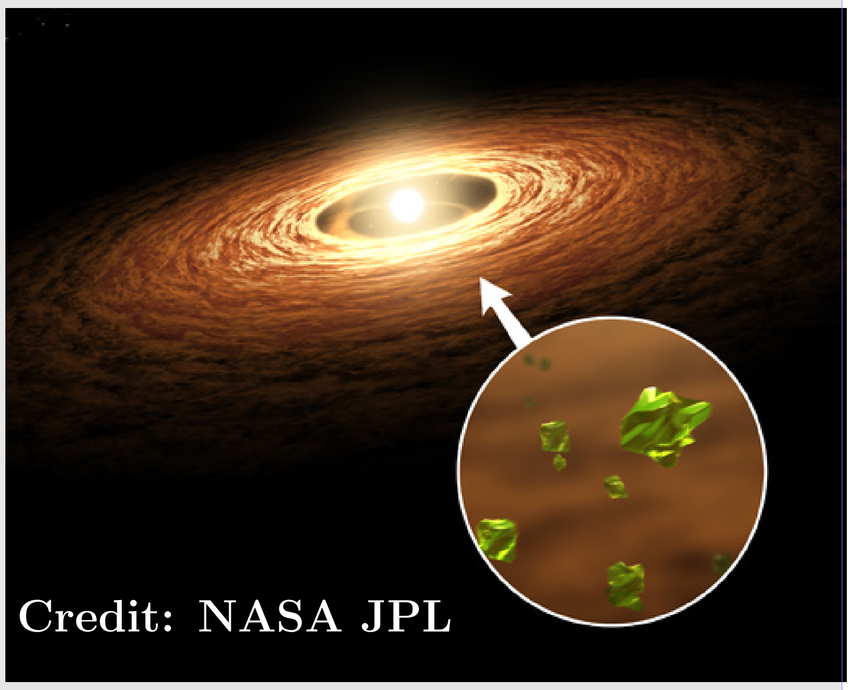
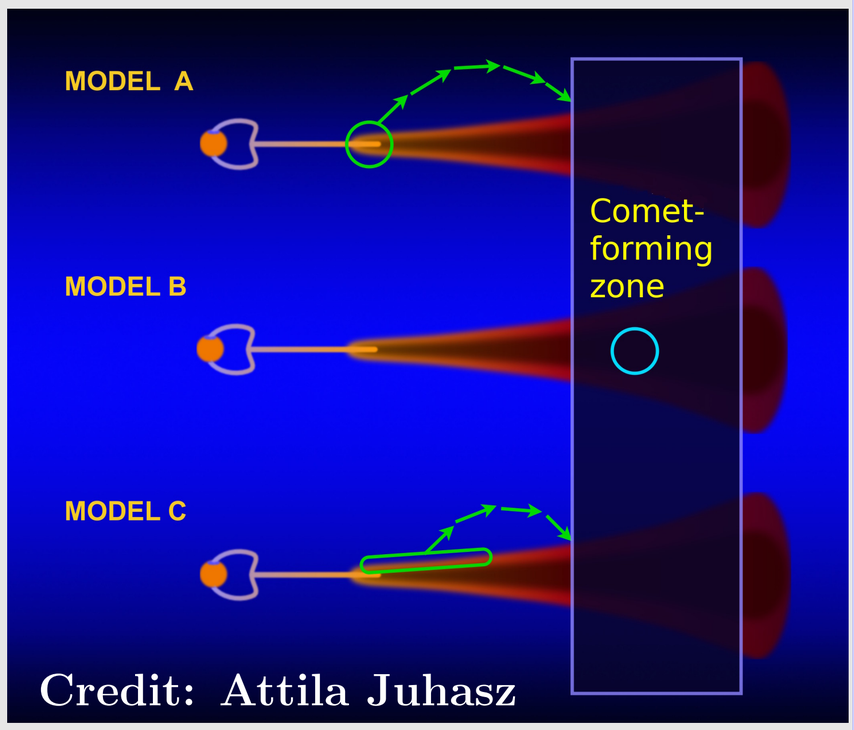
# Spectral evolution and radial dust transport in the disc of the prototype young eruptive star EX Lup

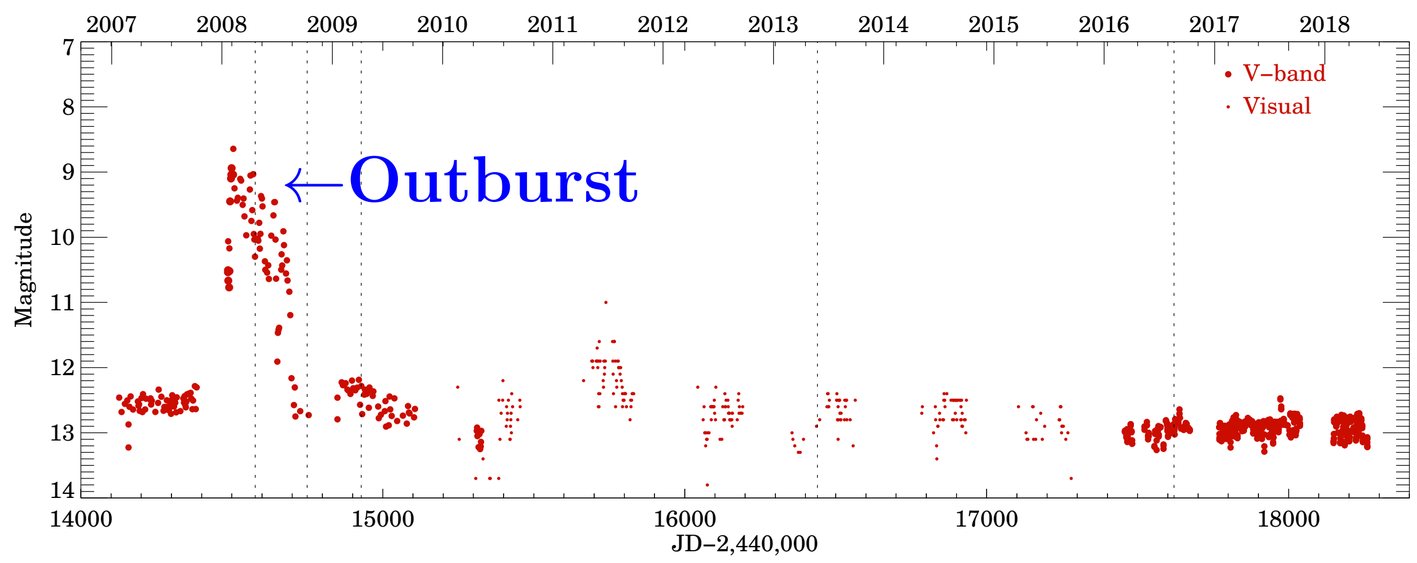
**L. Chen[1], P. Ábrahám[1], Á. Kóspál[1,2], A. Carmona[3], R. van Boekel[2]**
**[1]Konkoly Observatory, Hungary [2]Max-Planck-Institut für Astronomie, Germany**
**[3]Université de Toulouse, France**

- **Crystallization of silicate grains** (**amorphous** → **crystalline**) take place in protoplanetary discs.
  - ISM: **amorphous**
  - protoplanetary discs: **amorphous**+**crystalline**
  - solar system objects (comets, asteroids, etc.): **crystalline**




- **When and how** can the **amorphous** silicate grains be heated to ∼1000 K, so that they anneal into **crystalline**?
  - Model A: hot inner disk midplane at early phases (Gail+ 2004)
  - Model B: crystallization in local shock fronts (Desch 2005)
  - **Our model C: on inner disk surface during episodic outbursts, even at later stages (Ábrahám et al. 2009)**

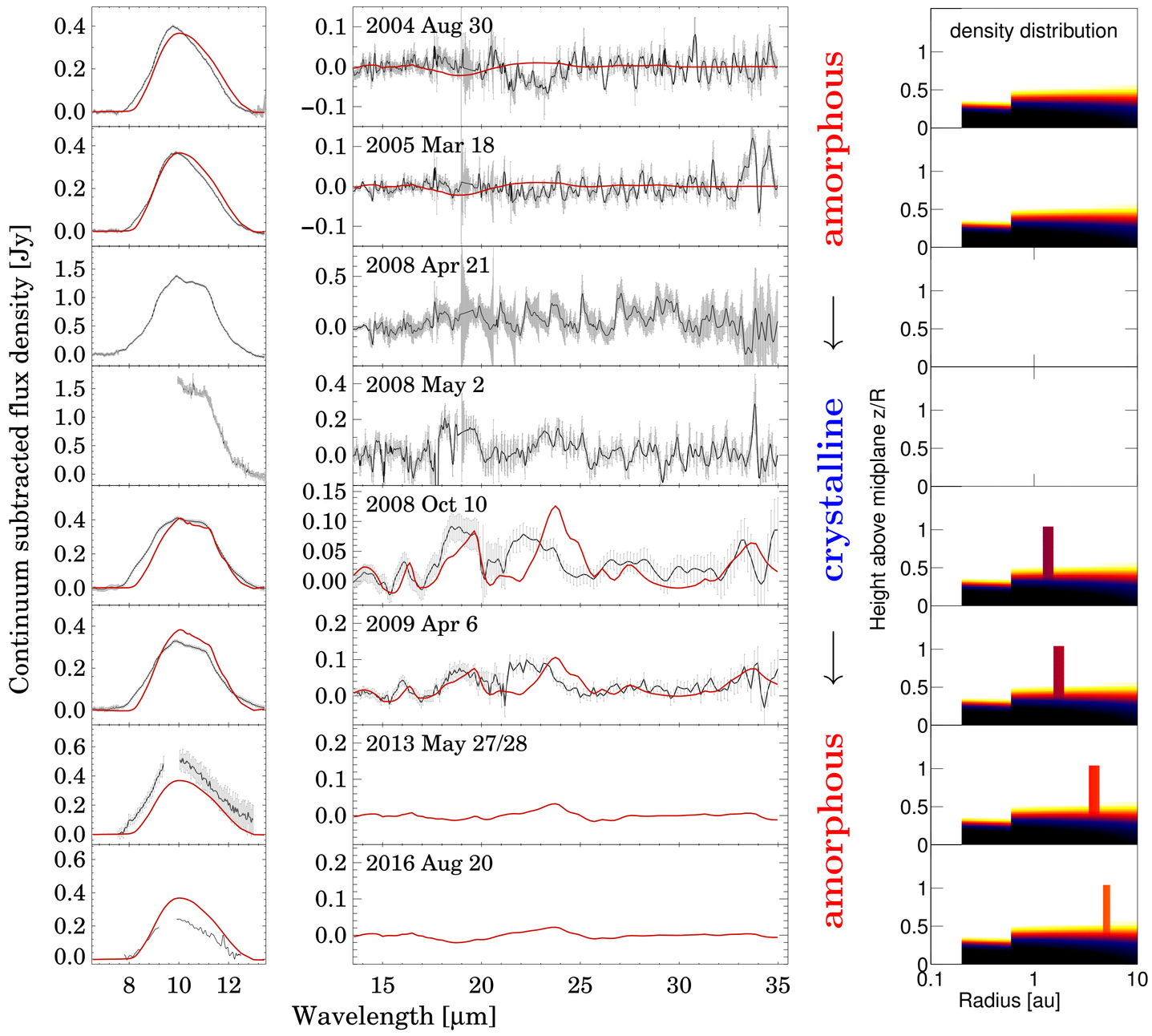



## Crystalline dust in EX Lupi

- **Formation during the outburst.**
  EX Lupi underwent its historically largest outburst in 2008 Jan to Sep, brightening by about 5 magnitudes in visual light. Spitzer observations during the outbursts detected strong crystalline silicate features, which we interpreted as crystalline formation in the inner disk surface due to the enhanced illumination (Ábrahám+ 2009, Juhász+ 2012).
- **Radial transport after the outburst.**
  The crystalline features faded substantially within only one year after the outburst, and disappeared in later observations in 2013 and 2016. We interpreted the fading with an expanding shell of crystalline dust. The increased distance from the central star makes the dust cooler and reduces its optical depth, hence the reduced emission features. We modelled the emission of the shell using RADMC3D, and fitted the crystalline mass, as well as the radial distance of the shell from the star at the different epochs. We obtained a crystalline dust mass of $\sim 10^4$ Hale-Bopp mass, and concluded that the expanding shell likely reached the water snowline, the brithplace of comets.

Multi-epoch spectra of EX Lupi (left and middle; black: observed; red: model), and the dust density distribution in the models (right).

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**Reference:**
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**Contact: Lei Chen**
Konkoly Observatory
Budapest, Hungary
Email: lei.chen@csfk.mta.hu