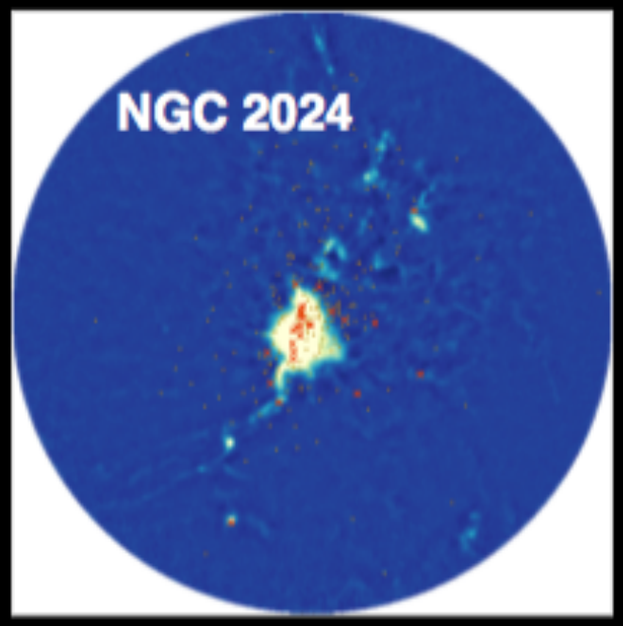
The light from the central source is reprocessed by the surrounding dust

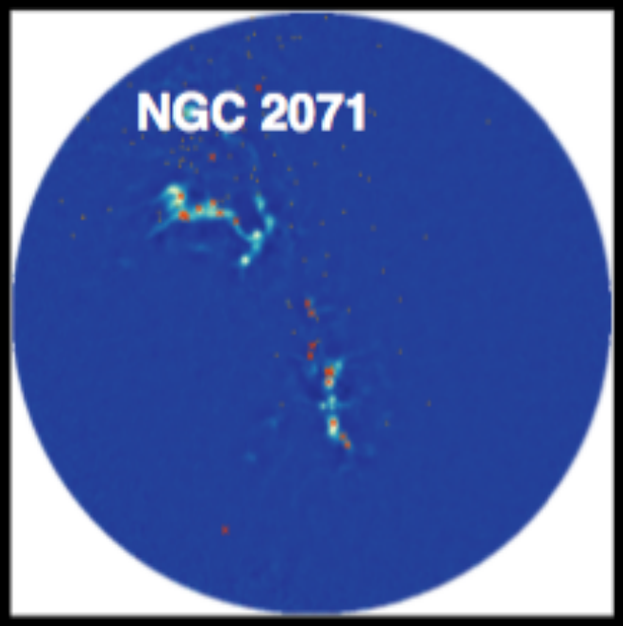
A typical low-mass star-forming envelope
Takes ~weeks to months to brighten and be detected in Submm

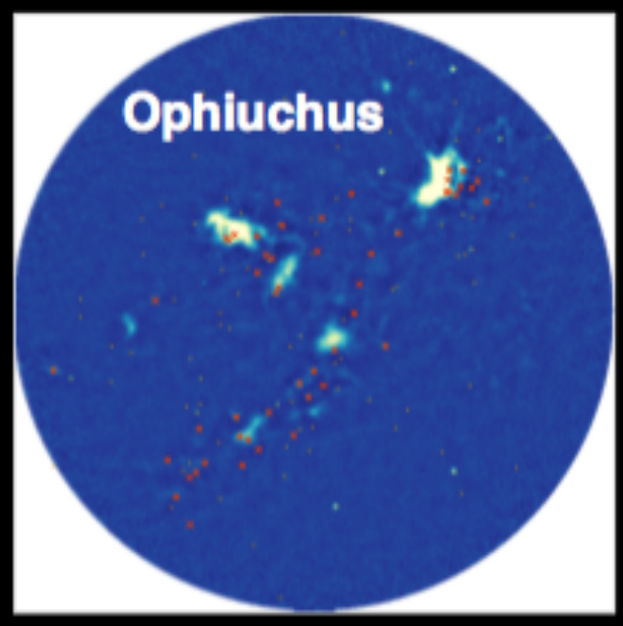
***Hops 383**
Safron et al (2015)

The JCMT Transient Survey







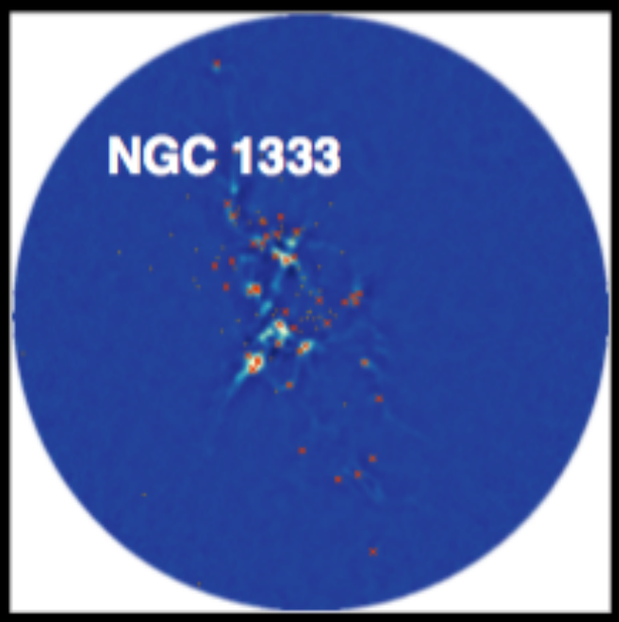


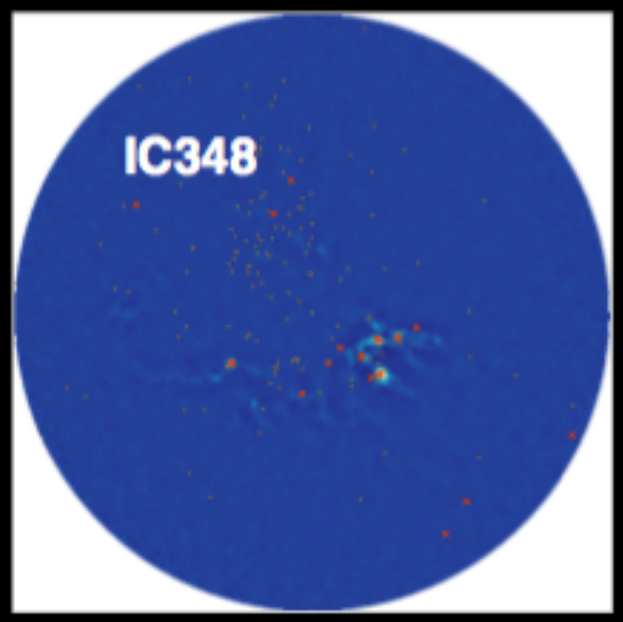
8 Regions < 500 pc (GBS)

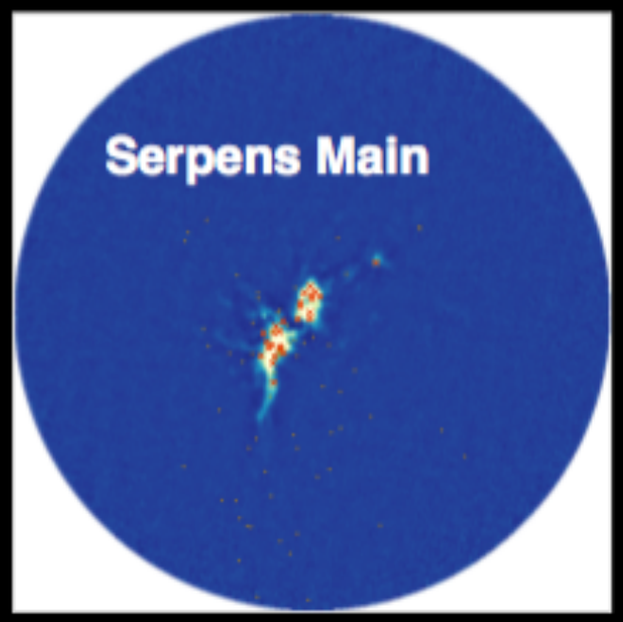
3 Year Survey

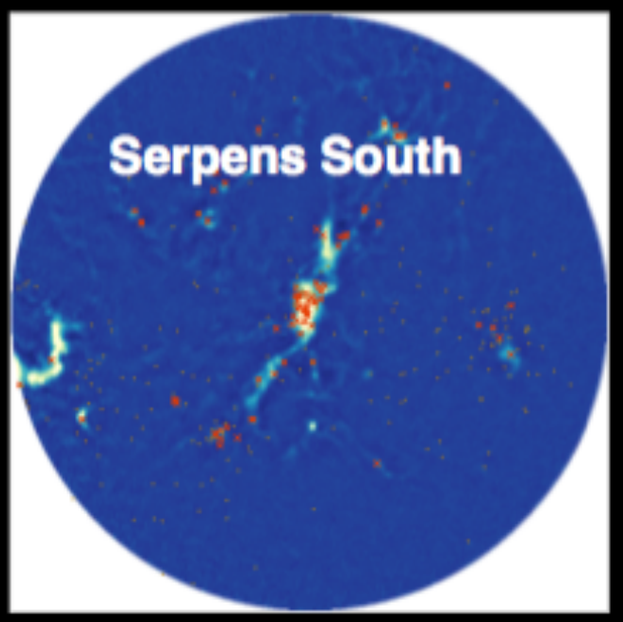
182 Protostars, 800 Disk sources

One Month Cadence

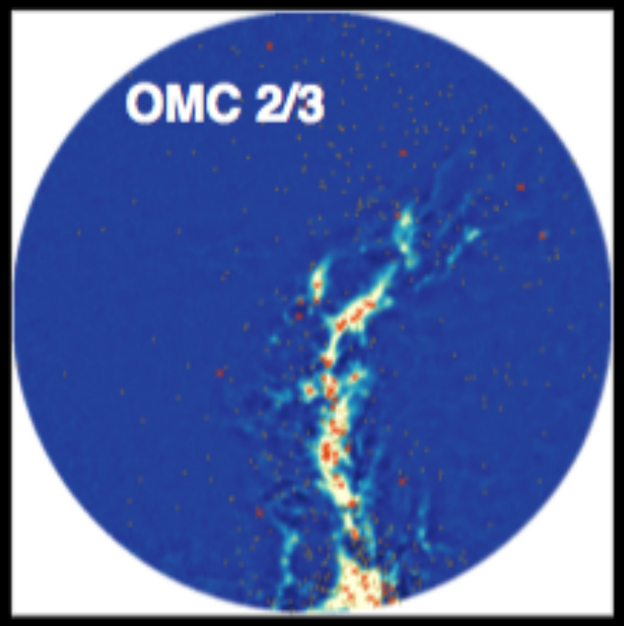


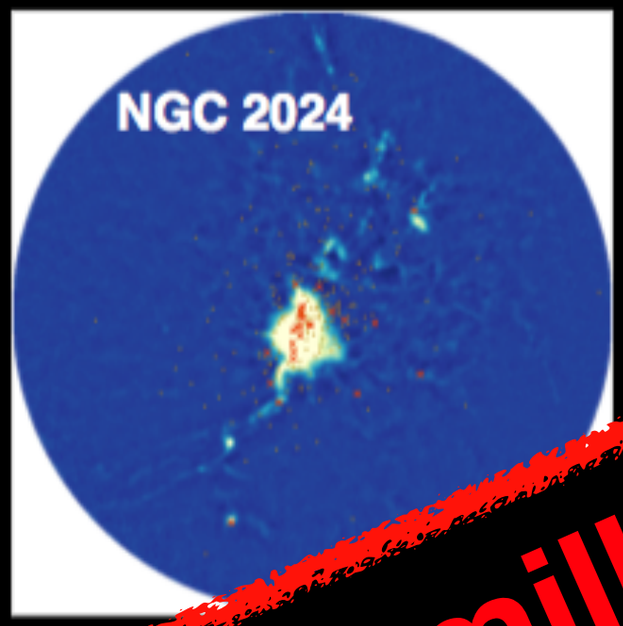






The JCMT Transient Survey





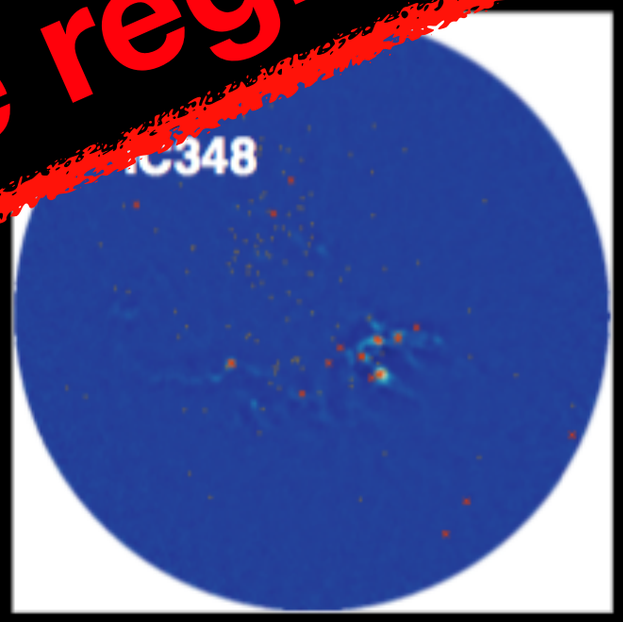
Deepest Submillimetre Maps of these regions by a factor of 2.5

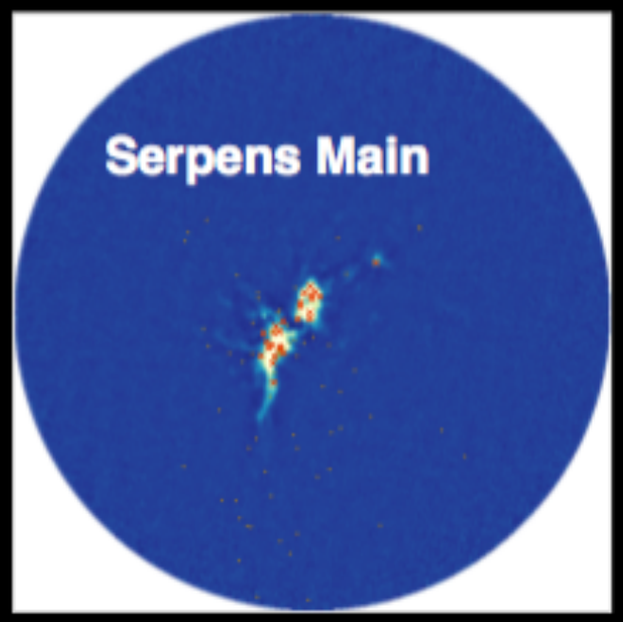
8 Regions

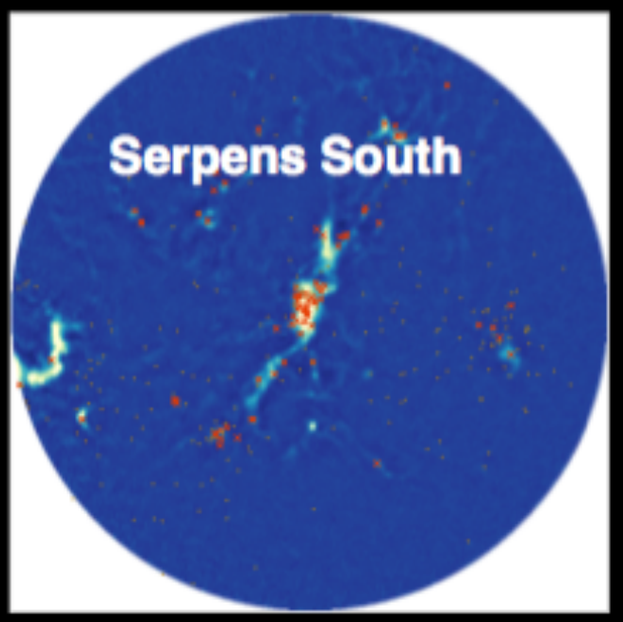
182

3 Year Survey

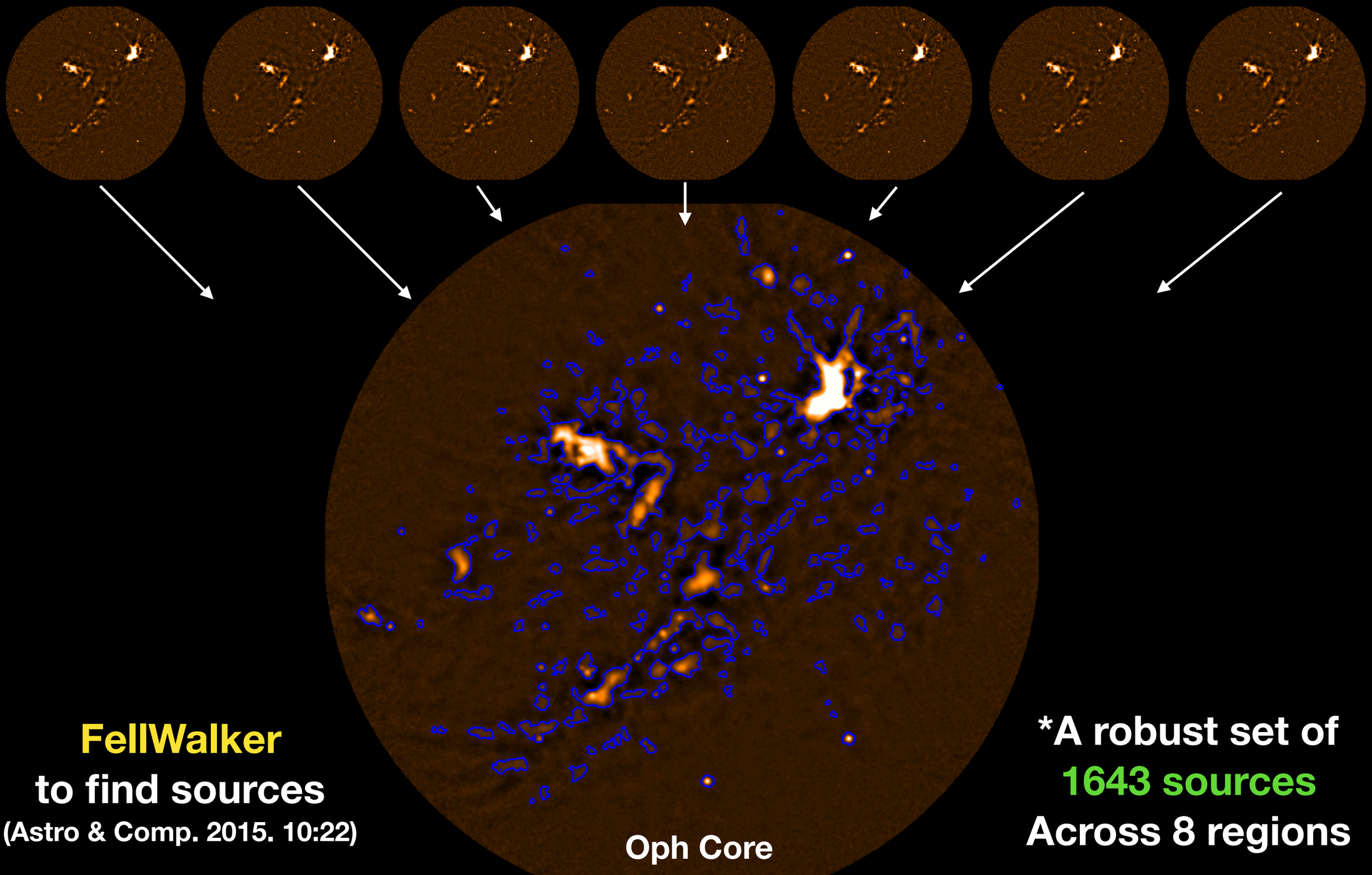
One Month Cadence







A Catalogue of Bright, Compact Sources

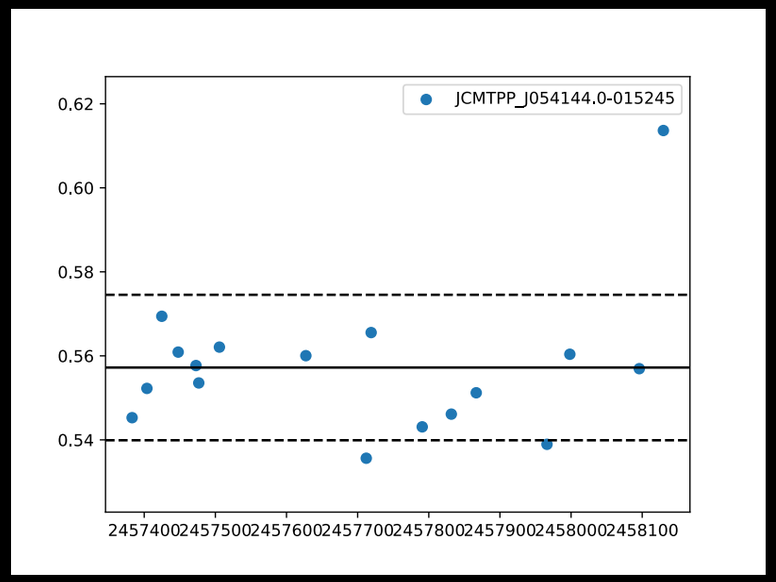


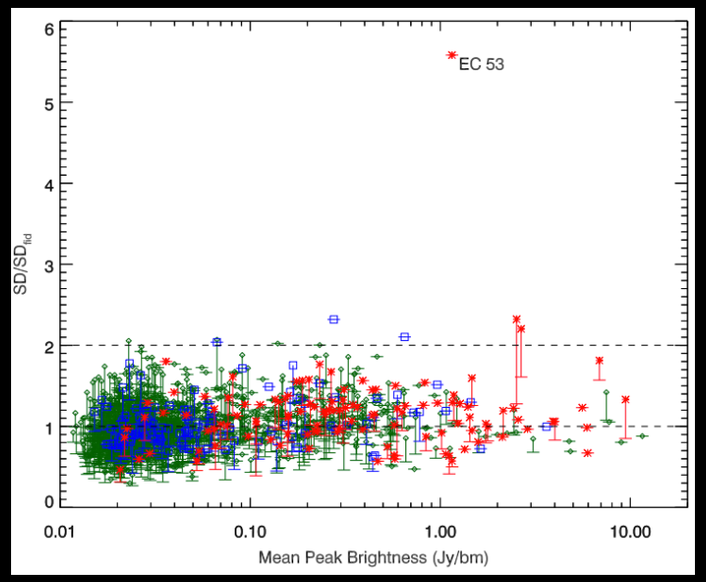
FellWalker
to find sources
(Astro & Comp. 2015. 10:22)

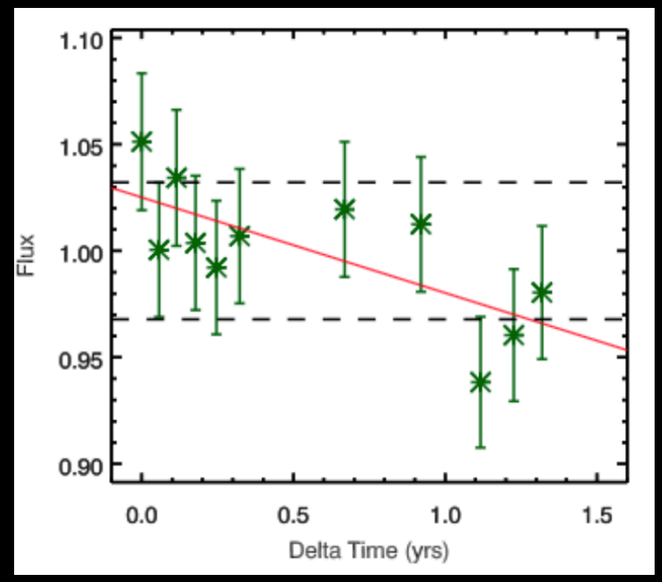
Oph Core

***A robust set of**
1643 sources
Across 8 regions

Three Tests For Variability

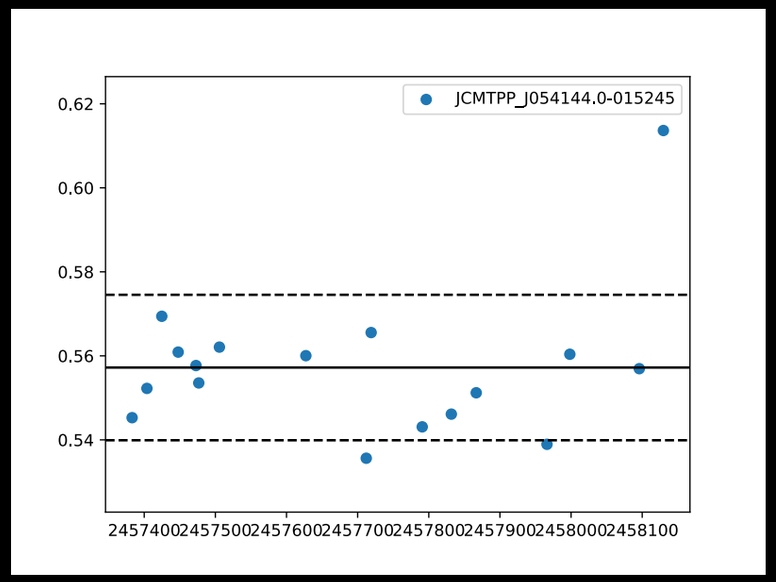


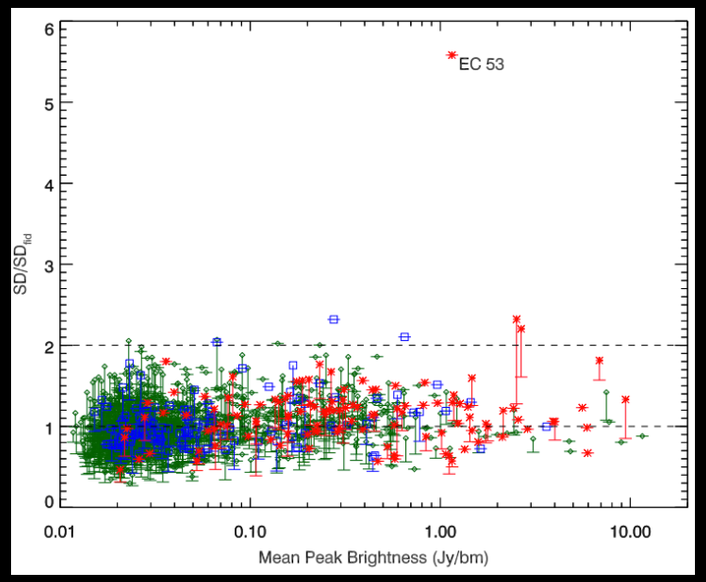


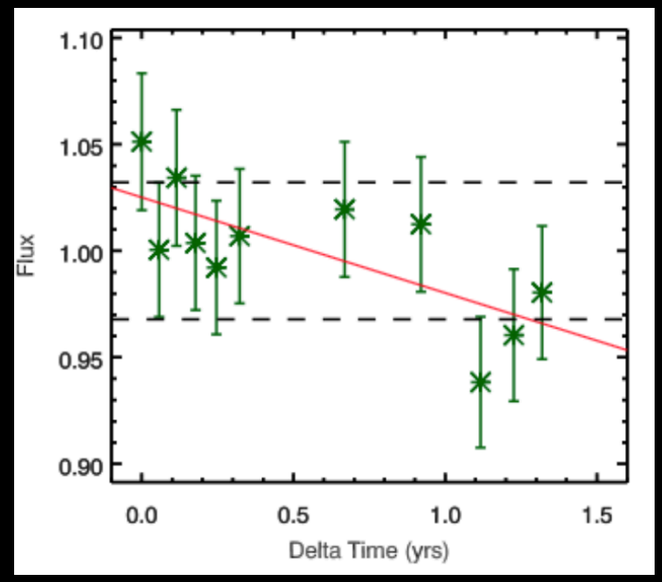


We have an automated system
Performing 3 statistical tests on all sources
(Johnstone, Herczeg, Mairs et al. 2018; ApJ. 854:31)

Three Tests For Variability







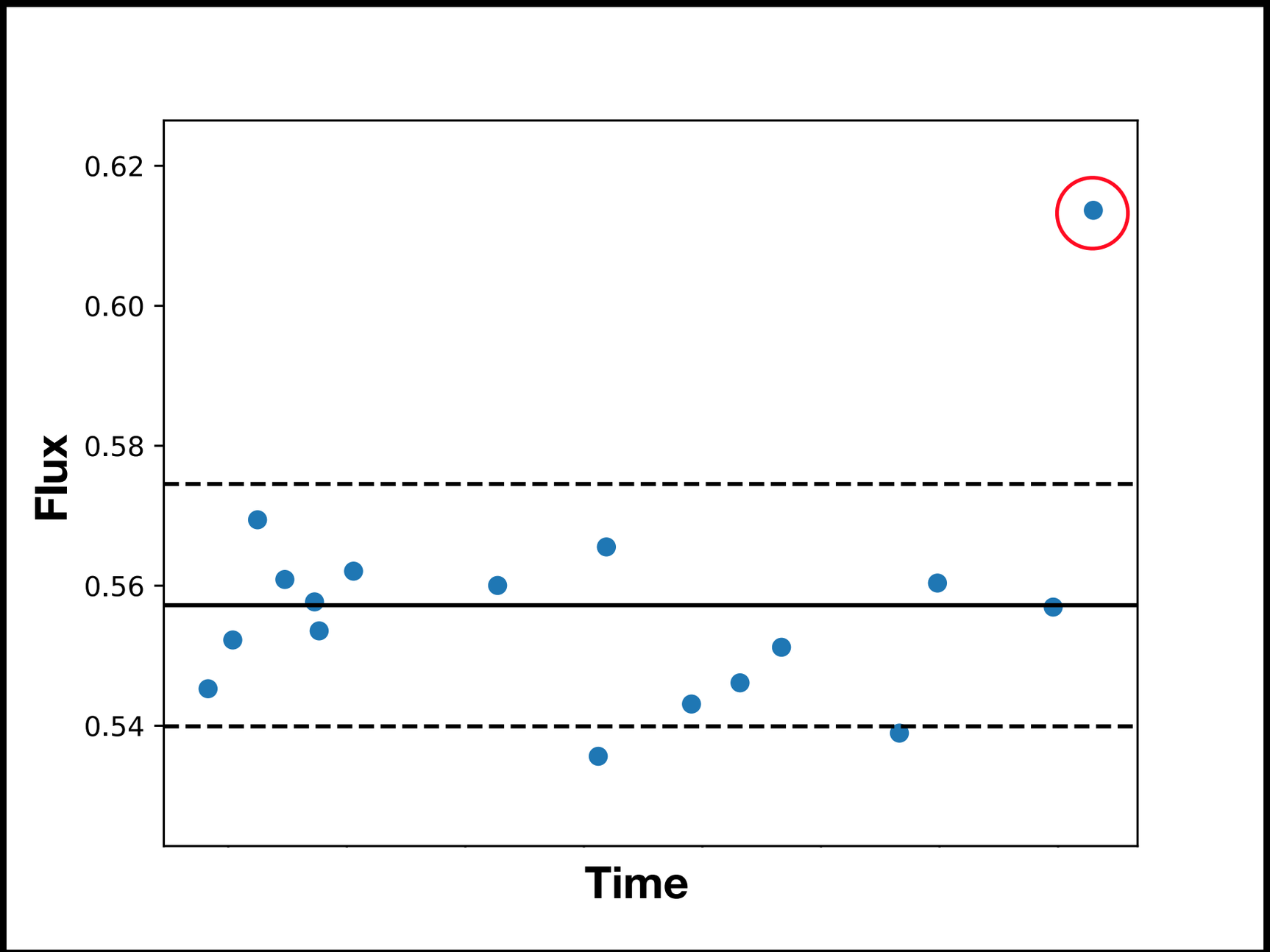
We have an automated system
Performing 3 statistical tests on all sources
(Johnstone, Herczeg, Mairs et al. 2018; ApJ. 854:31)

Example Email:

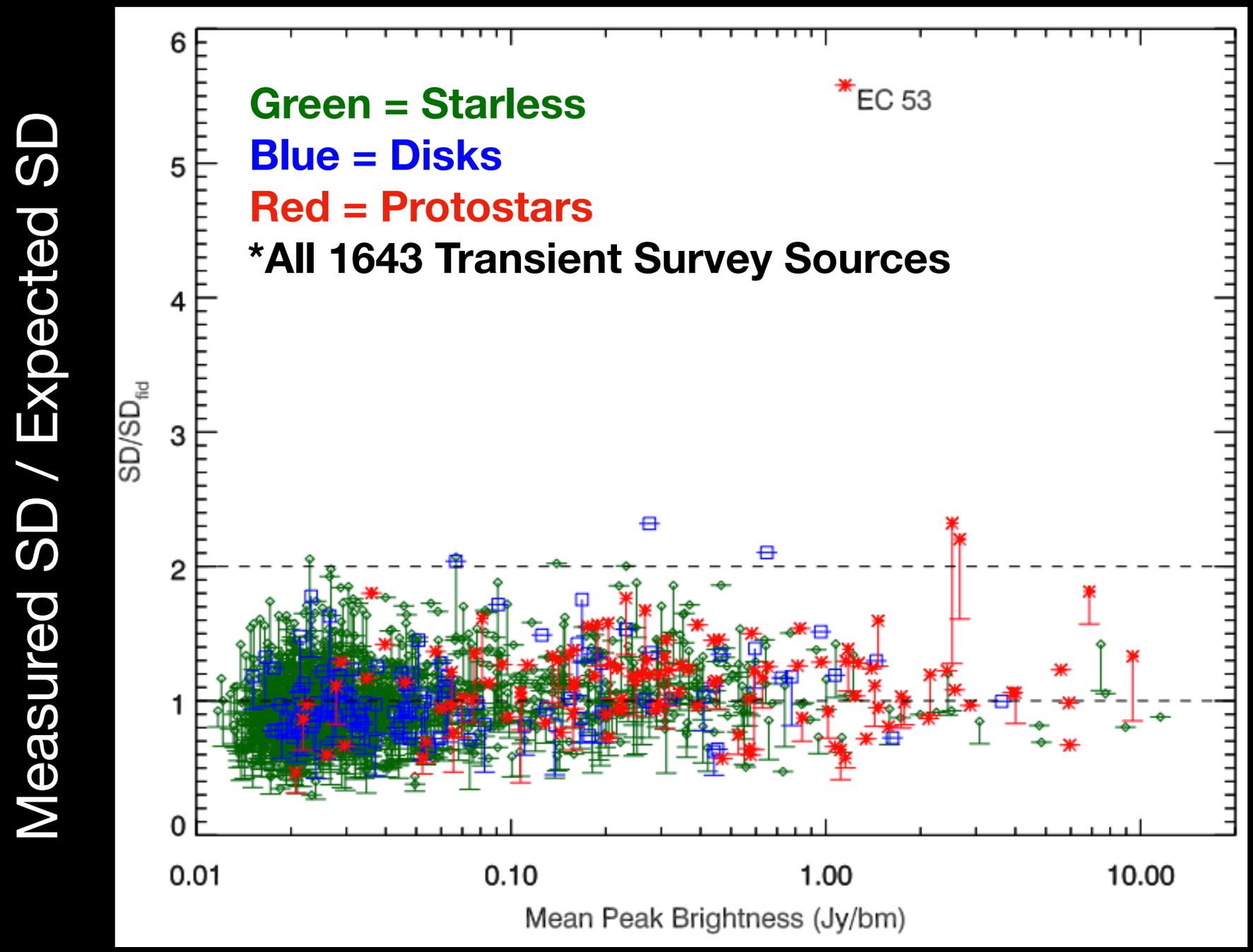
Source JCMTPP_J054144.0-015245 has abs(flux - flux_m)/SD = 6.17
On JD: 2458129.75634 = 2018/01/11
This is greater than the current threshold: 4.
Mean Source Brightness: 0.5572 Jy/beam.
This source is located at (RA, dec) = (85.43334,-1.8792)
The nearest protostar is 41.38" away and the nearest disc is 11.82" away.

1. Detecting Atypical Fluxes

$$\text{Significance} = \frac{\text{Flux\_}i - \text{Flux\_mean}}{\text{SD\_Flux}}$$

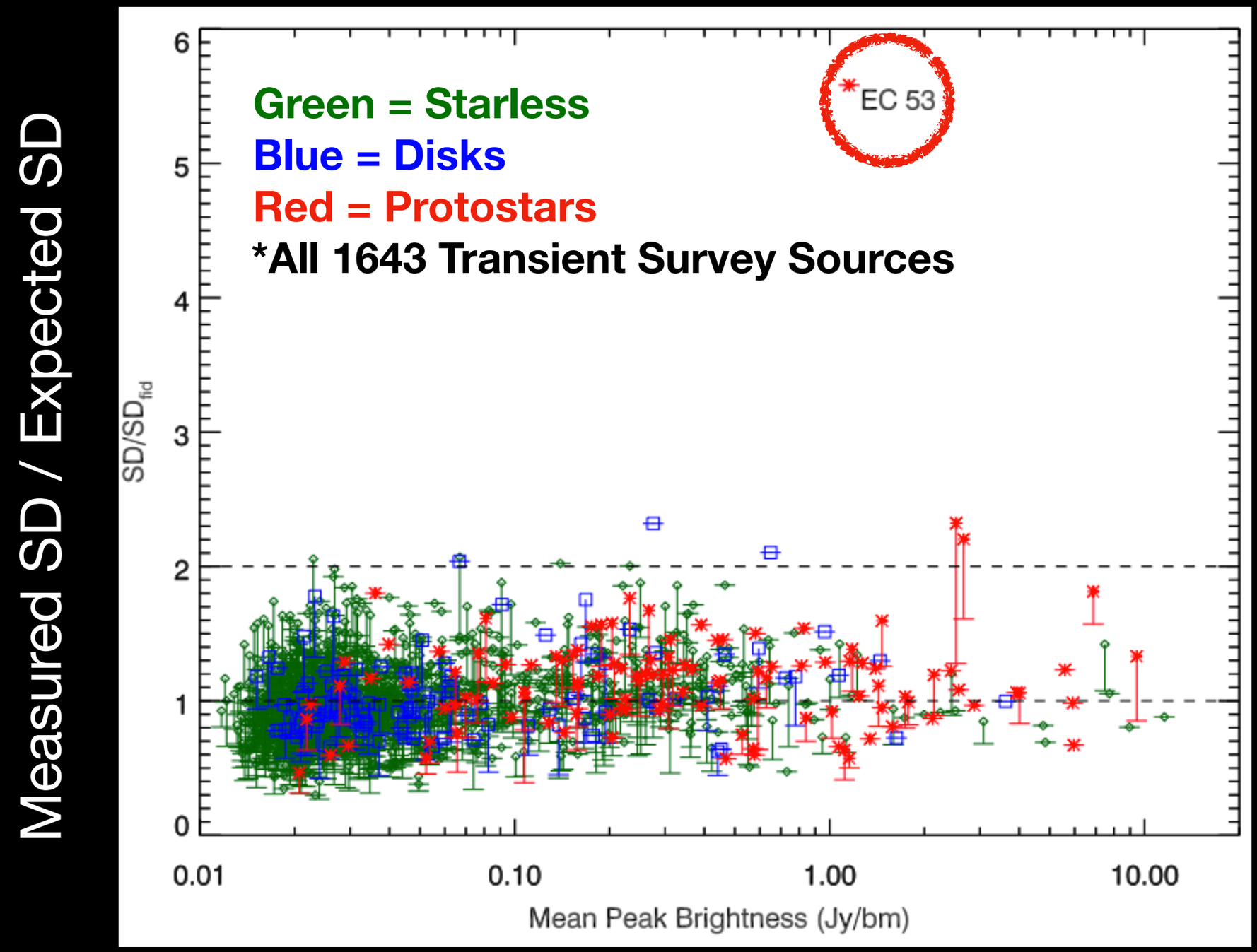


2. Comparing Light Curves to a Fiducial Model



Mean Peak Brightness

2. Comparing Light Curves to a Fiducial Model

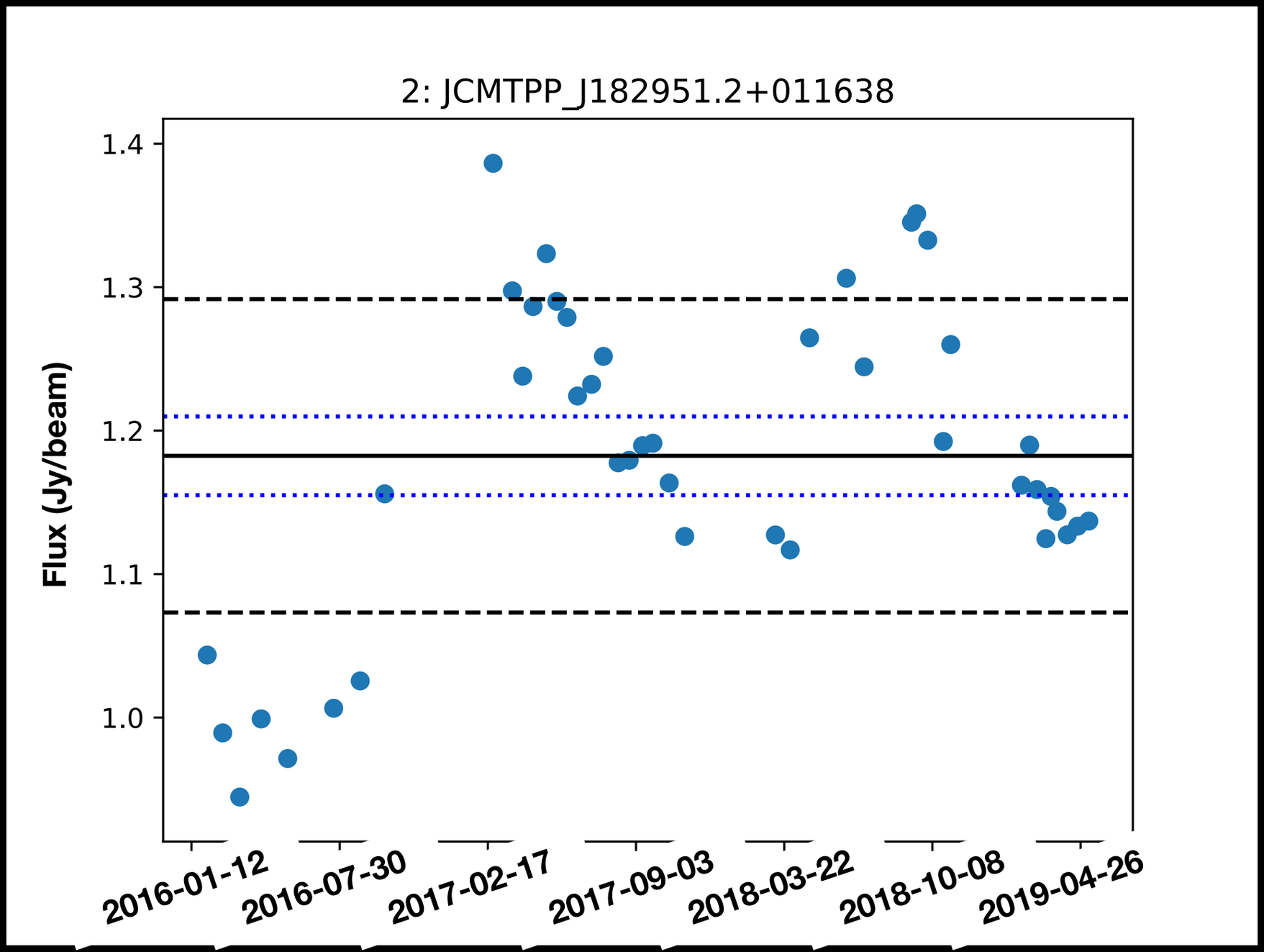


Mean Peak Brightness

EC 53: A Periodic Variable

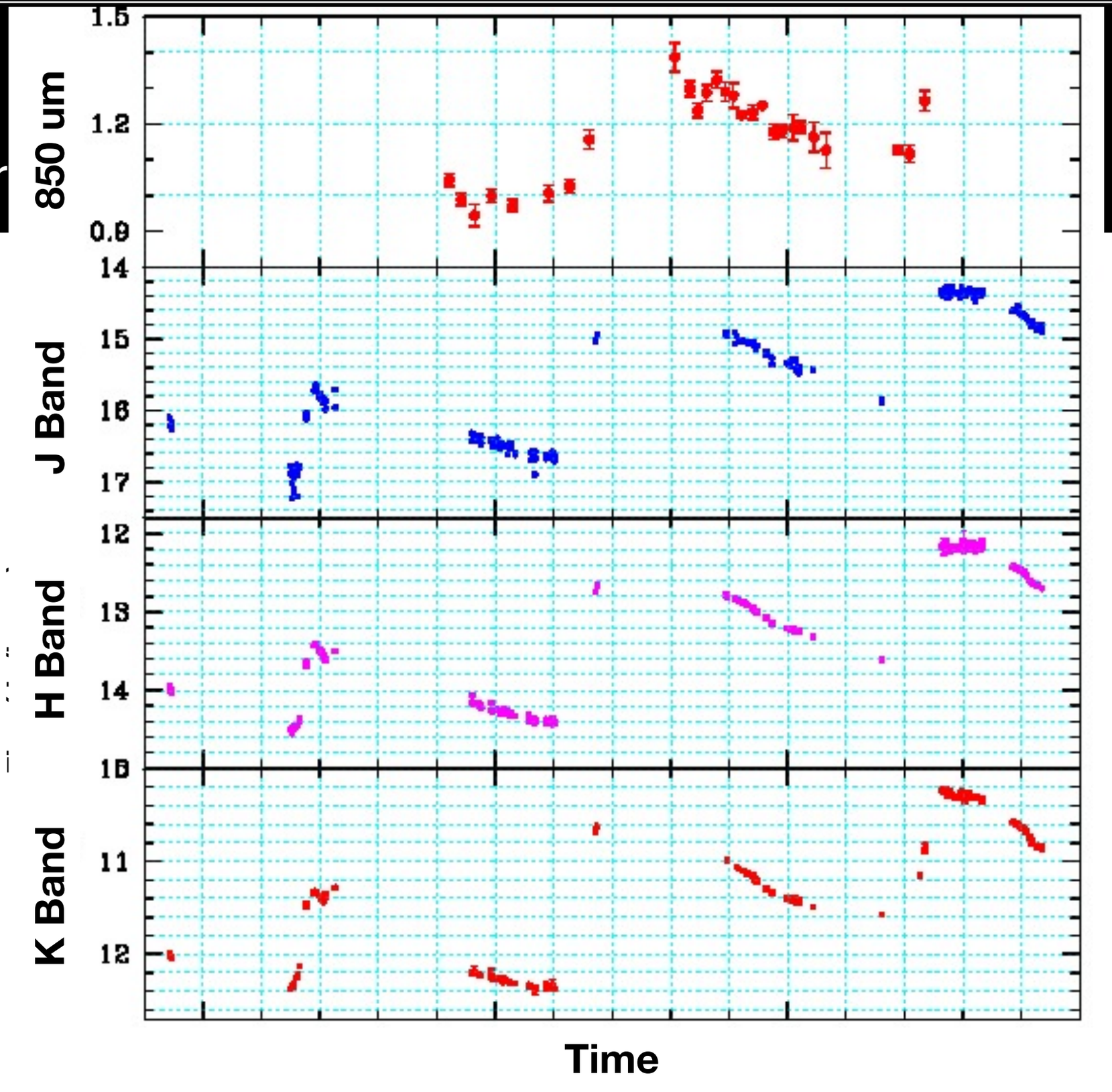
2017 ApJ 849:69. Yoo, H. et al.

EC 53: A periodic variable detected at infrared and submillimetre wavelengths



EC 53: A Periodic Variable

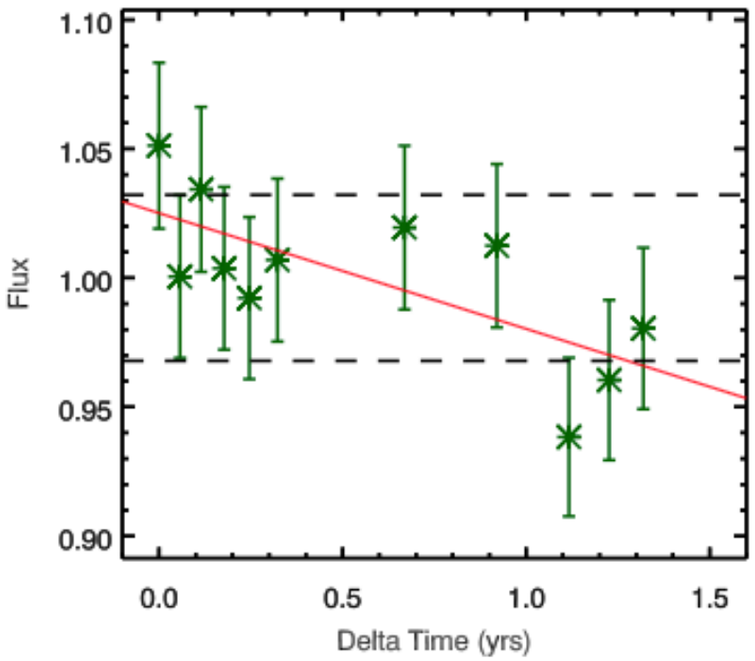
EC 53: A per

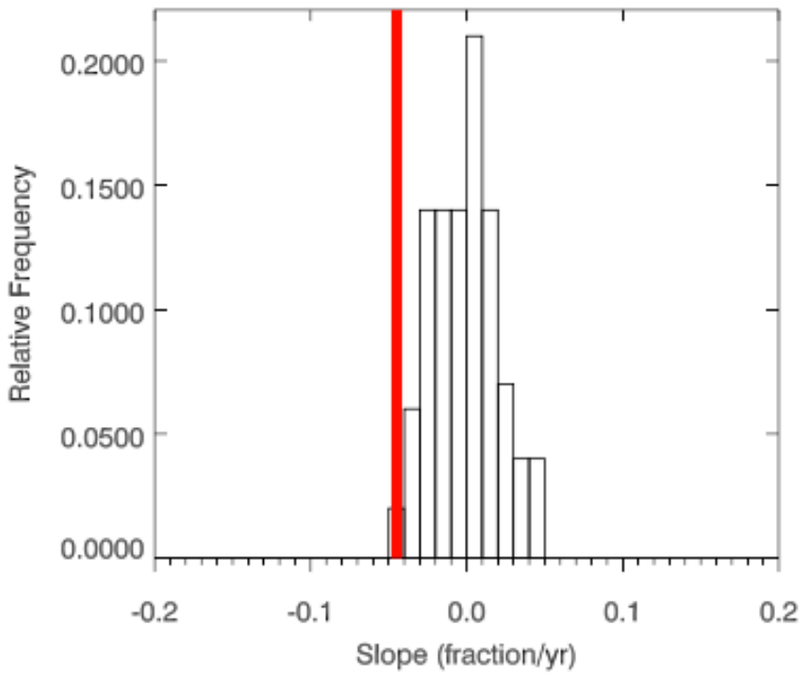


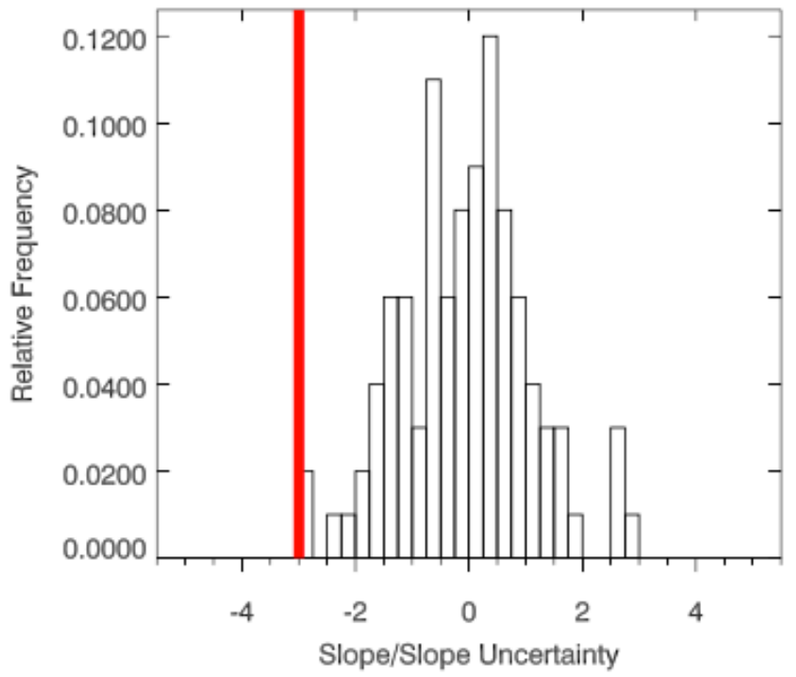
wavelengths

3. Linear Fitting to Light Curves

We also measured a **linear slope of each source's light curve** and compared it with the slope uncertainty.





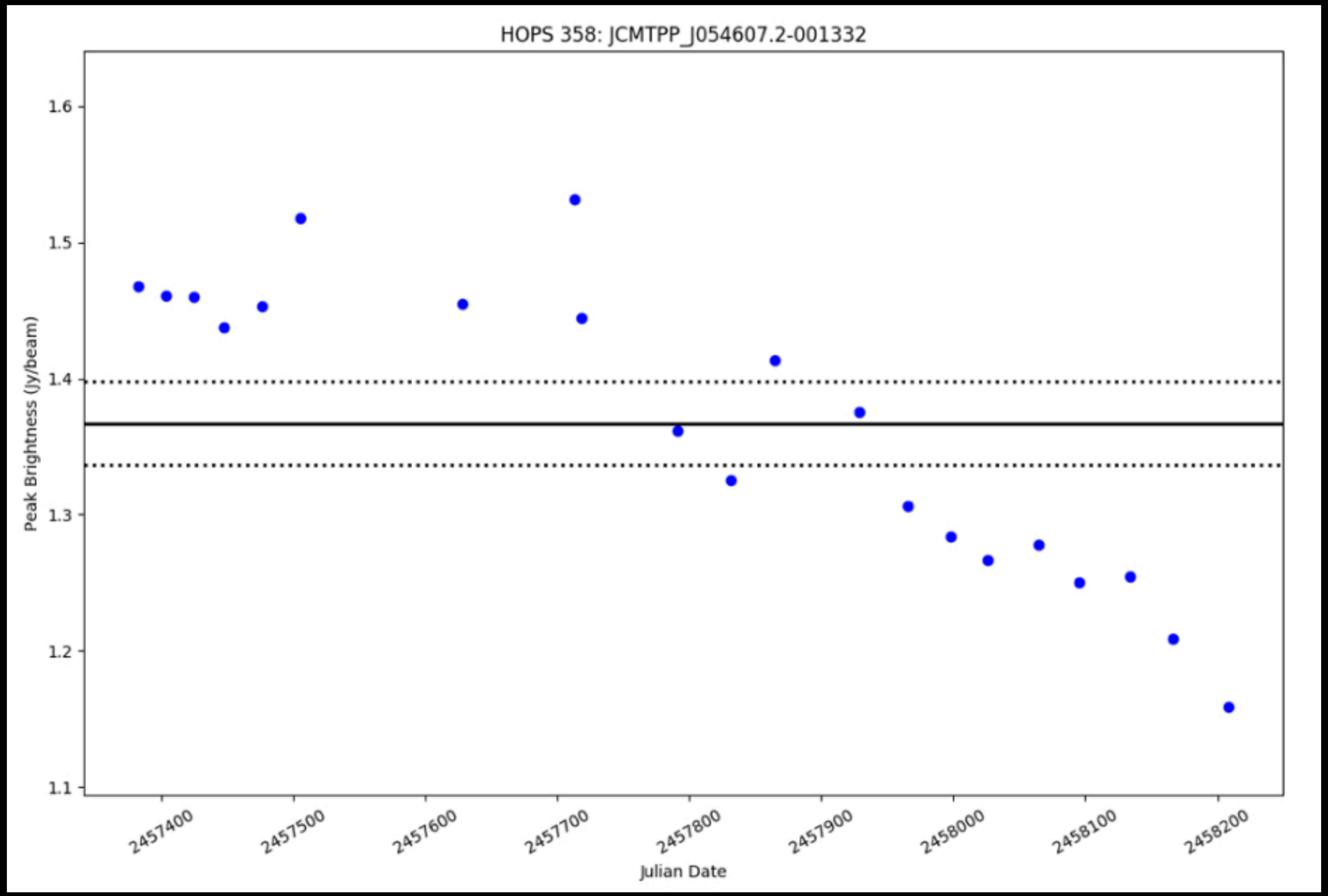


This metric is getting better over time!

We have used this analysis to compare JCMT data over 4 year timescales

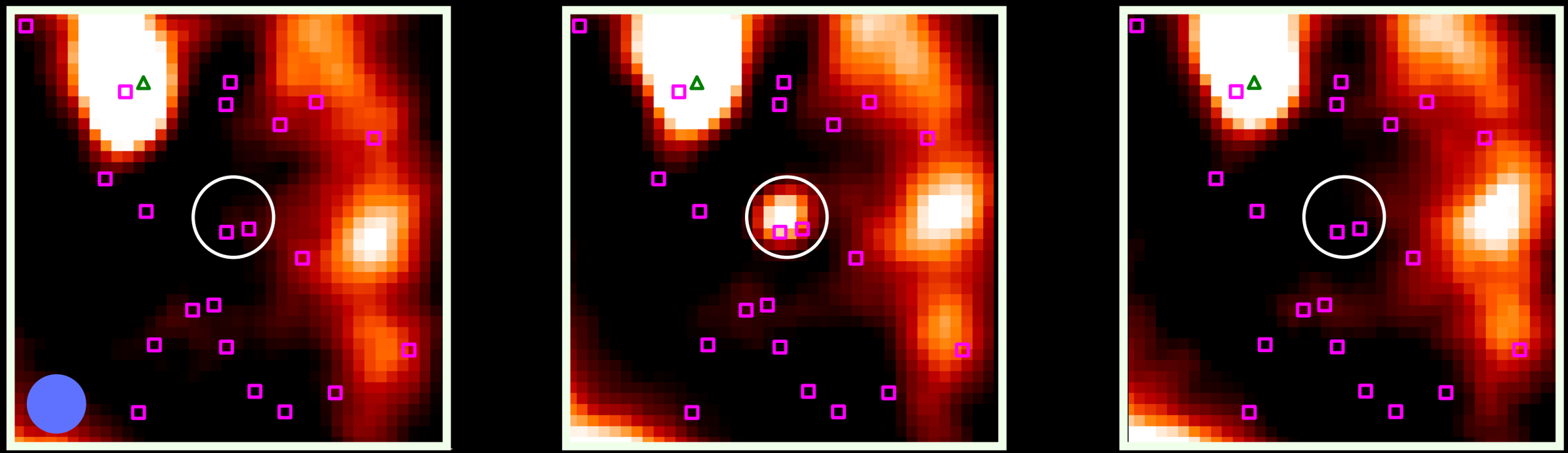
3. HOPS 358

First ATel with Keywords YSO and Submillimetre, together



An Extraordinary Submillimetre Flare Event

(Mairs et al, 2019, ApJ 871:72)



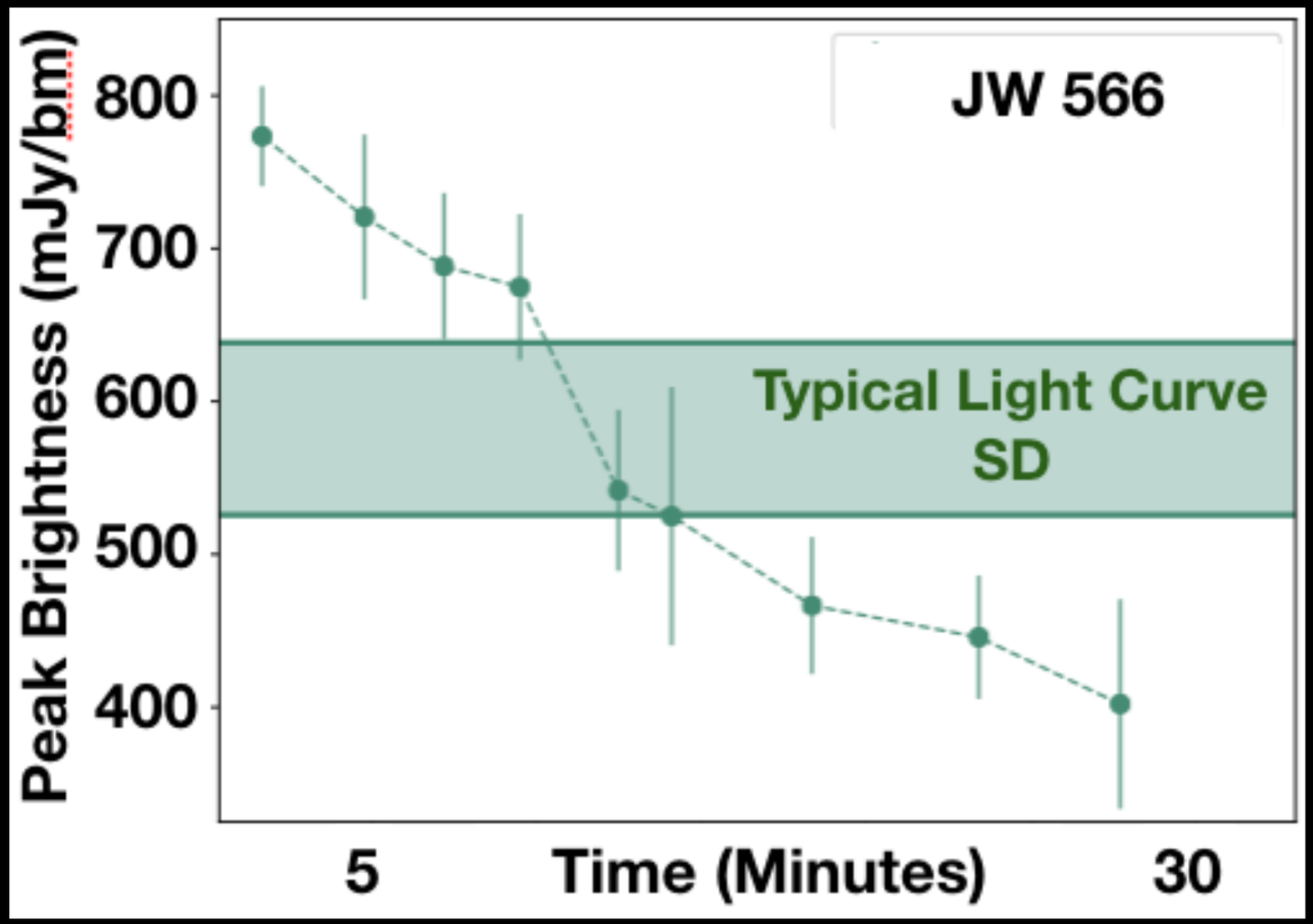
2016-11-20 2016-11-26 2017-02-06

□ = Previously Identified Class II (Disk) Source (Megeath et al. 2012)

● = JCMT Beam size (~15” at 850 microns)

✳ Point Source
✳ Coincident with binary disk system JW 566
✳ Previously known X-ray Variable (timescales of hours)
✳ No simultaneous optical, infrared, x-ray, or radio data

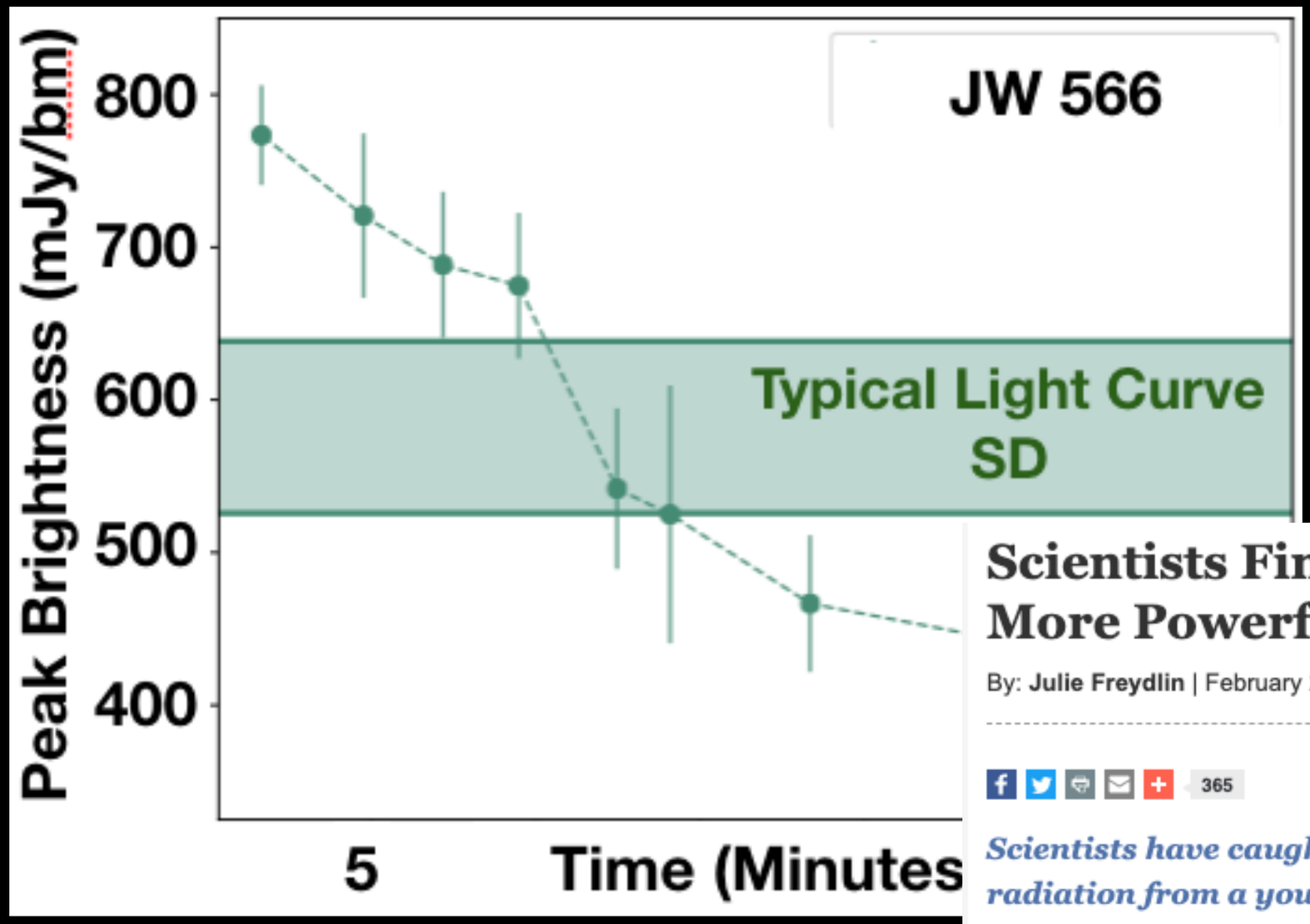
Minute-to-Minute Light Curve



SCUBA-2 reads out data every 30 seconds

Brightness Diminished by ~50% in 30 minutes

Minute-to-Minute Light Curve



SCUBA-2 reads out data every 30 seconds

Brightness Diminished by ~50% in 30 minutes

This discovery was covered in several newspapers and in Sky and Telescope Magazine (Feb 21, 2019)

Scientists Find Stellar Flare 10 Billion Times More Powerful Than Those on the Sun

By: **Julie Freydlin** | February 21, 2019

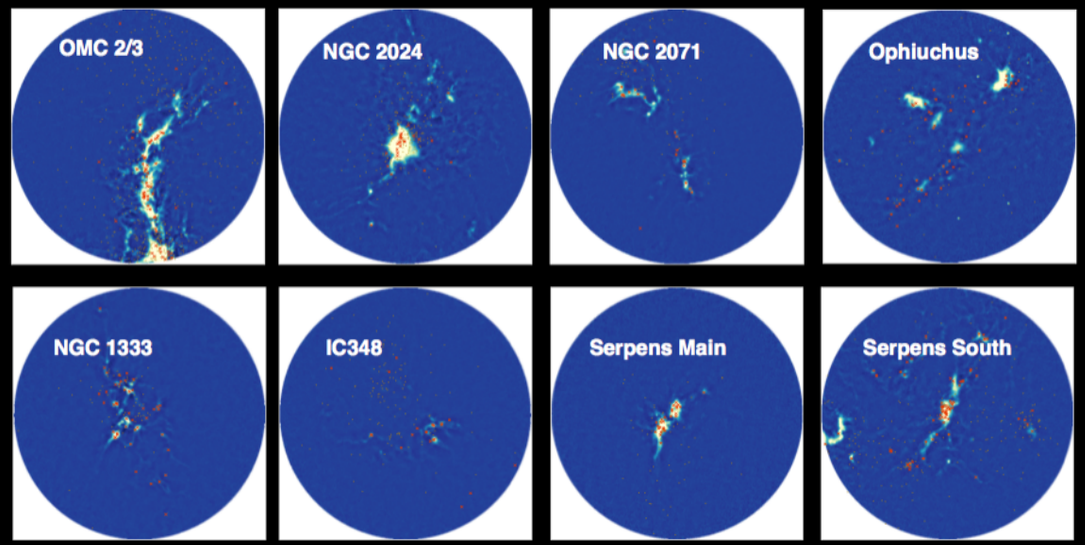
365

Scientists have caught a powerful flare of submillimeter-wavelength radiation from a young star in the Orion Nebula.

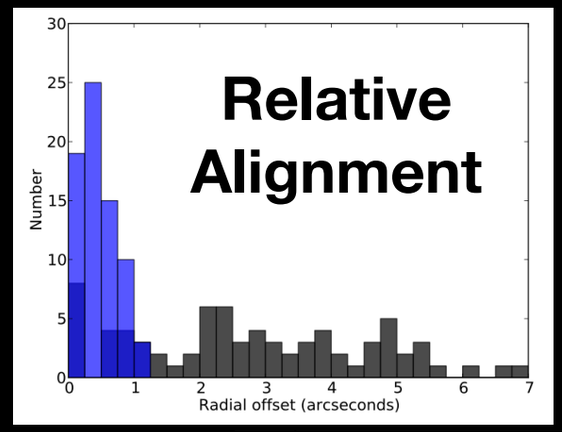
A research team using the James Clerk Maxwell Telescope (JCMT) has discovered the first stellar flare at submillimeter wavelengths — one that is 10 billion times more powerful than flares from our Sun. This finding, published January 20th in *The Astrophysical Journal*, can help scientists better

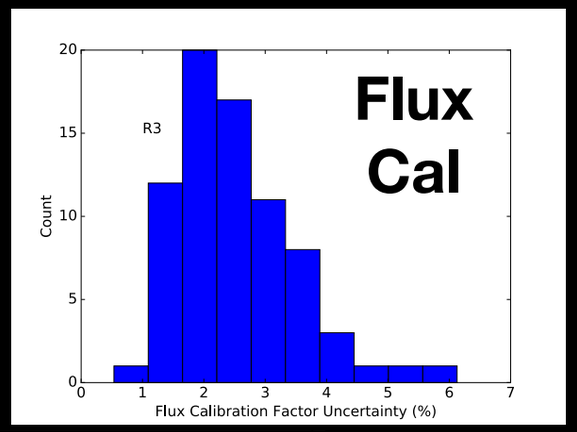
Summary/More Information

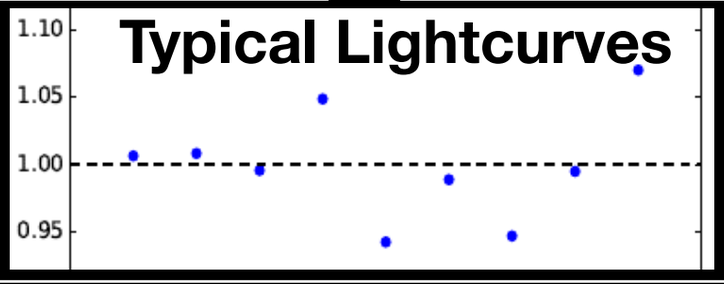
JCMT Transient Survey Overview:
Herczeg, G. et al. 2017ApJ...849...43H



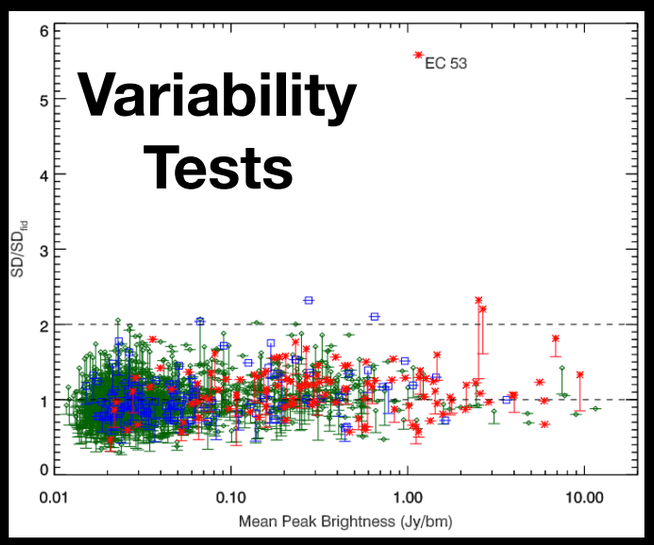
Data Reduction/Calibration:
Mairs, S. et al. 2017ApJ...843...55M

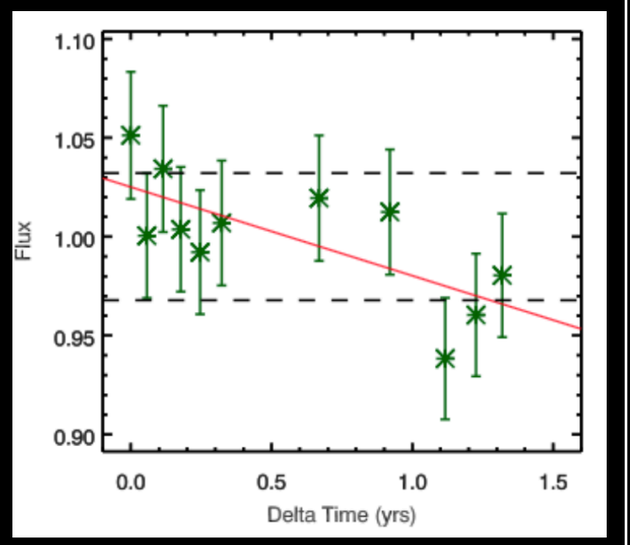




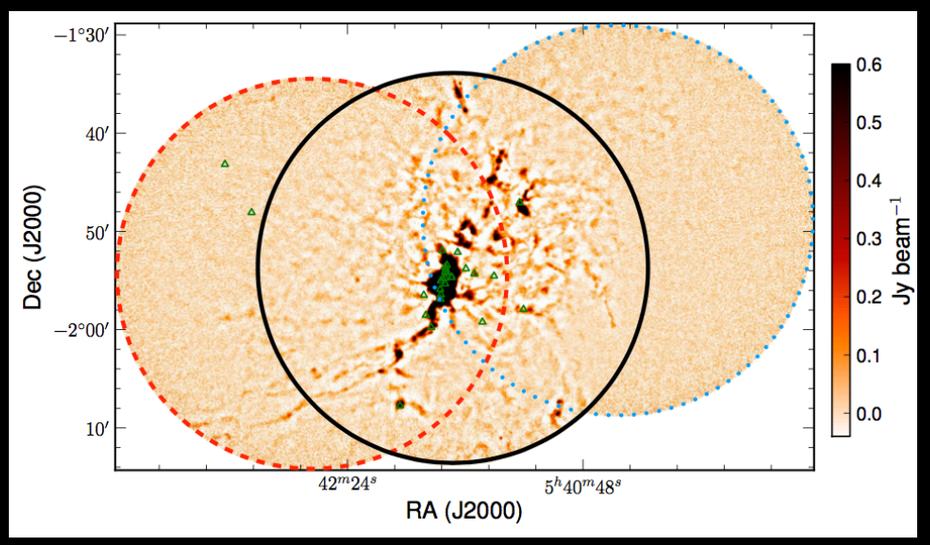


Summary of first 1.5 years:
Johnstone, D. et al. 2018ApJ...854...31J



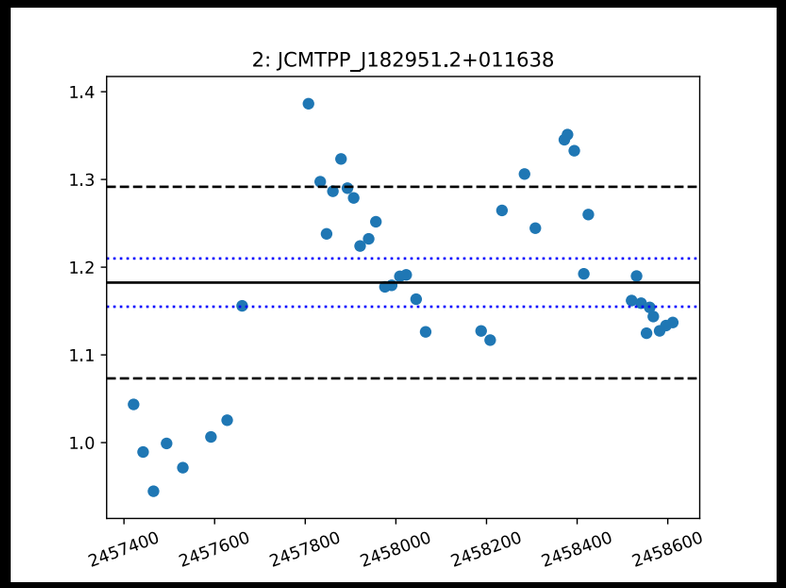


Variability over ~4 year timescales:
Mairs, S. et al. 2017ApJ...849..107M

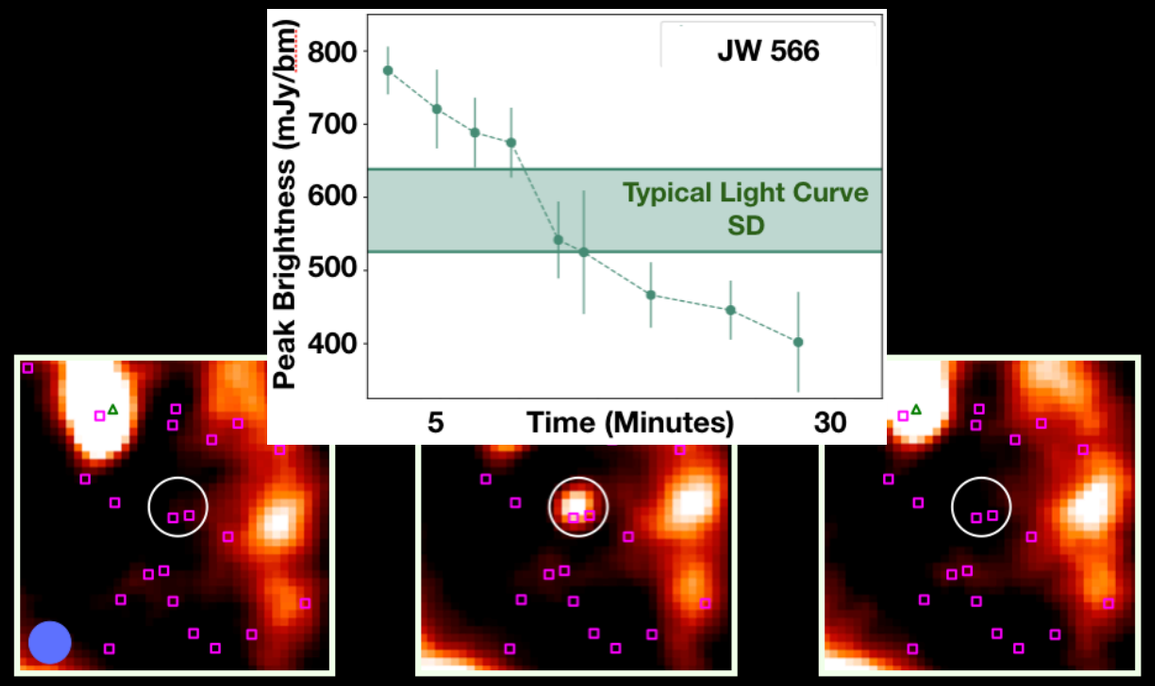


Summary/More Information

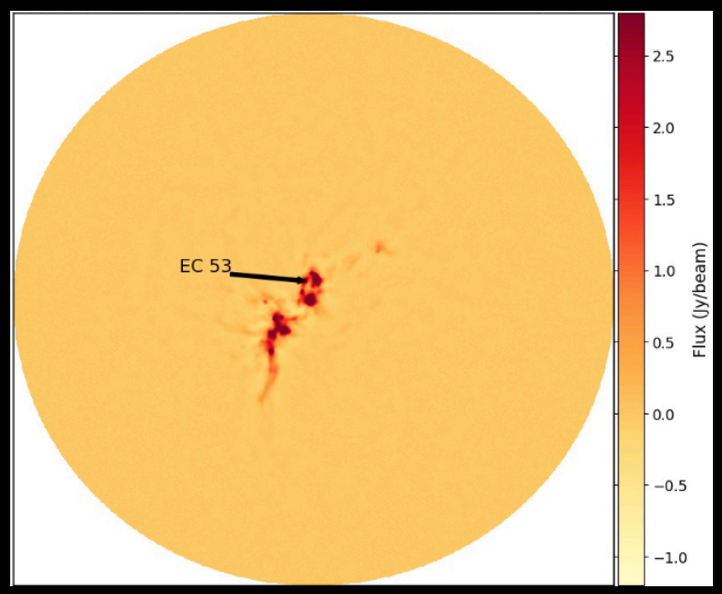
The Periodic Variable EC 53:
Yoo, H. et al. 2017ApJ...849...69Y



The Stellar Flare, JW 566:
Mairs, S. et al. 2019ApJ...871...72M



EC 53 ATel #11614:
Johnstone, D. et al. 2018ATel11614....1J



HOPS 358 ATel #11583:
Mairs, S. et al. 2018ATel11583....1M