# Search for rapid inner disk re-arrangements in a young eruptive star

Ágnes Kóspál

esa

"From atoms to pebbles"
Herschel's view of
Star and Planet Formation
March 22, 2012

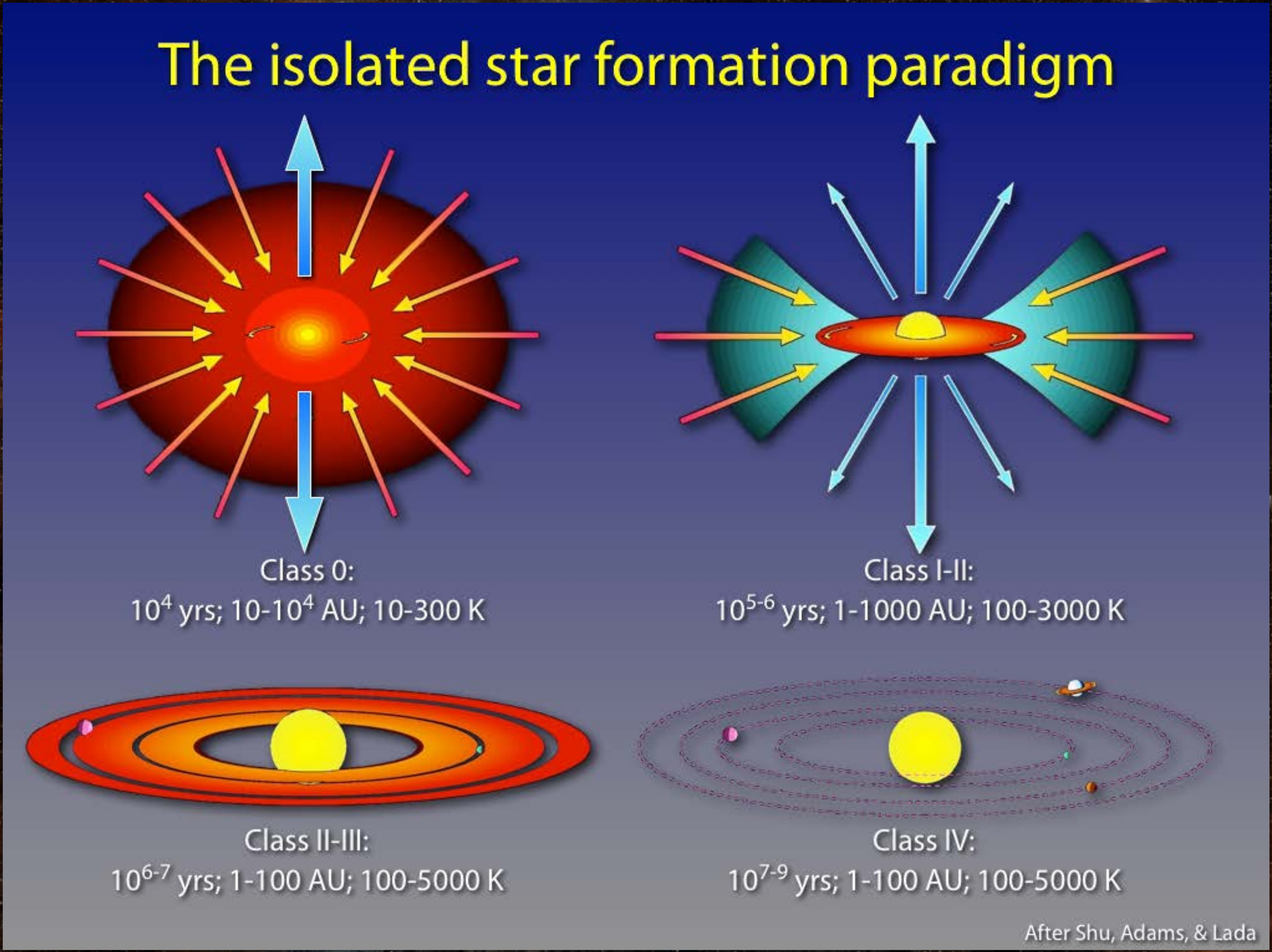
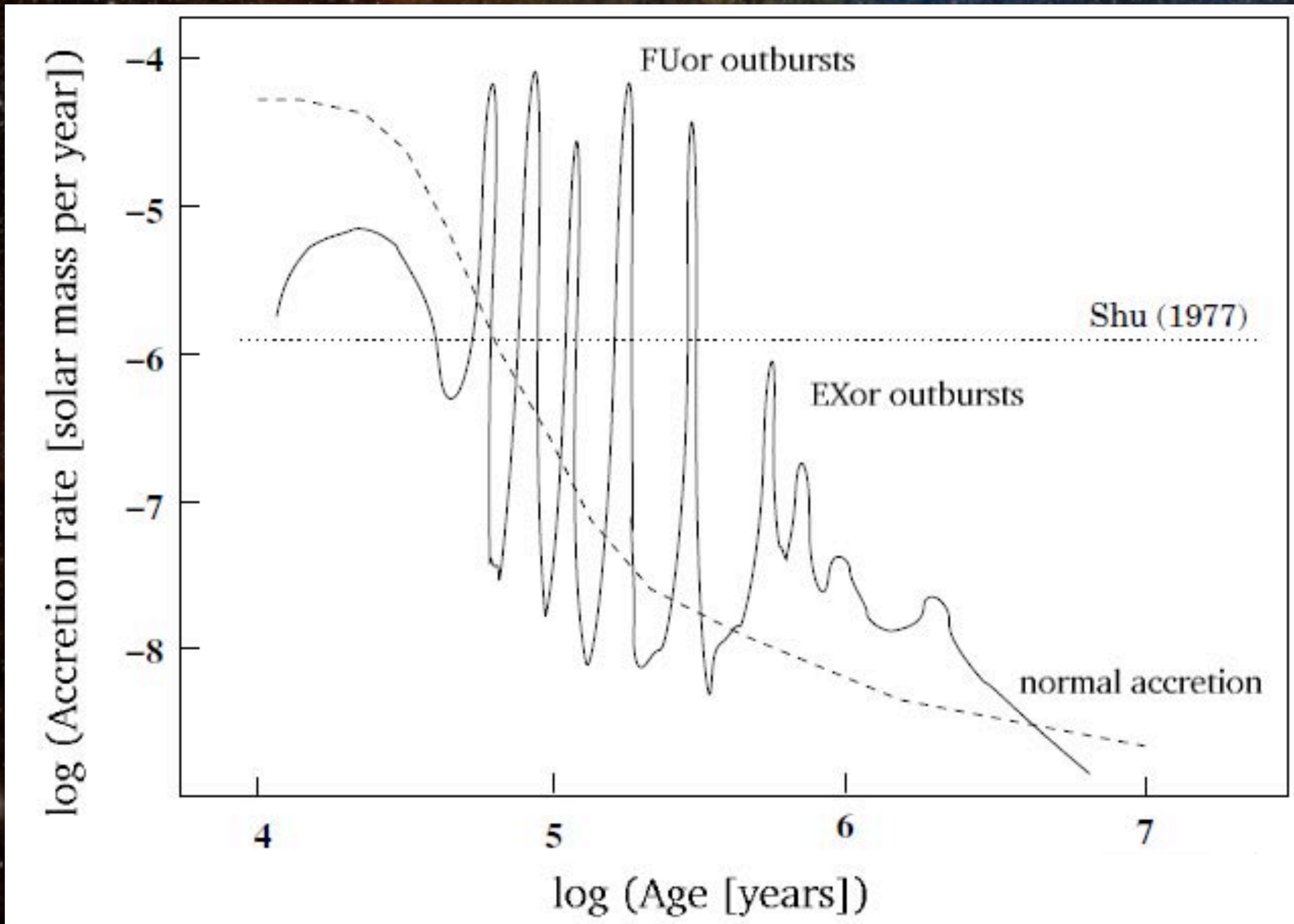



Figure courtesy of Mark McCaughrean

# Episodic accretion

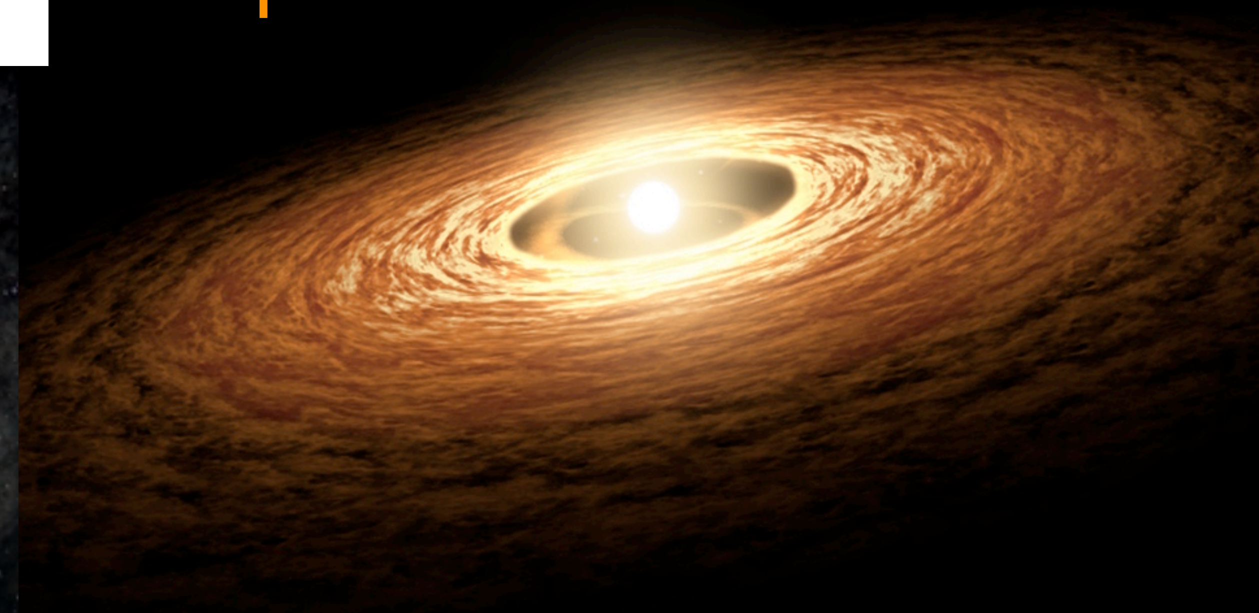



Schulz et al. (1995)

- Material accumulates close to the star
- Thermal instability → ionization front
- Material suddenly flows onto the star
- Outburst powered by enhanced accretion
- Outbursts are rare, episodic, unpredictable

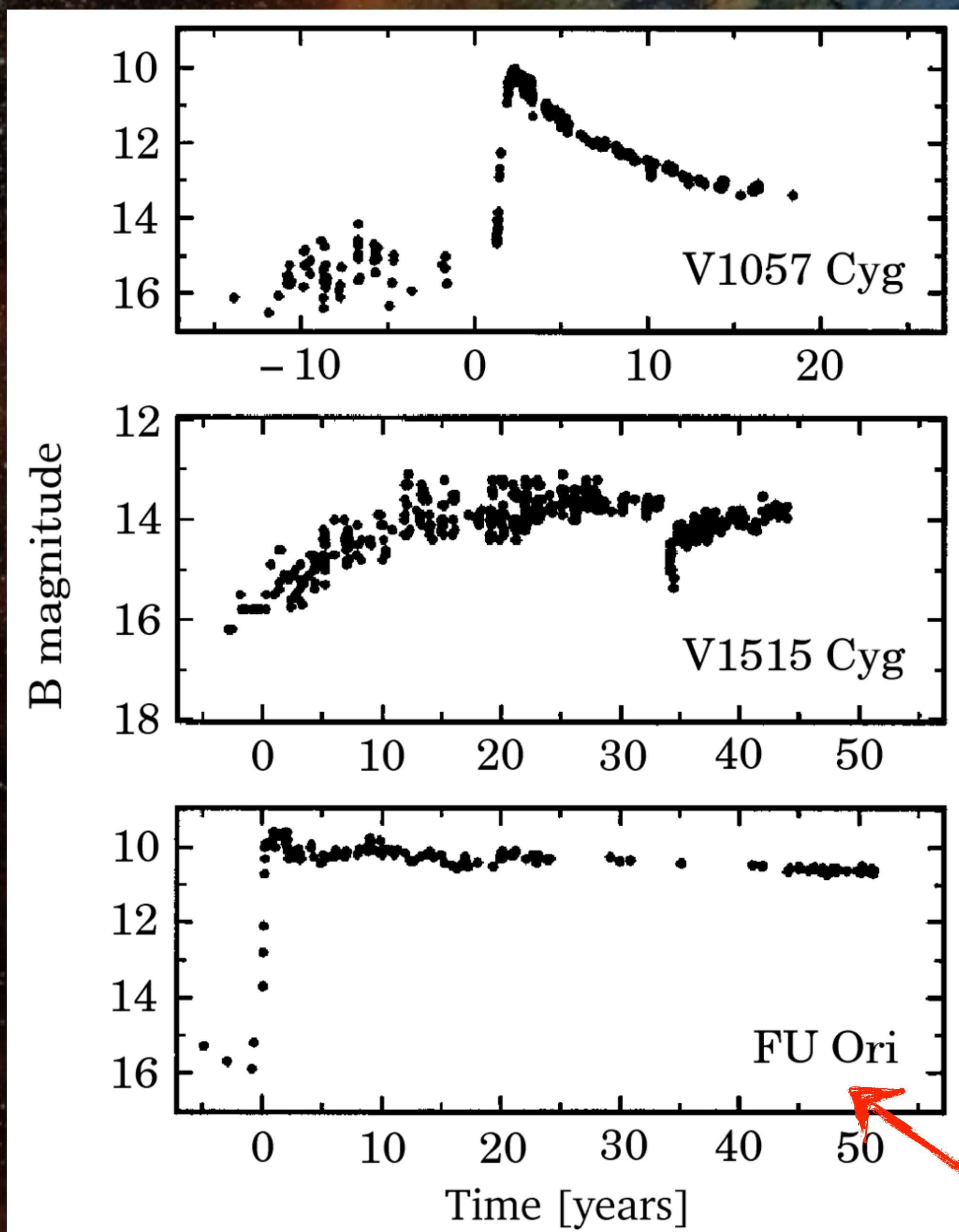
Eruption affects the disk:

- density, temperature, chemical structure
- conditions for planet formation



NASA/JPL-Caltech/T. Pyle

# Classical picture: FUors and EXors

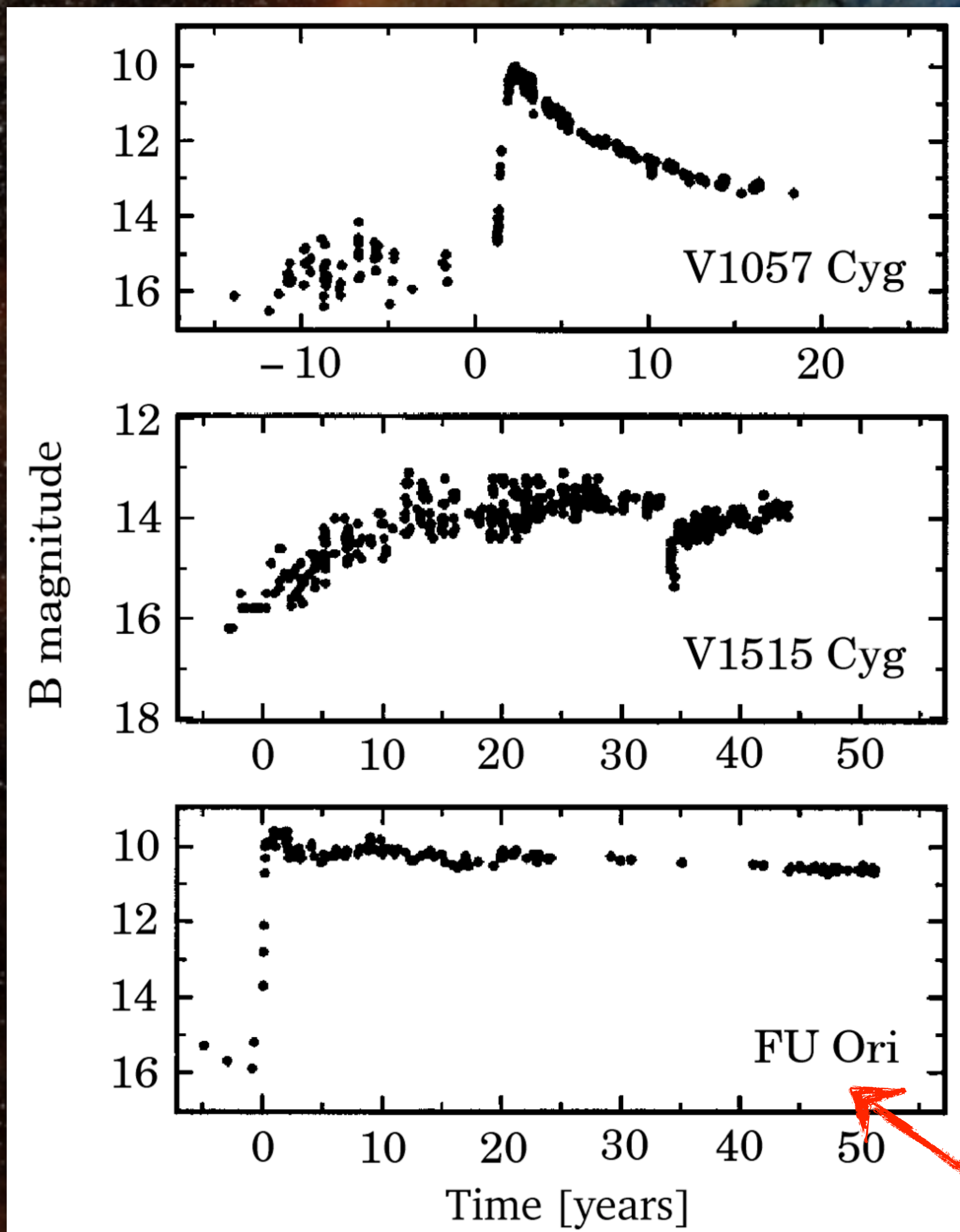



Hartmann & Kenyon (1996)

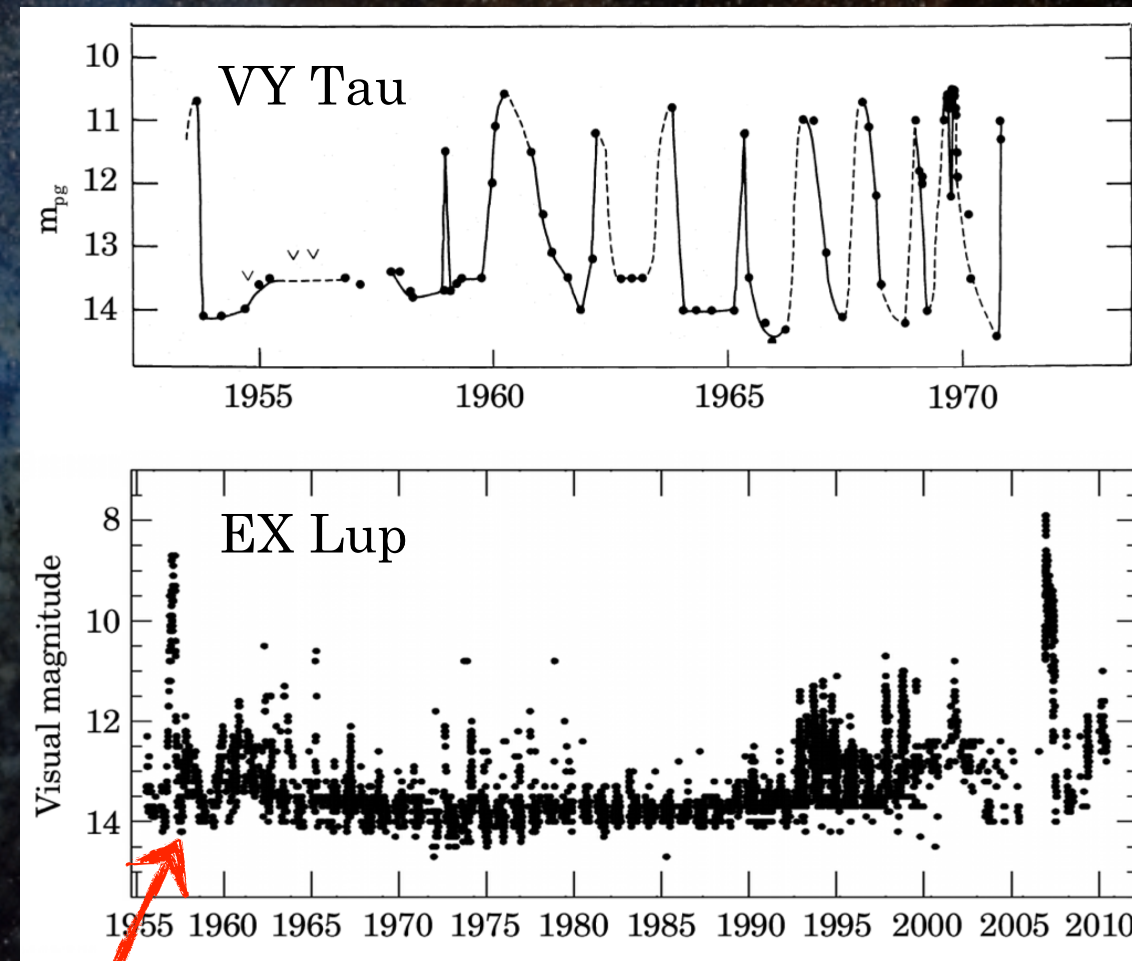
Accretion rate: up to $10^{-4}$ $M_\odot$/yr

Spectrum: absorption lines

# Classical picture: FUors and EXors




Hartmann & Kenyon (1996)




Herbig (1977), AAVSO

Accretion rate: up to $10^{-6}$ $M_{\odot}$/yr

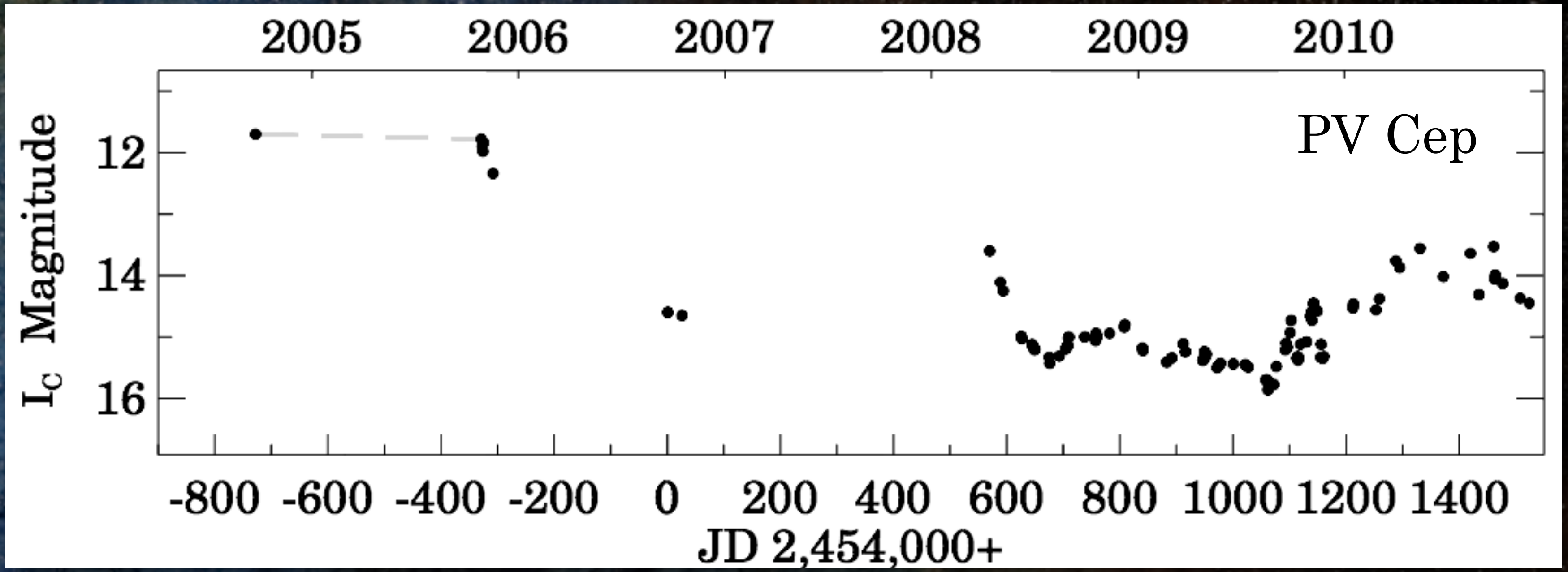
Spectrum: emission lines

Accretion rate: up to $10^{-4}$ $M_{\odot}$/yr

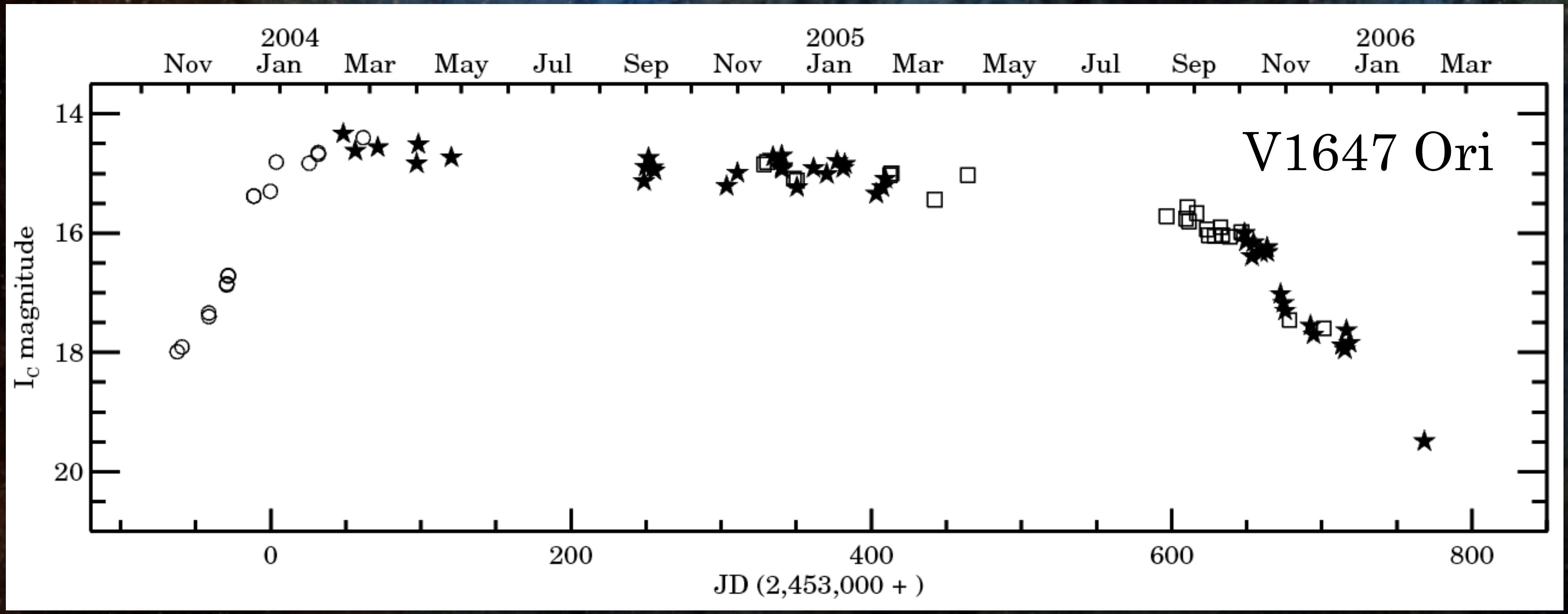
Spectrum: absorption lines

# Recently discovered outbursts

- Do not fit into the classical FUor/EXor groups




Kun et al. (2011)




Kóspál et al. (2005), Acosta-Pulido et al. (2007)

- Extinction changes play an important role

# Open questions

- Why does the extinction change?
  Is it caused by the outburst?
  Is the dust evaporated by the heat of the outburst?
- Are eruptive young stars special objects?
  Are all low-mass young stars undergo eruptive phases?

To answer these questions, we need to study those objects where the extinction changes are particularly large, and the effect is very well visible.

# Our target

image credit: Anna Morris (www.eprisephoto.com)

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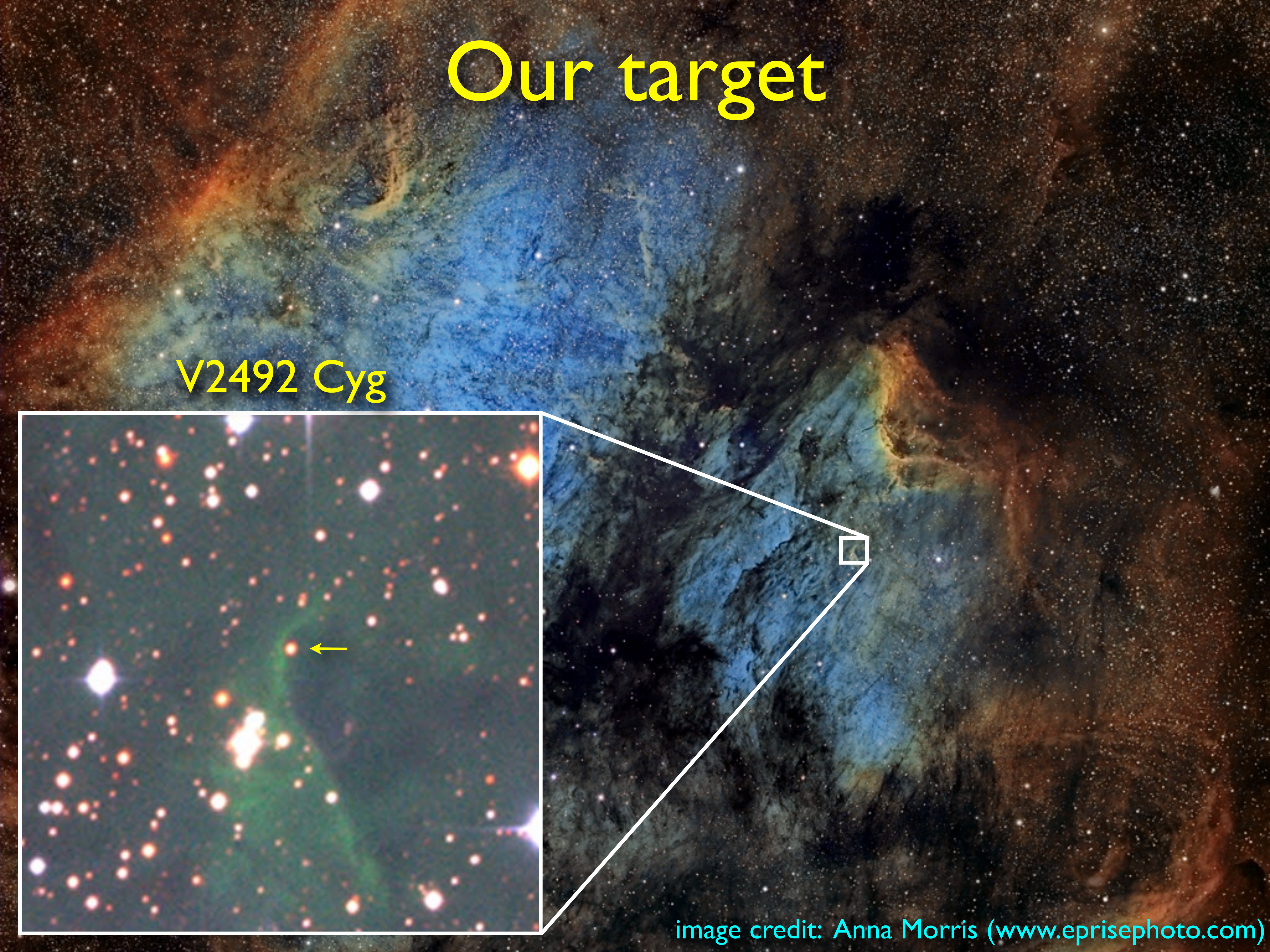
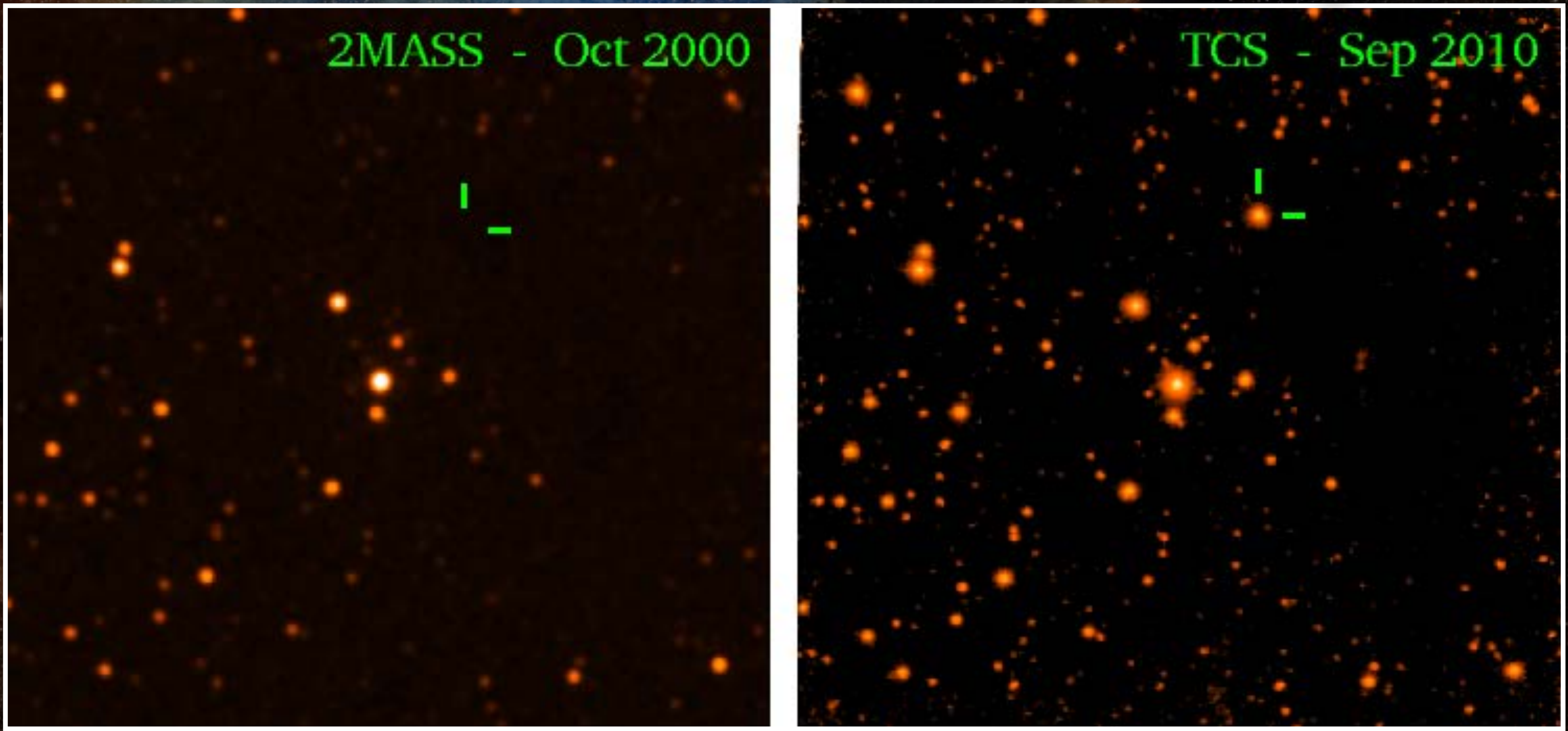



image credit: Anna Morris (www.eprisephoto.com)

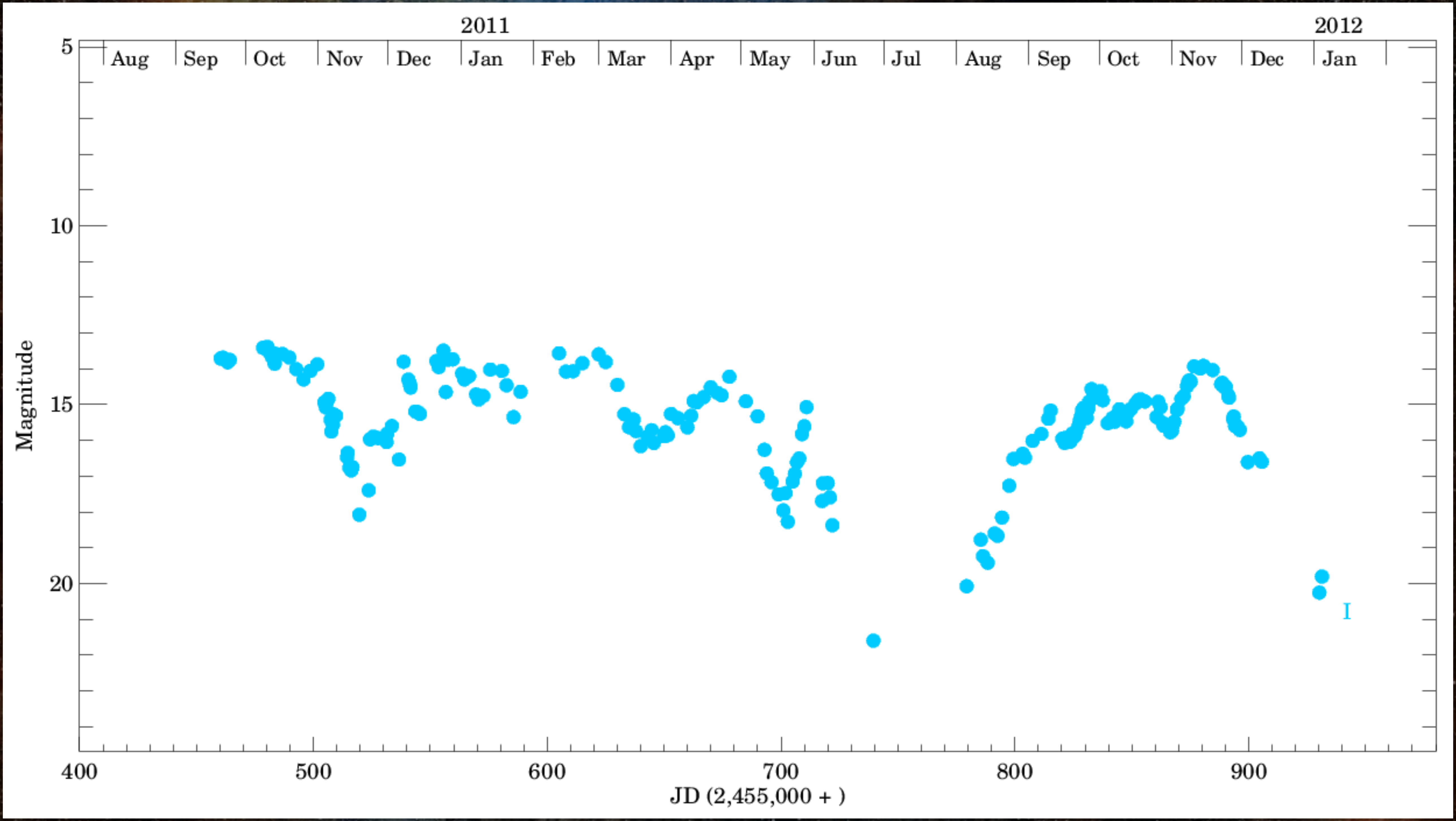
# Why is V2492 Cyg so special?

Huge outburst amplitudes: $\Delta J = 7.9$ mag
$\Delta H = 6.7$ mag
$\Delta Ks = 4.8$ mag



# Why is V2492 Cyg so special?

## Peculiar light curve




Kóspál et al. (2011), Kóspál et al. (in prep.), AAVSO

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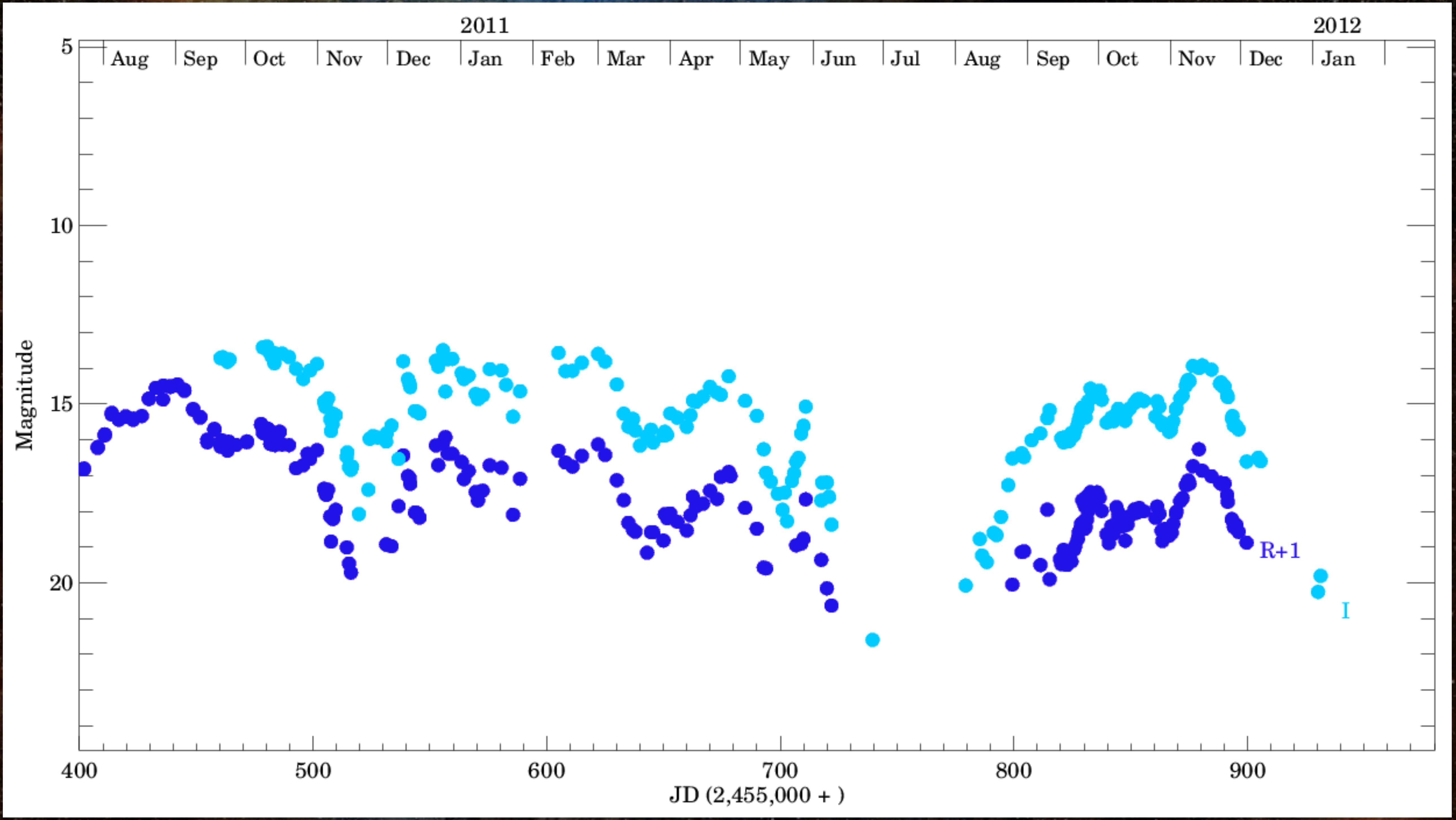


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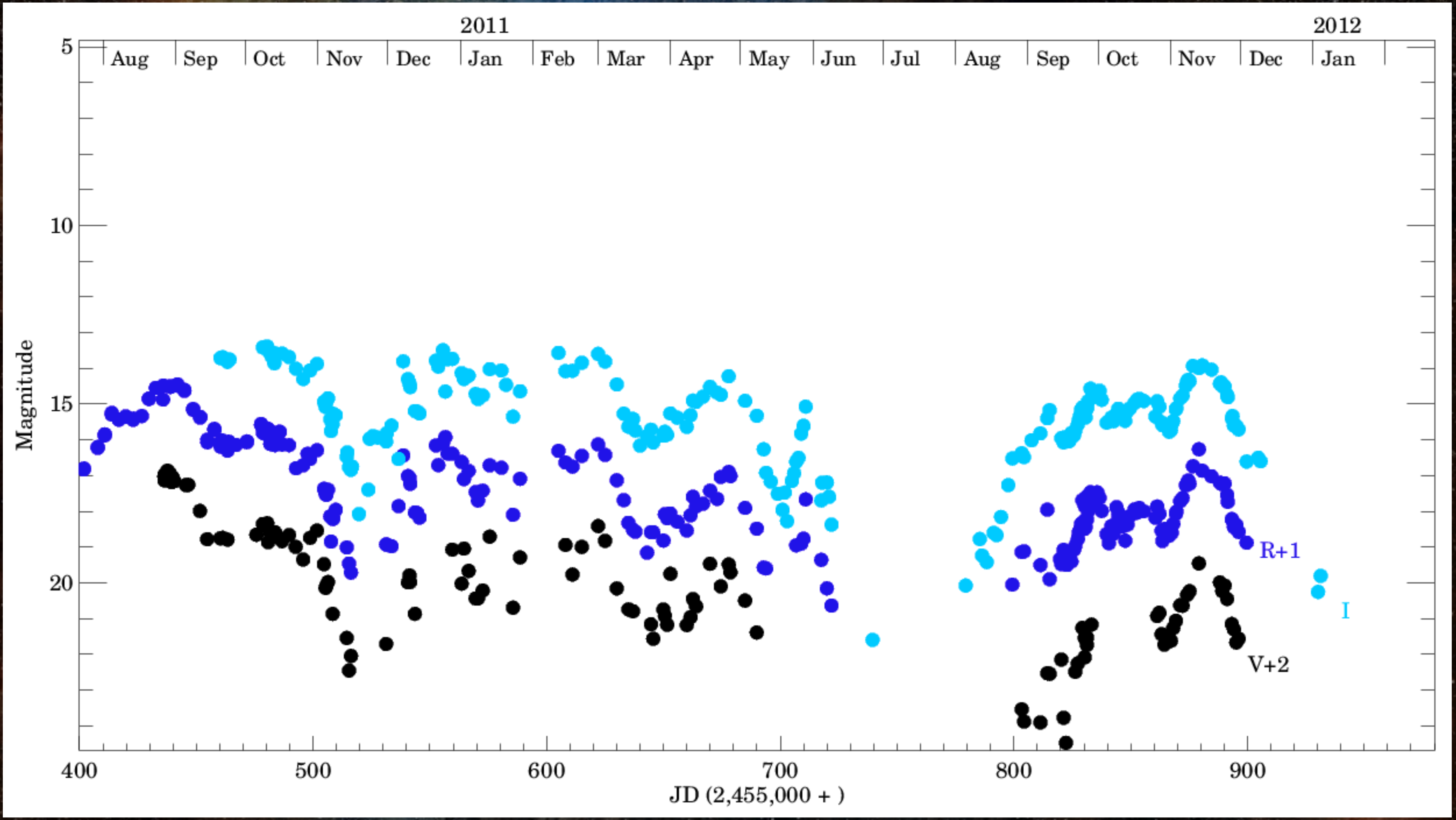


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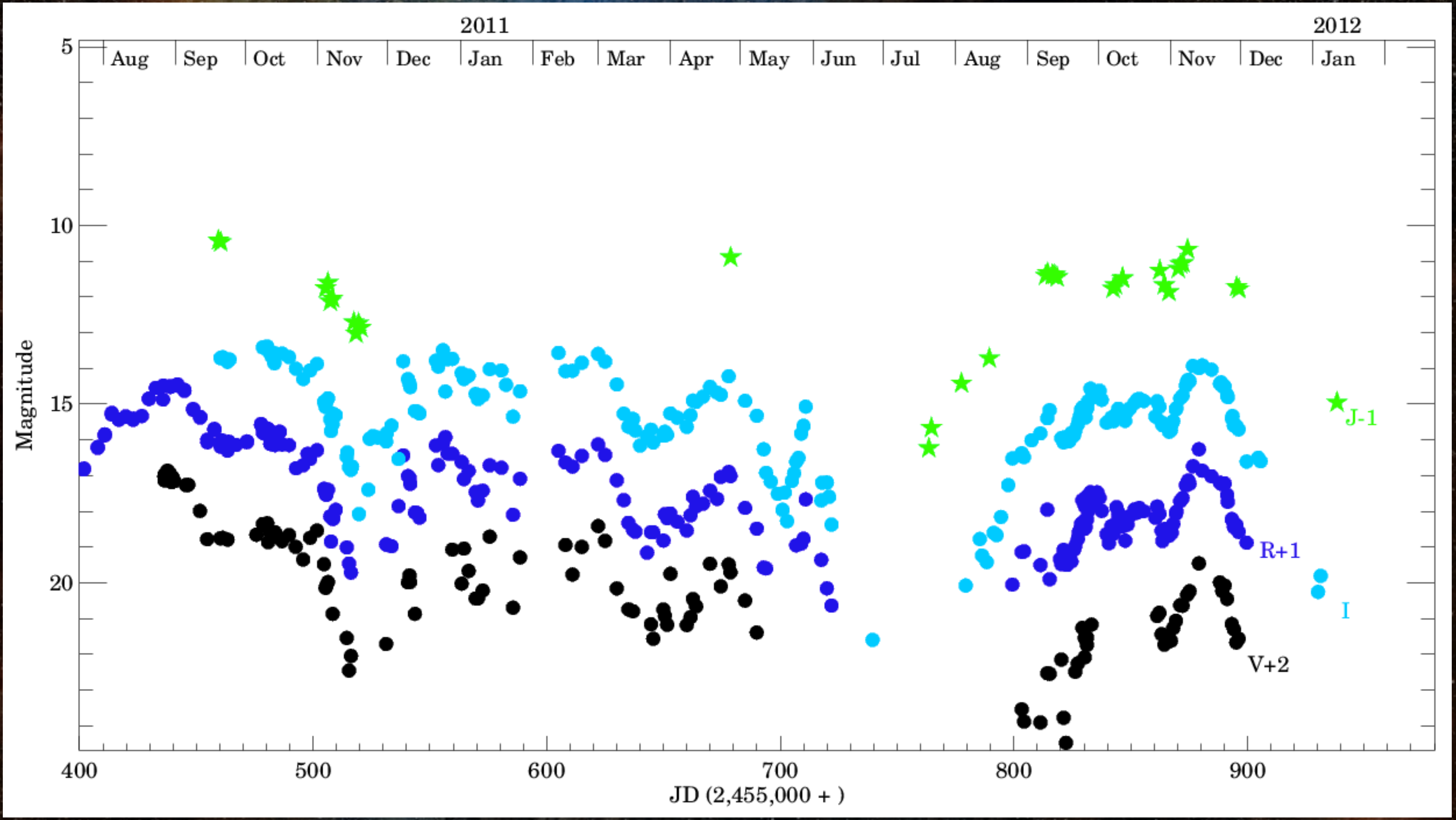


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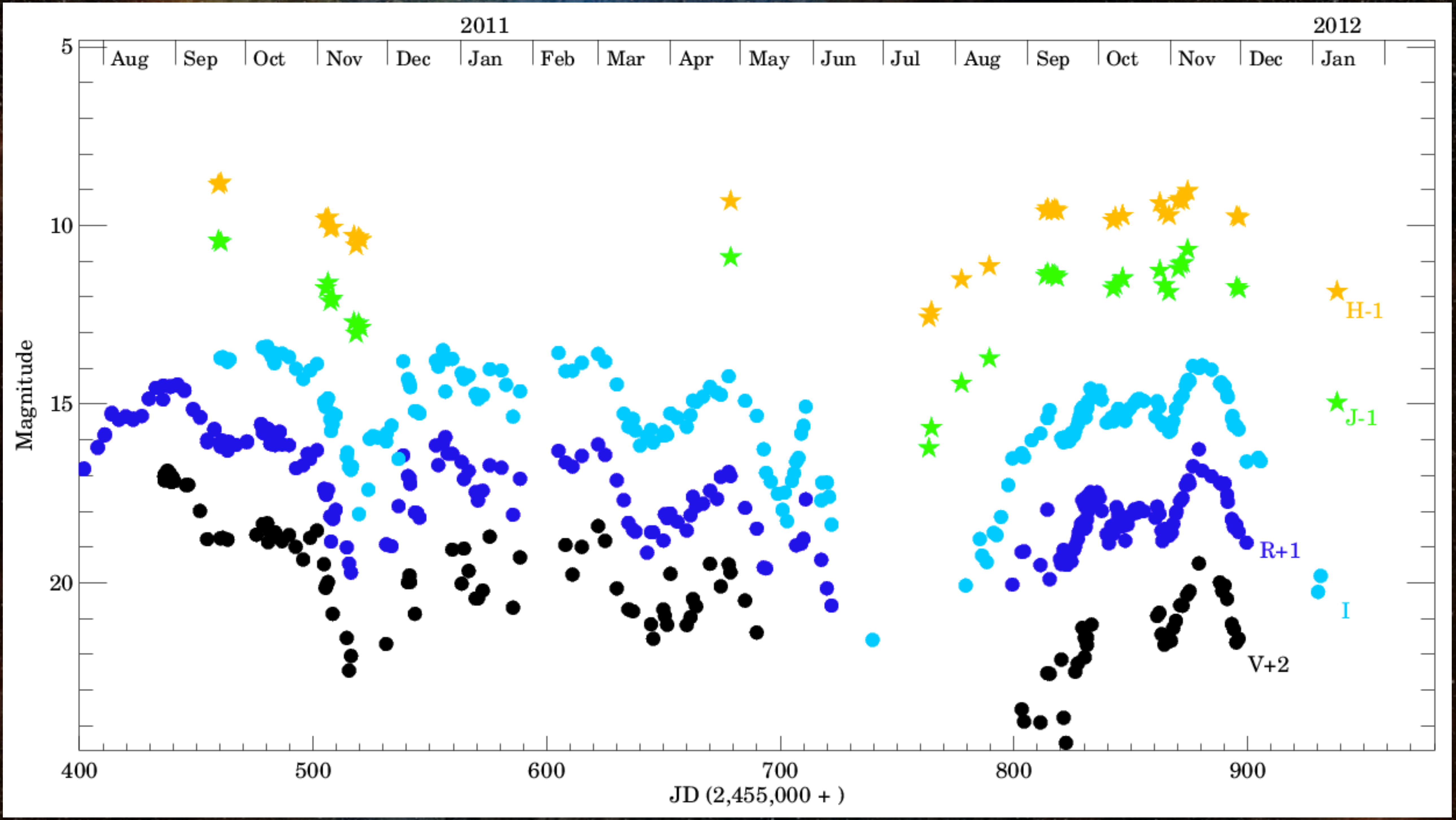


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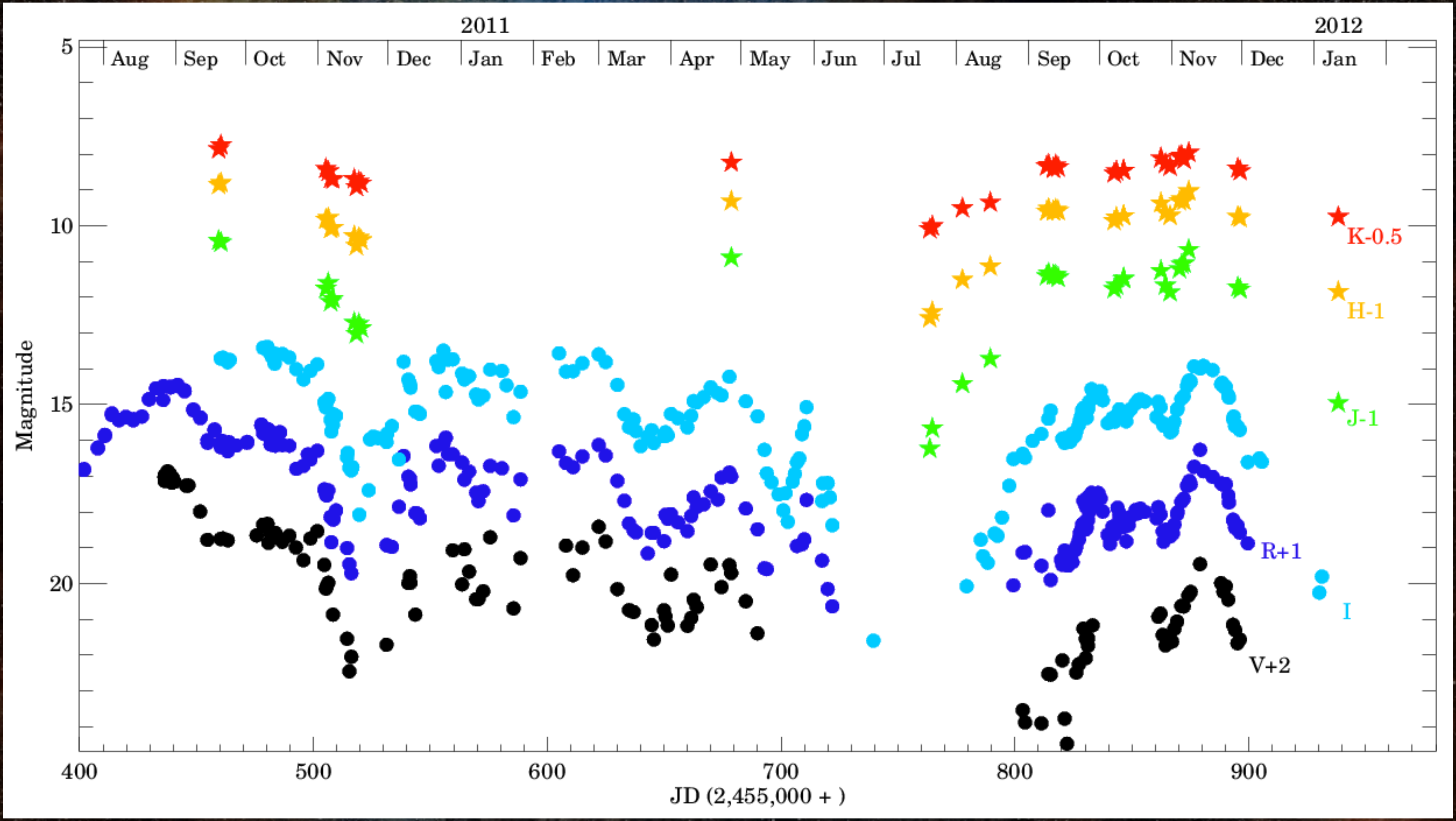


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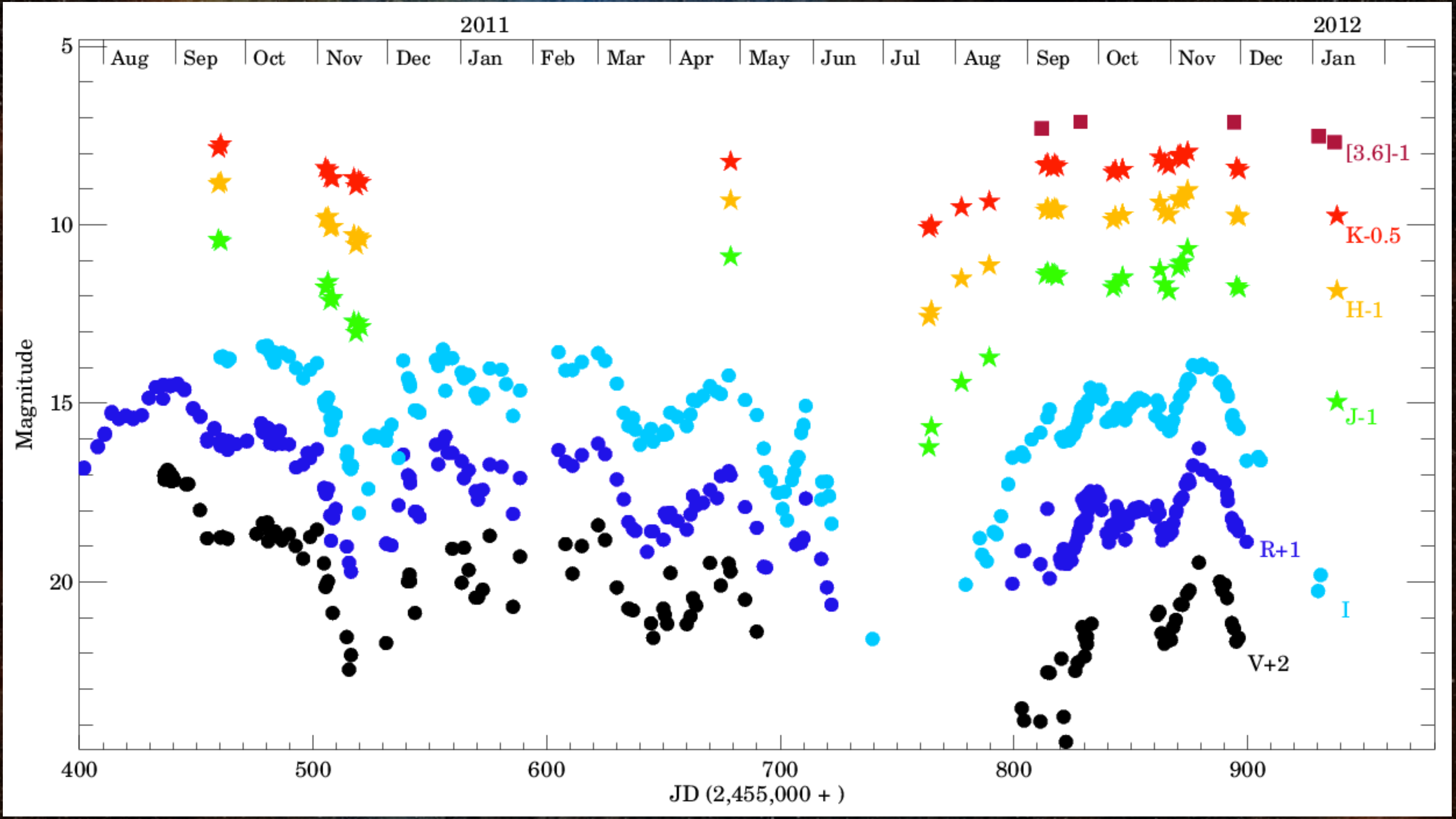


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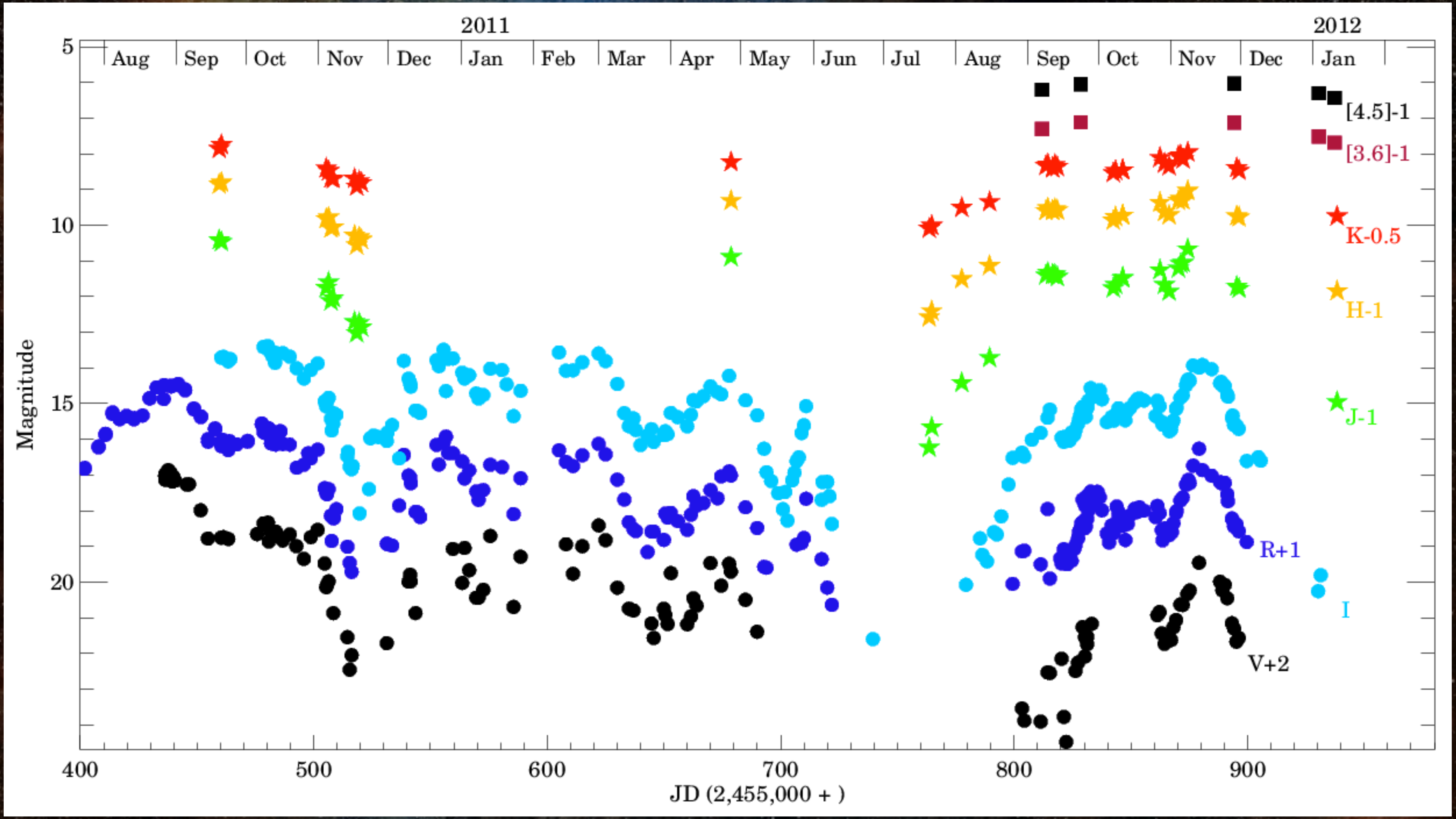
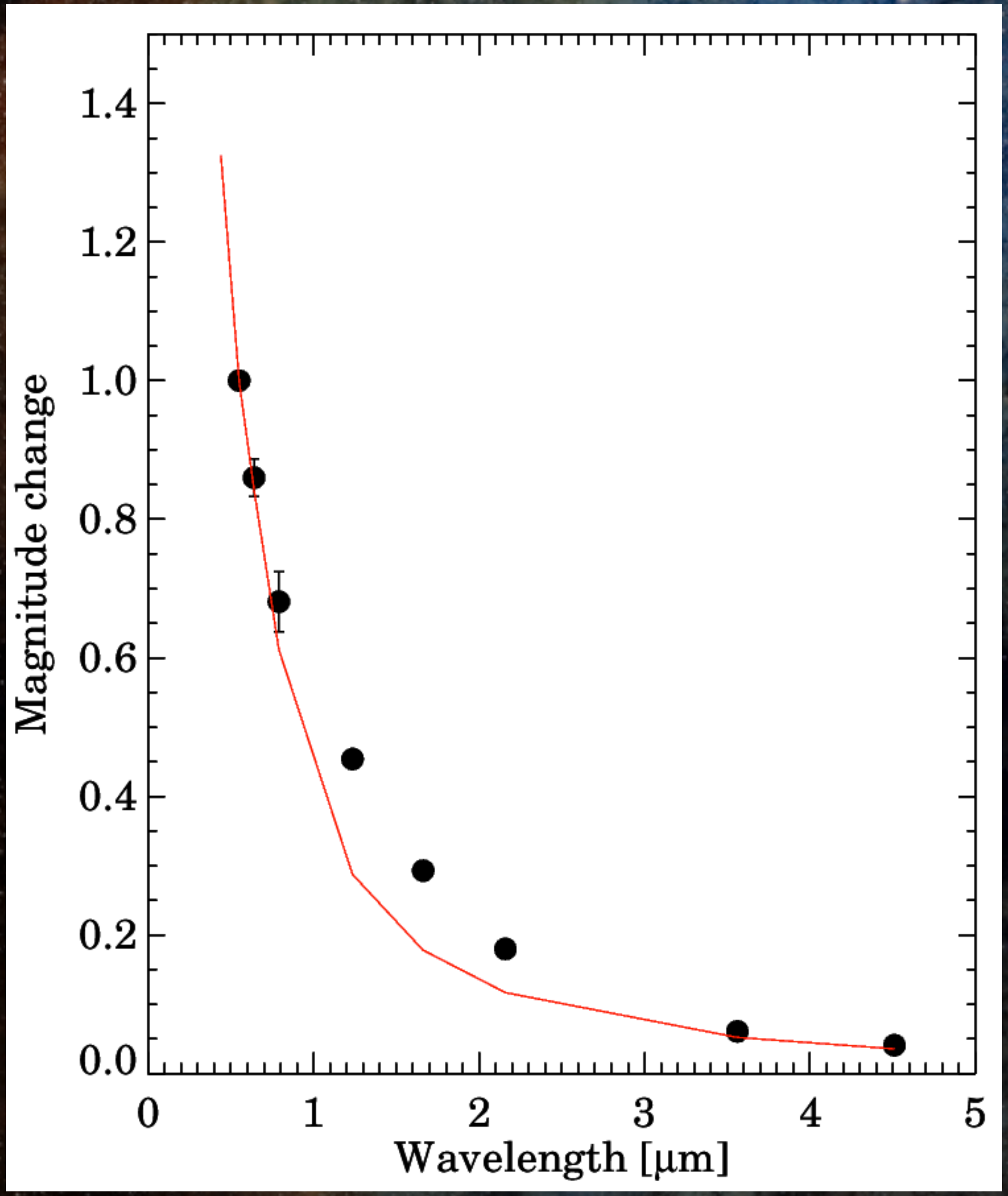


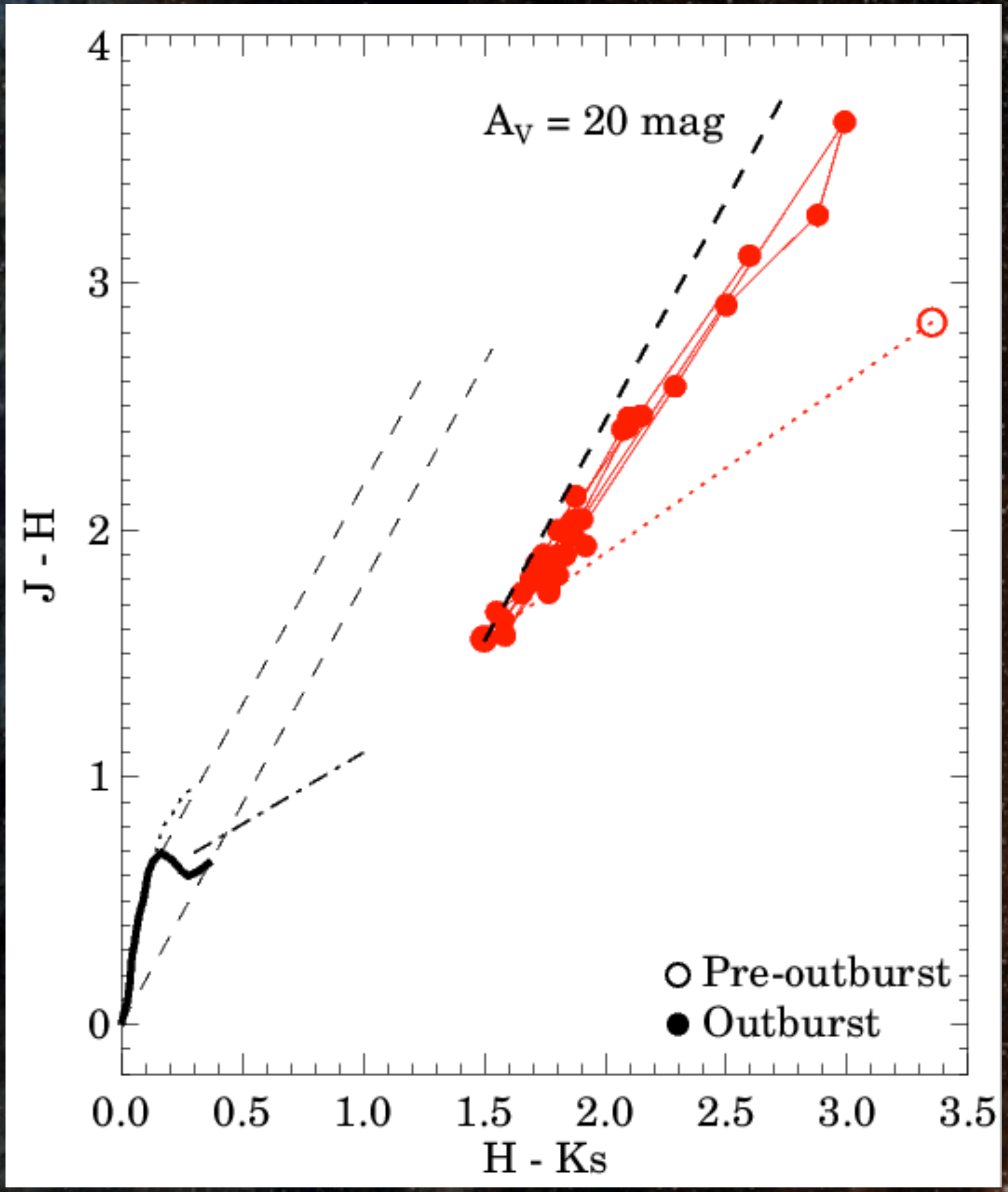

Kóspál et al. (2011), Kóspál et al. (in prep.), AAVSO

# Why is V2492 Cyg so special?

## Peculiar color changes

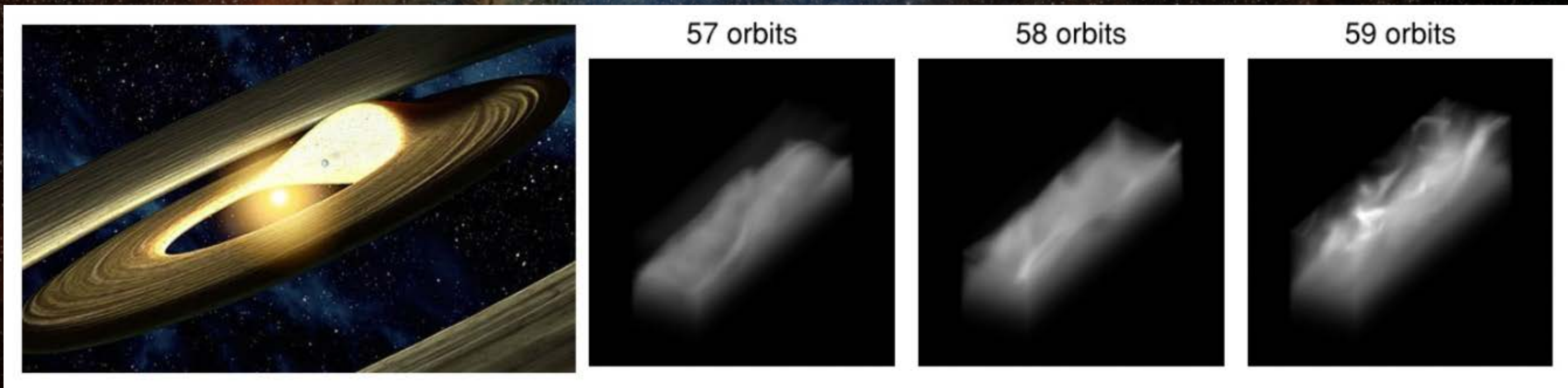



Kóspál et al. (in prep.)




Kóspál et al. (2011), Kóspál et al. (in prep.)

# Possible reasons for flux changes




Muzerolle et al. (2009)
Flaherty et al. (2011)

Turner et al. (2010)

Existing dust cloud/ lump in the disk orbits the star

Due to turbulence/magnetic activity, dust clouds are lifted off the surface of the disk

Let's look for far-infrared flux variations!

# What do we expect?

Pre-existing, orbiting dust cloud/lump

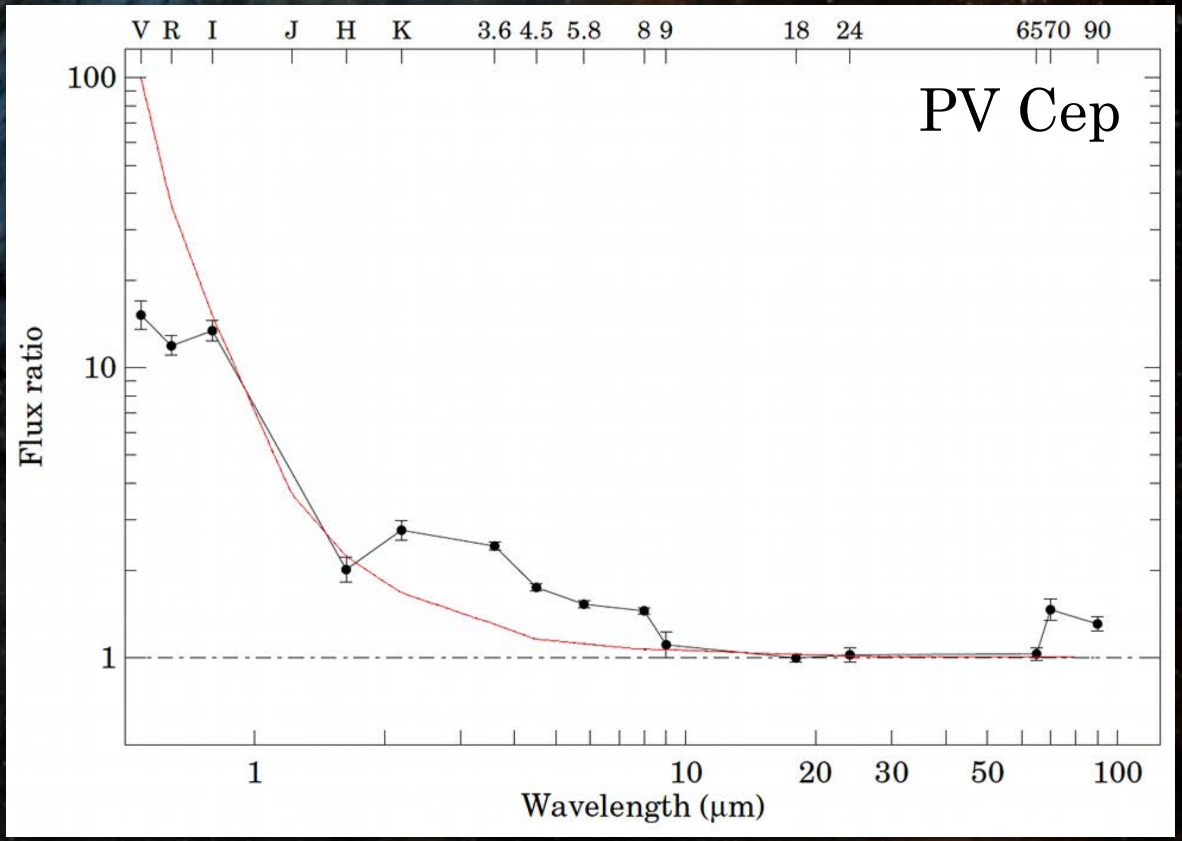
⇓

Constant far-infrared flux

Forming/disappearing dust cloud/lump

⇓

Variable far-infrared flux



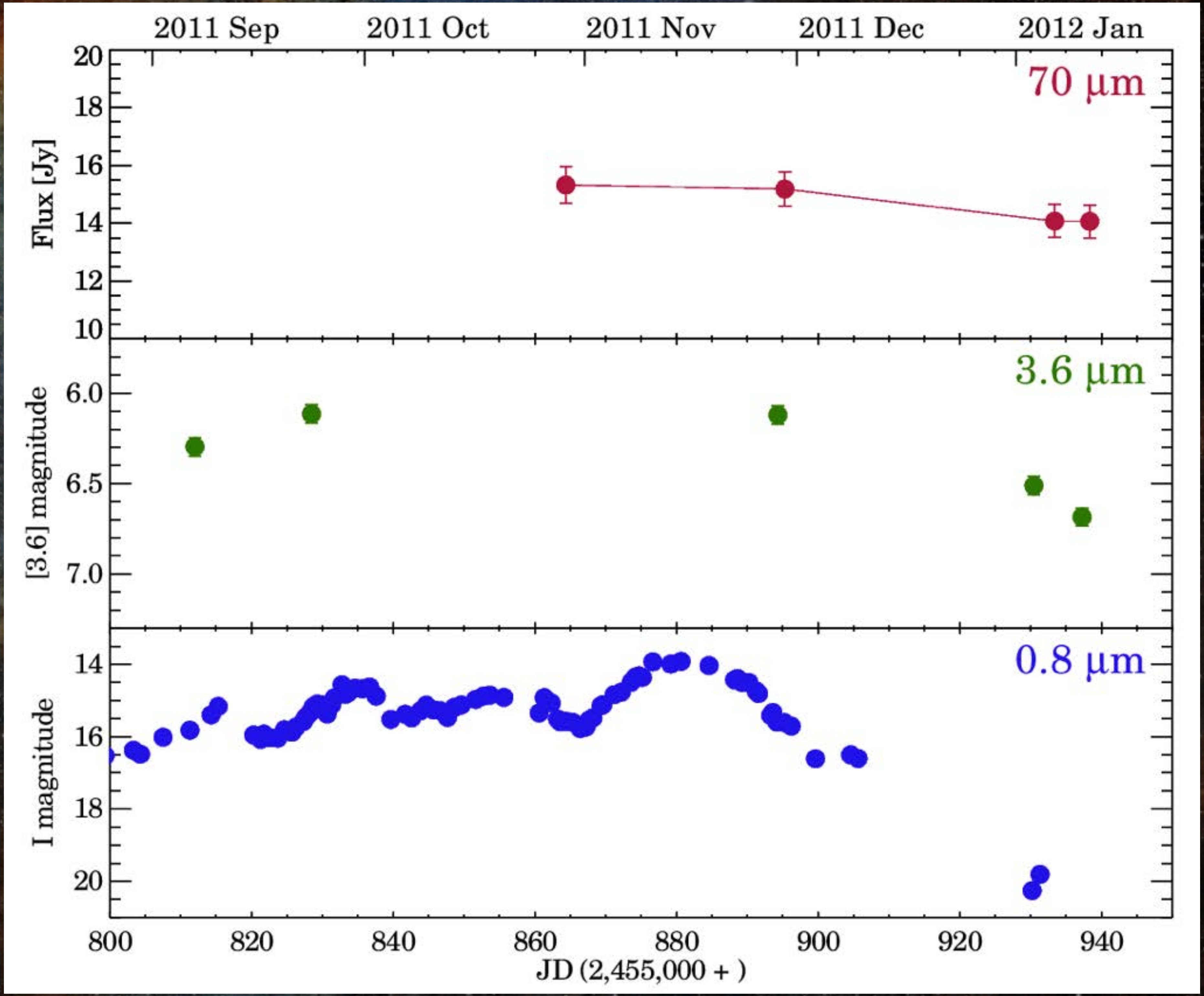

Kun et al. (2011)

# Herschel DDT monitoring of V2492 Cyg (coordinated with Spitzer)

| Date | Instrument | Wavelength |
|---|---|---|
| 2011-Oct-29 | PACS | 70, 160 |
| 2011-Nov-29 | PACS | 70, 100, 160 |
| 2012-Jan-03 | SPIRE | 250, 350, 500 |
| 2011-Jan-06 | PACS | 70,160 |
| 2011-Jan-11 | PACS | 70, 160 |

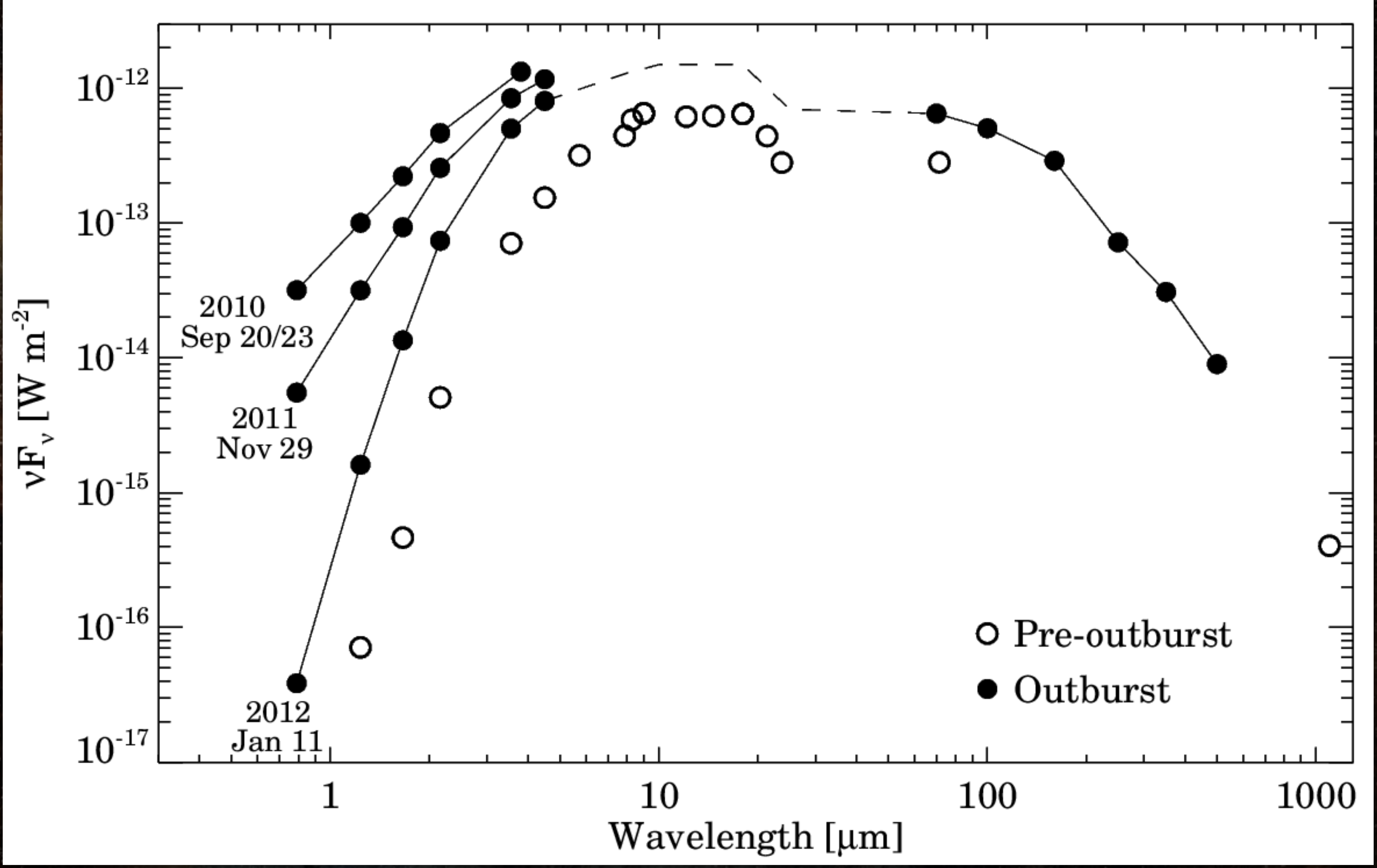
PV Cep

# FIR light curves of V2492 Cyg




Kóspál et al. (in prep.)

# SED of V2492 Cyg



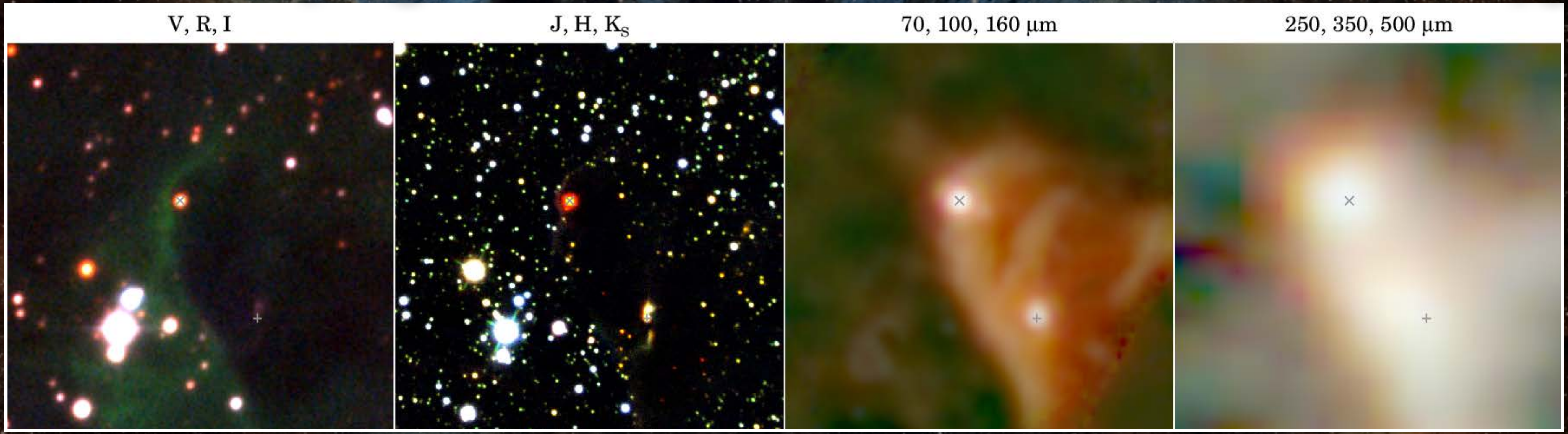

Kóspál et al. (2011), Kóspál et al. (in prep.)

# Summary

- V2492 Cyg went into outburst reaching a peak around August 2010
- Since then, the optical-infrared light curves show signs of changing extinction ($\Delta A_V$ = 20 mag, $\Delta$(column density) = 0.07 g cm$^{-2}$) → dust inhomogeneities/clouds/lumps in the inner disk
- We performed a co-ordinated Spitzer-Herschel monitoring to see if there is any indication for changing illumination of the outer disk/envelope
- The 70 μm monitoring shows constant flux → favors the model of an orbiting dust cloud in the system

# Outlook

- Question: what is the physical mechanism which could produce and maintain such huge dust concentrations?
- General significance: the existence of large density fluctuations in the inner part of the system, the planet-forming zone, may have consequences for grain growth and planetesimal formation
- Work in progress: the broader environment of V2492 Cyg



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