OO Serpentis:

an intermediate-type object between FUors and EXors?

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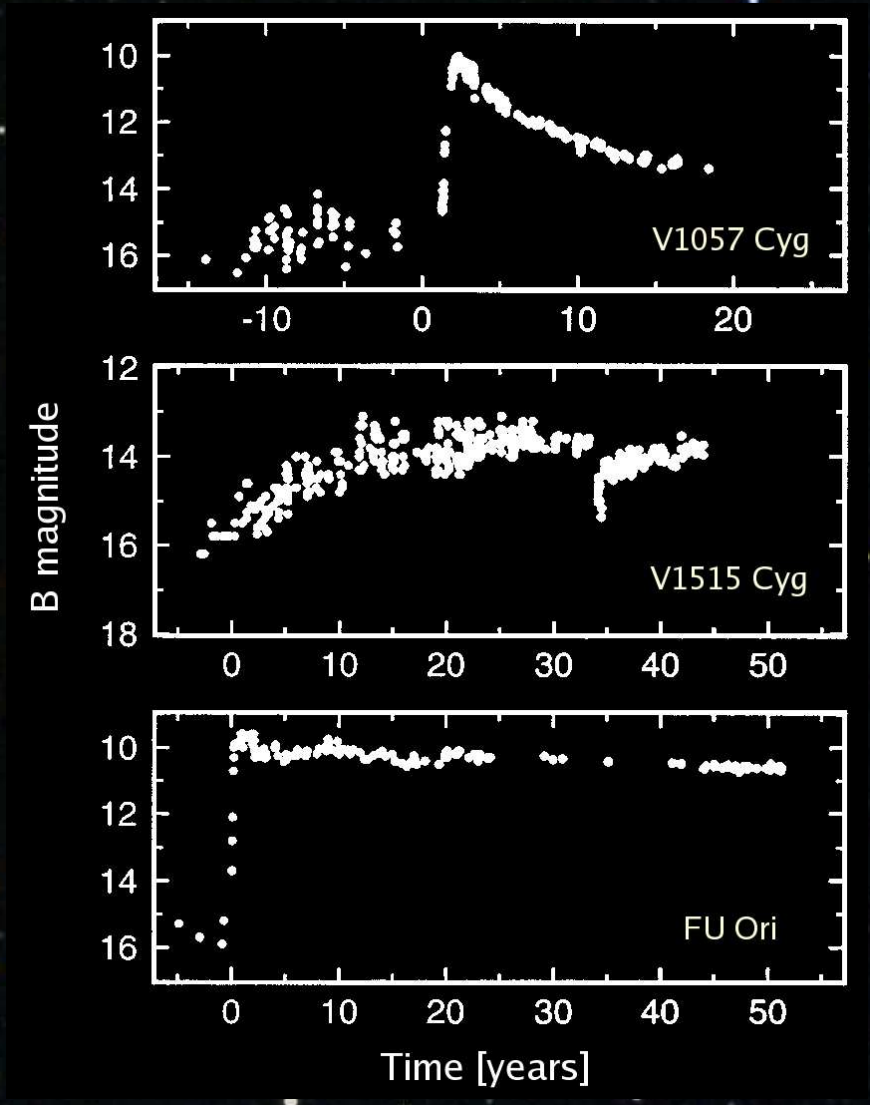
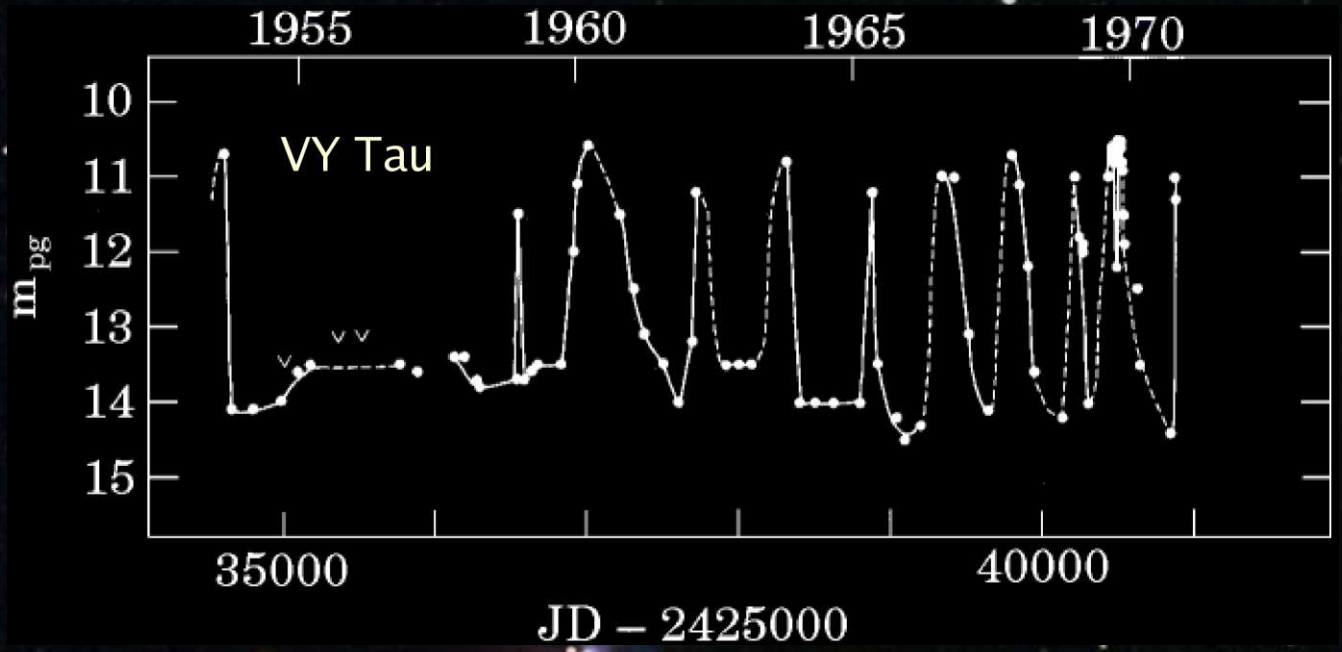
FU Orionis-type objects

- Low-mass ($M < 2M_{\odot}$), pre-main sequence objects
- Star + large amount of circumstellar material (disc + envelope)
- Optical outburst powered by enhanced accretion
- Possibly all young stars undergo FUor-phases during their pre-main sequence evolution



(Hartmann & Kenyon, 1996)

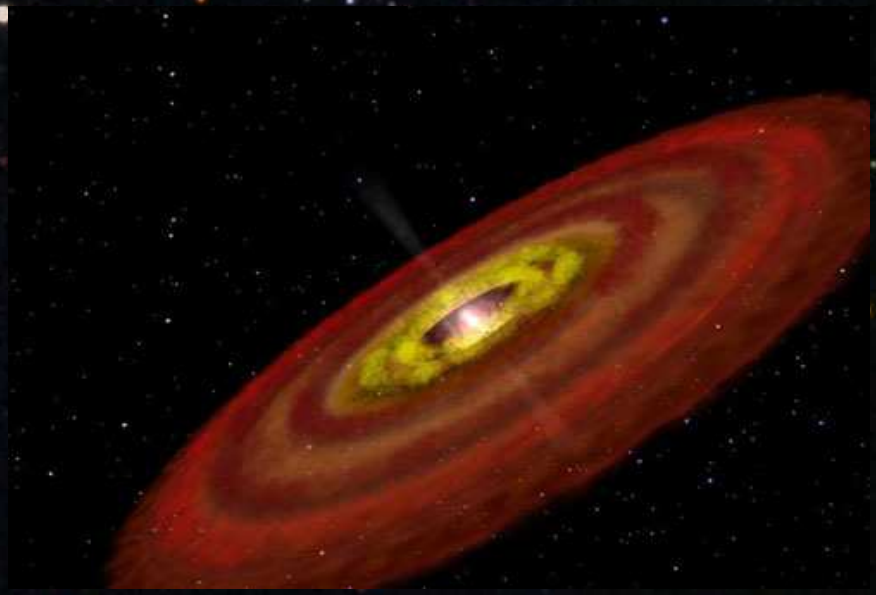
EX Lupi-type objects



(Herbig, 1977)

- Similar outbursts to that of FUors but outbursts are
  - shorter
  - repetitive

Structure of circumstellar material



- star
- disc
- envelope

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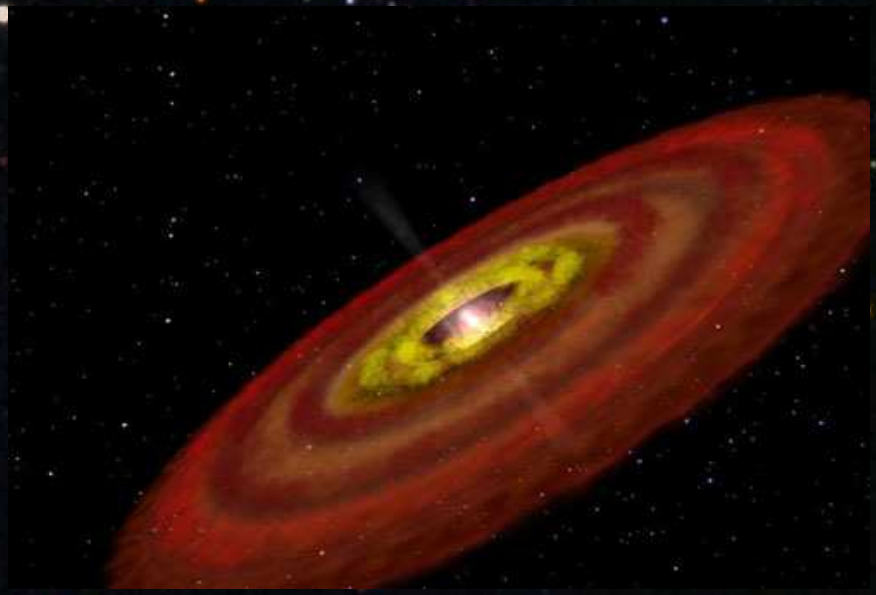

- star
- disc
- envelope

Reason of outburst:

- material accumulates close to the star
- thermal instability
- ionisation front
- material suddenly flows to the star

Motivation

- Are FUors and EXors two dinstinct classes? What is their relationship? Are there intermediate objects?

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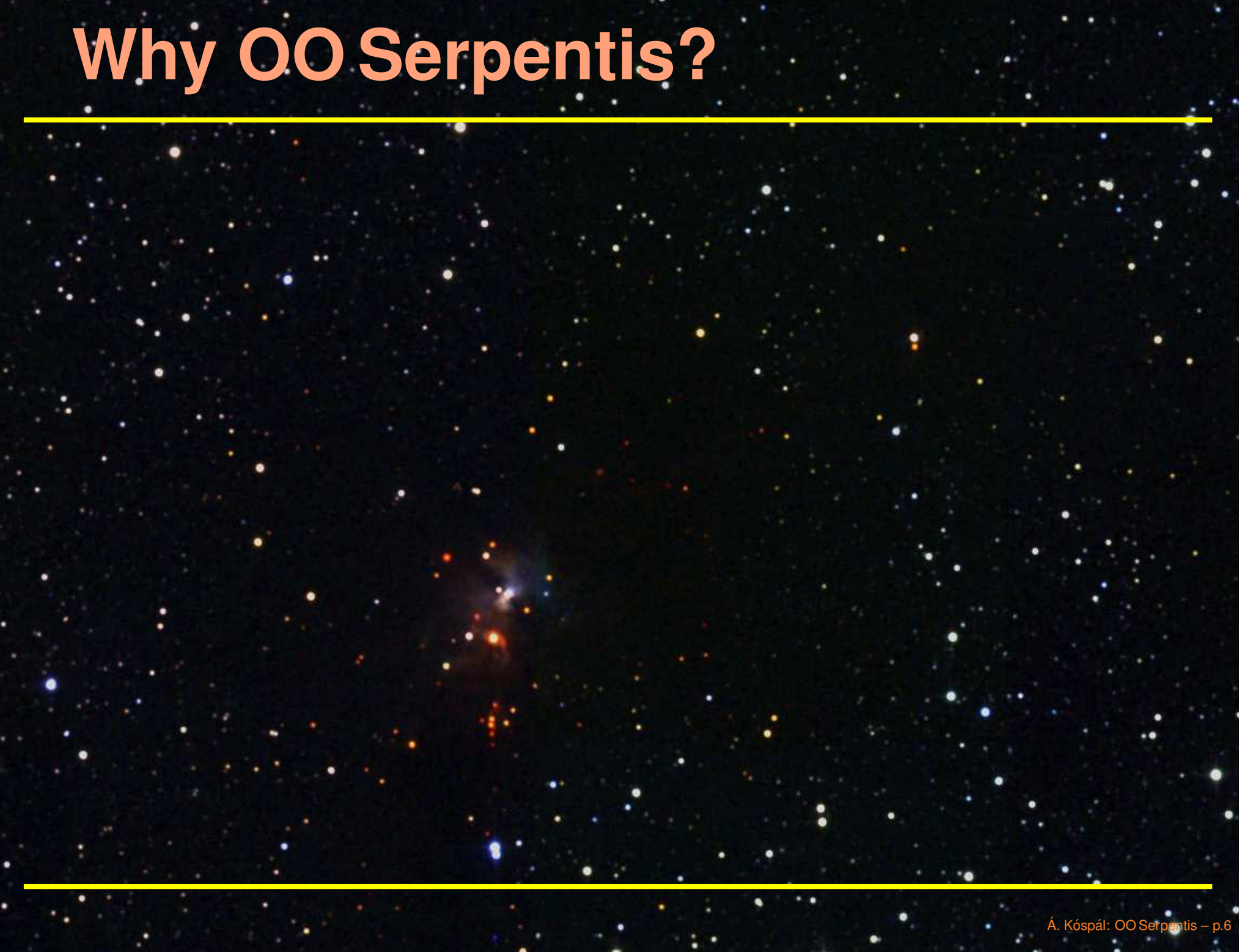
- What is the role of the circumstellar matter in the eruption?
  What does their circumstellar environment look like?
  What is the energy source of the circumstellar material?
  - reprocessed starlight?
  - accretion?

Why OO Serpentis?



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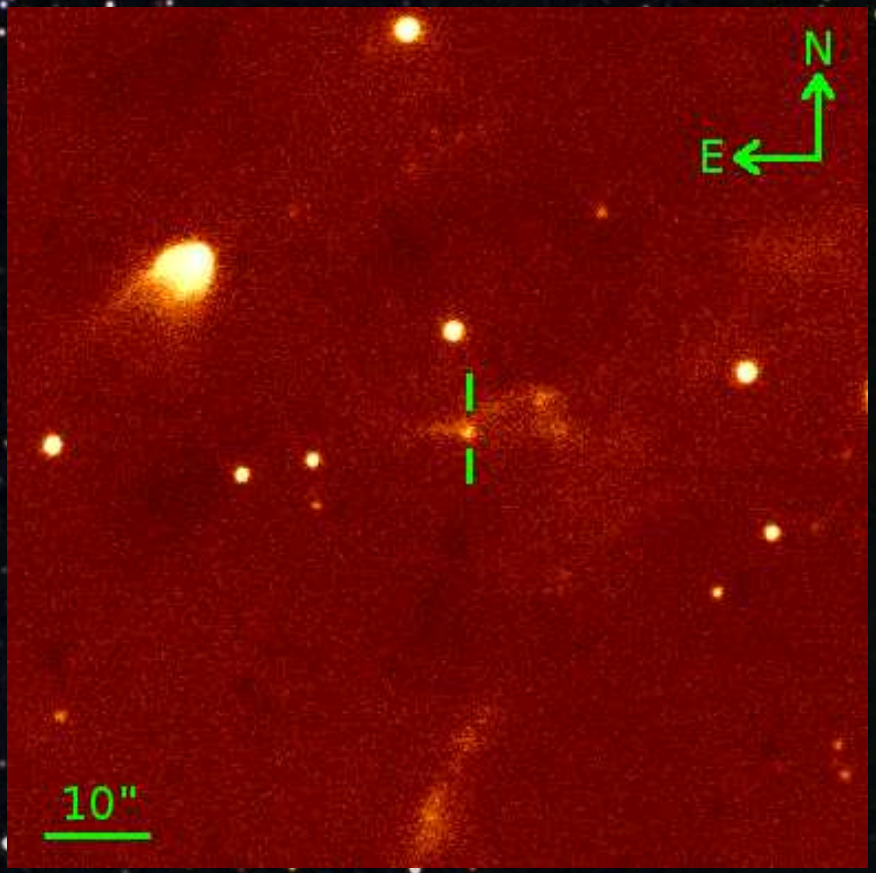

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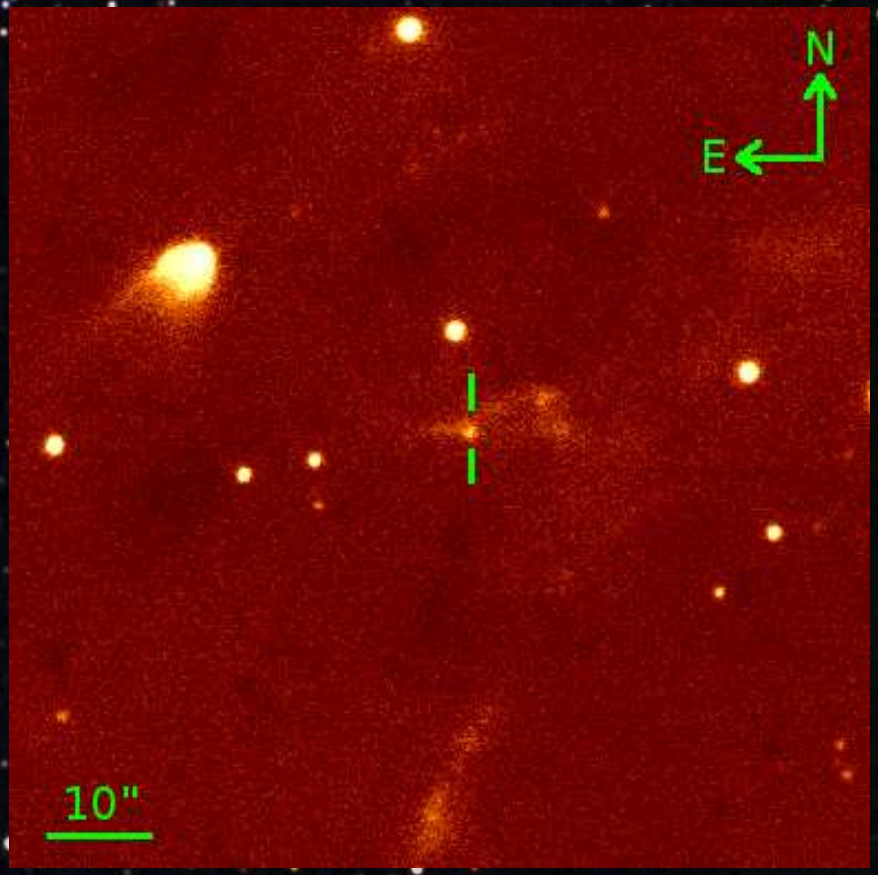

- Outbursts are very rare events!

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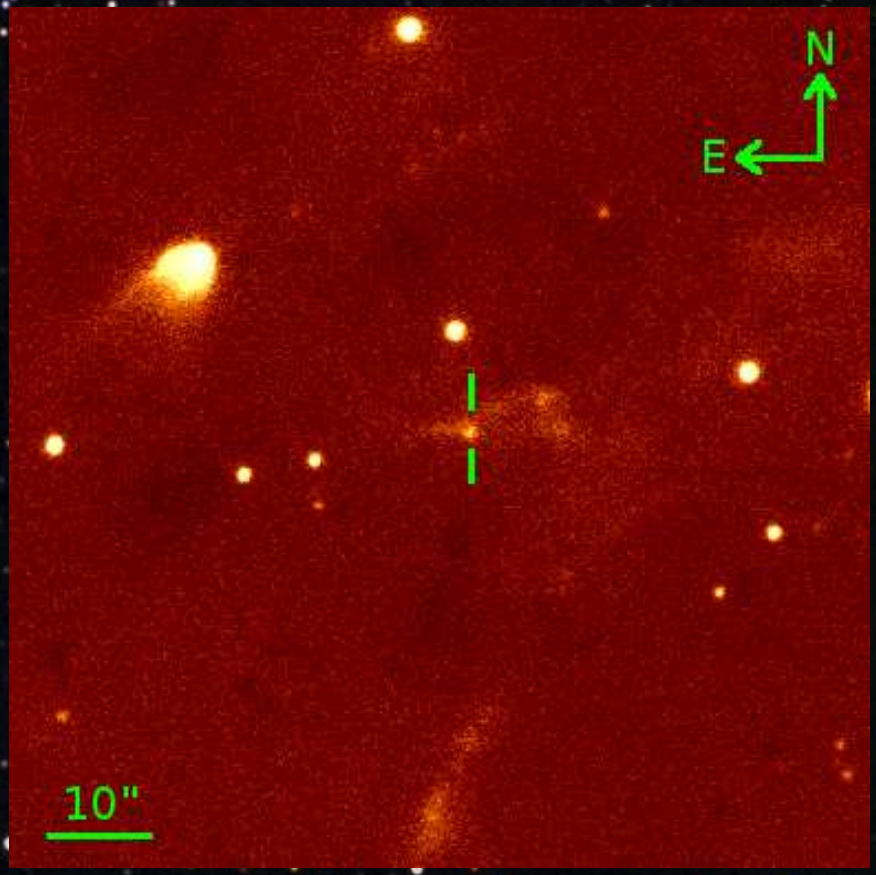

- Outbursts are very rare events!
- We only know about 23 FUors and 13 EXors (including candidates)!

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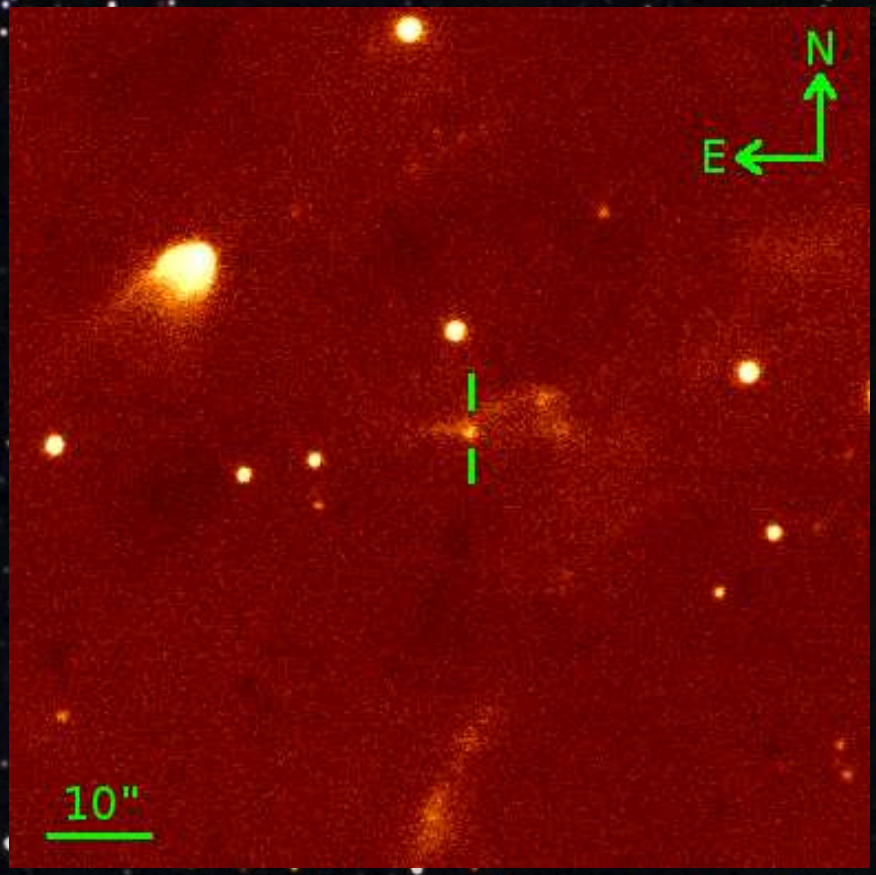

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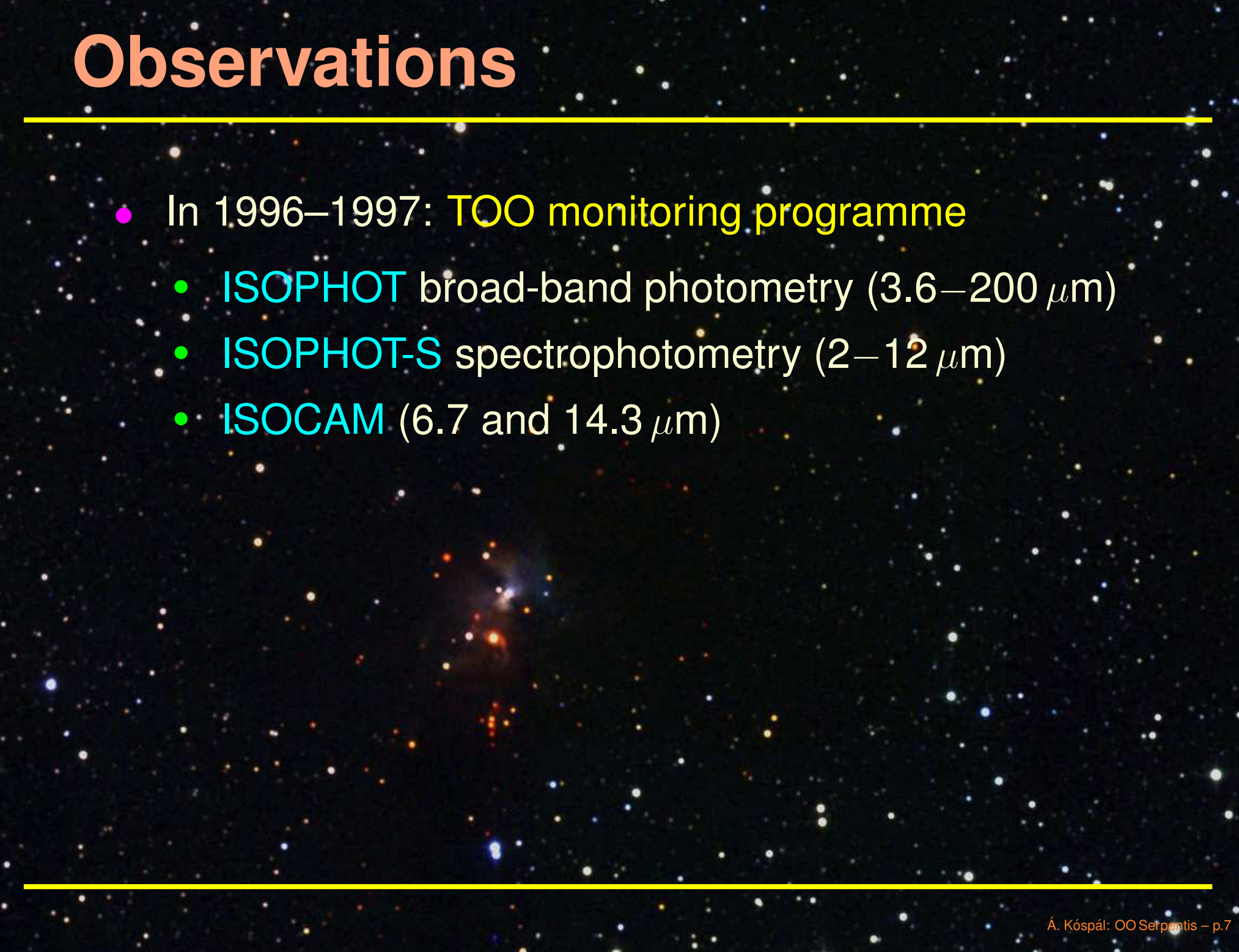
- We only know about 23 FUors and 13 EXors (including candidates)!
- Infrared data are rare and scarce

Observations

- In 1996–1997: TOO monitoring programme
  - ISOPHOT broad-band photometry (3.6−200 μm)
  - ISOPHOT-S spectrophotometry (2−12 μm)
  - ISOCAM (6.7 and 14.3 μm)



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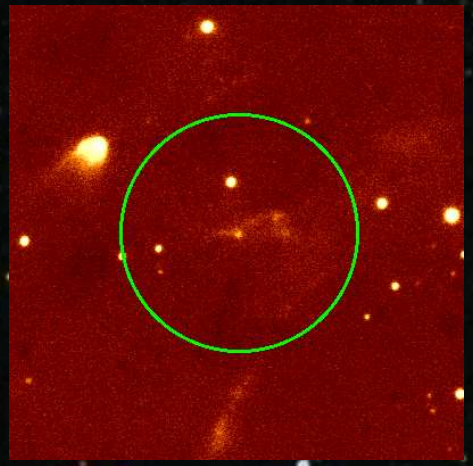
  - ISOCAM (6.7 and 14.3 μm)
- In 2004:
  - WHT/LIRIS (2.2 μm)
  - ESO3.6/TIMMI2 (12 μm)
  - Spitzer IRAC (3.6−8 μm) and MIPS (24 and 70 μm)

Data reduction

Special attention was paid to:

- source confusion



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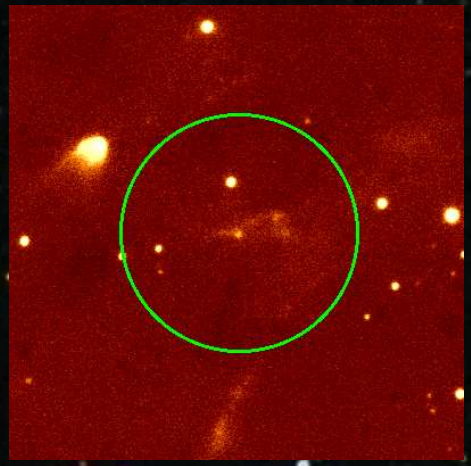
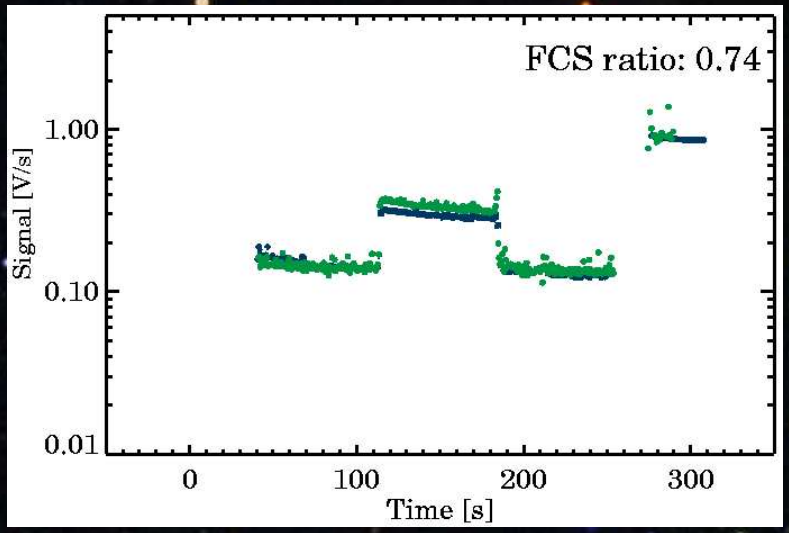
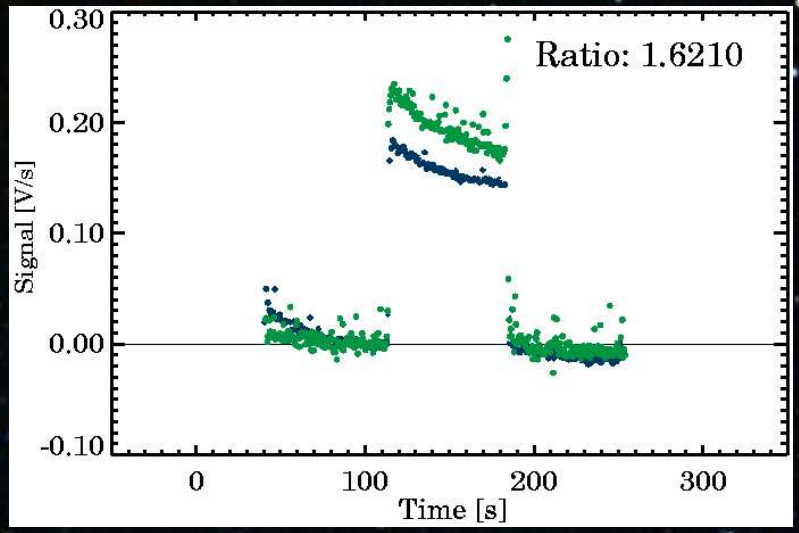
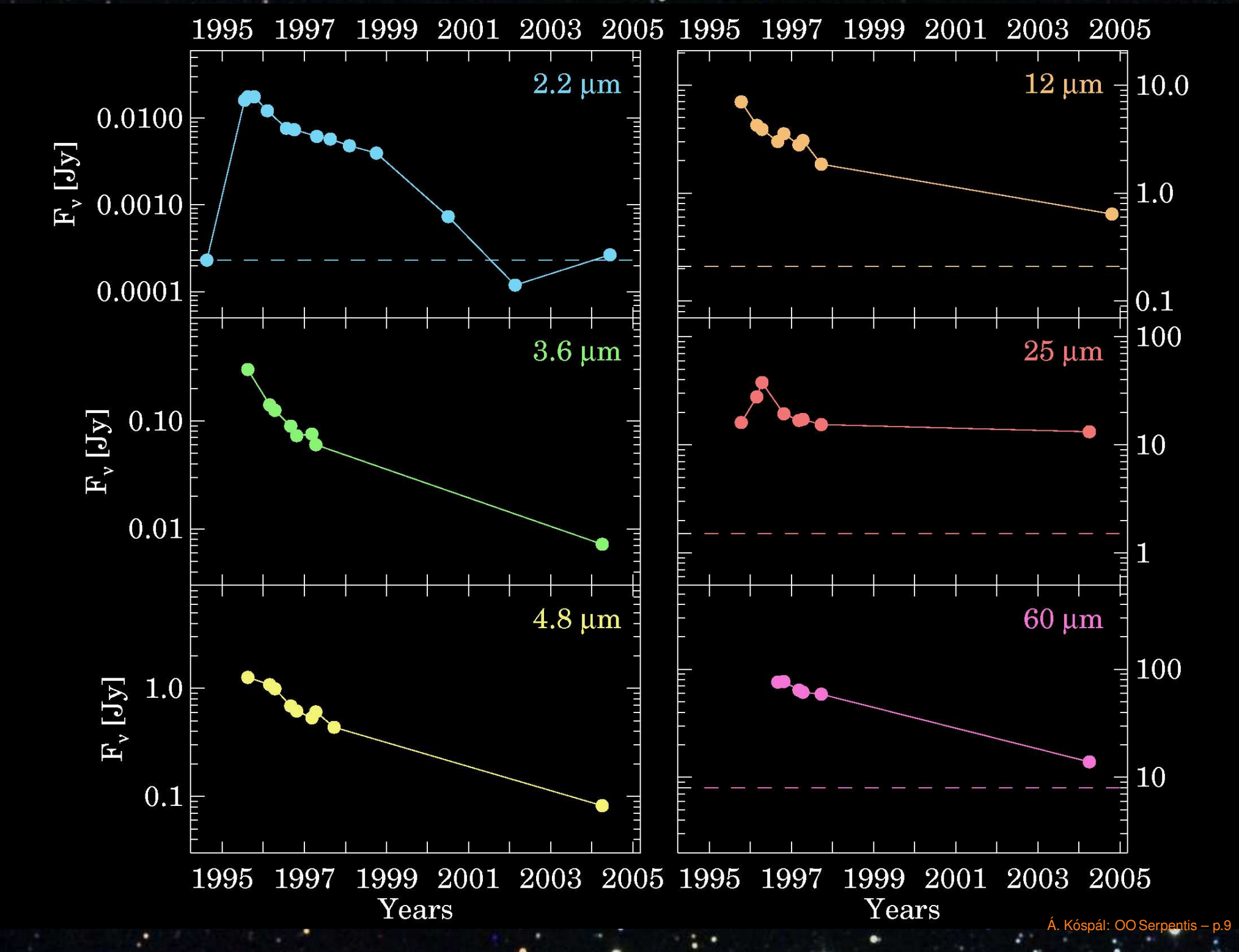


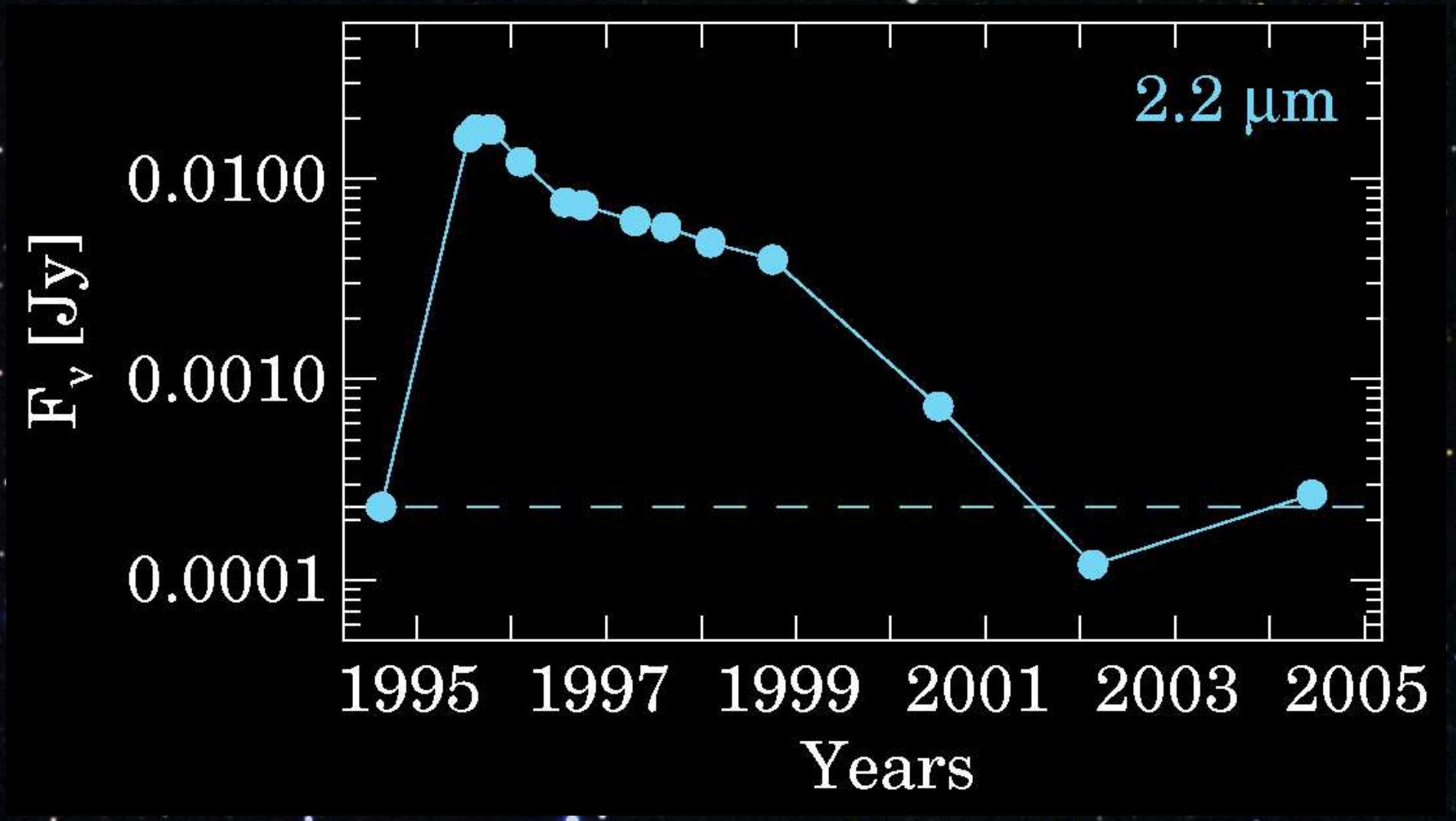
- relative calibration of ISOPHOT measurements

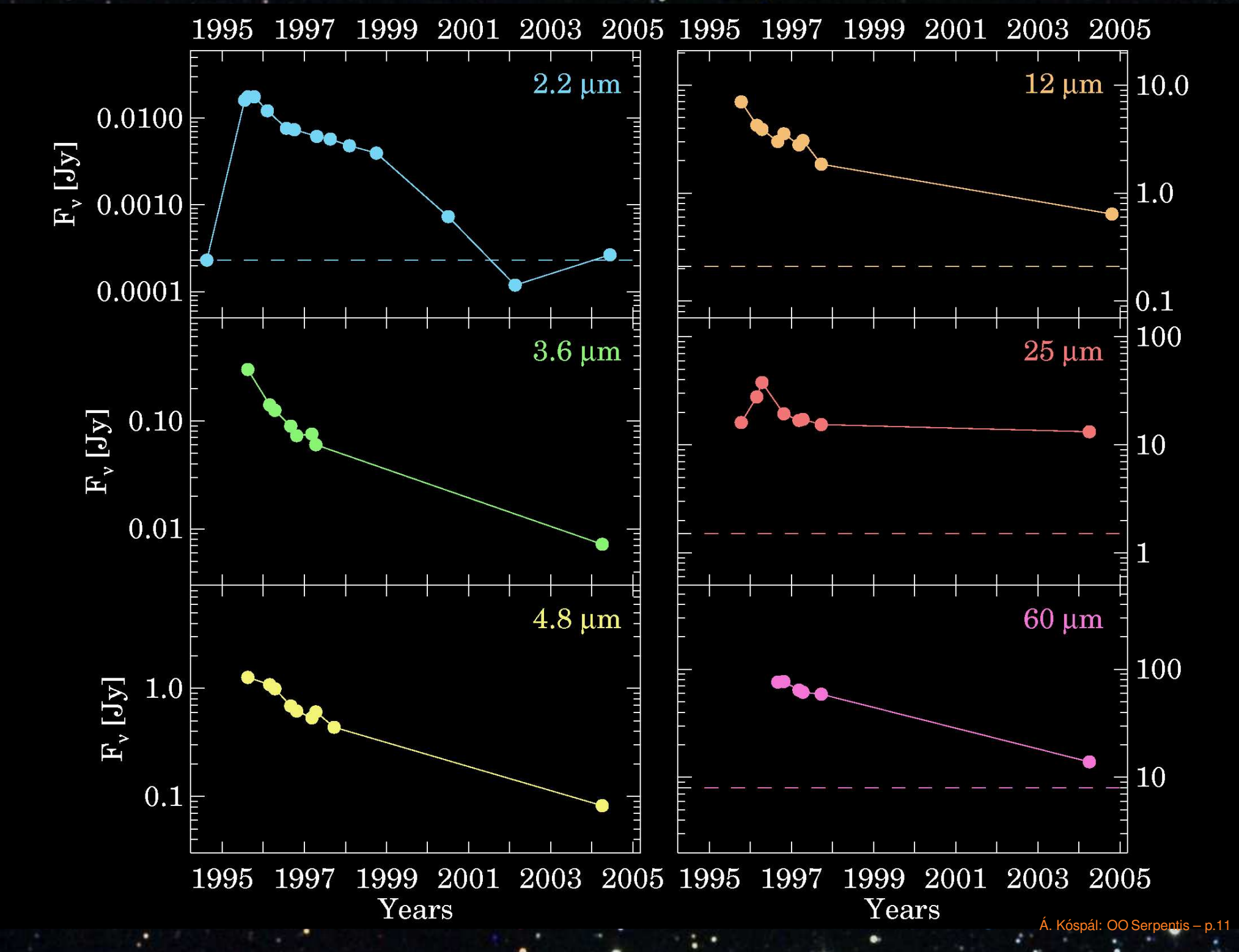





2.2 μm
12 μm
3.6 μm
25 μm
4.8 μm
60 μm
F_ν [Jy]
0.0100
0.0010
0.0001
10.0
1.0
0.1
0.10
0.01
100
10
1
100
10
1995 1997 1999 2001 2003 2005
Years

Results: the 2.2 μm light curve

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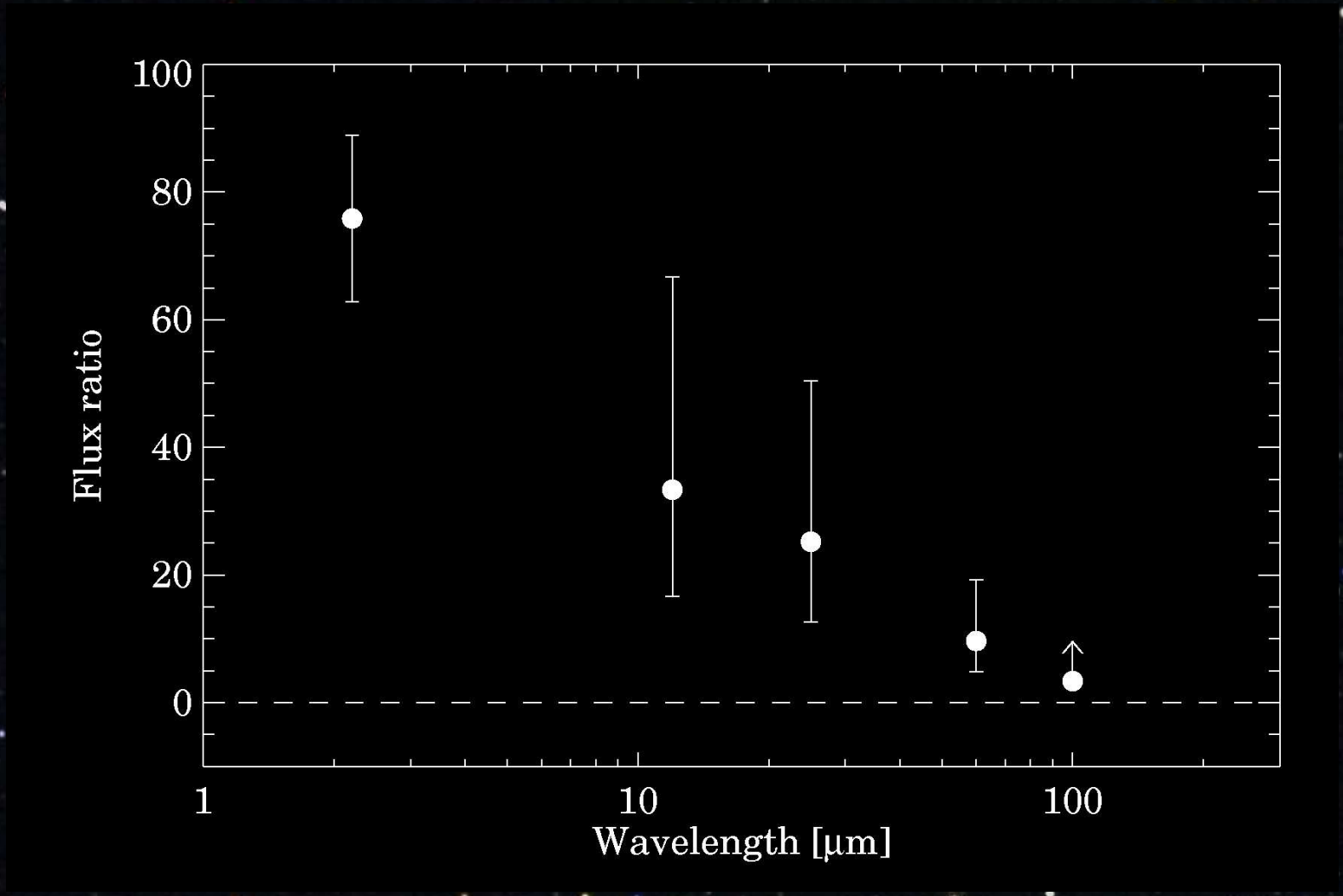
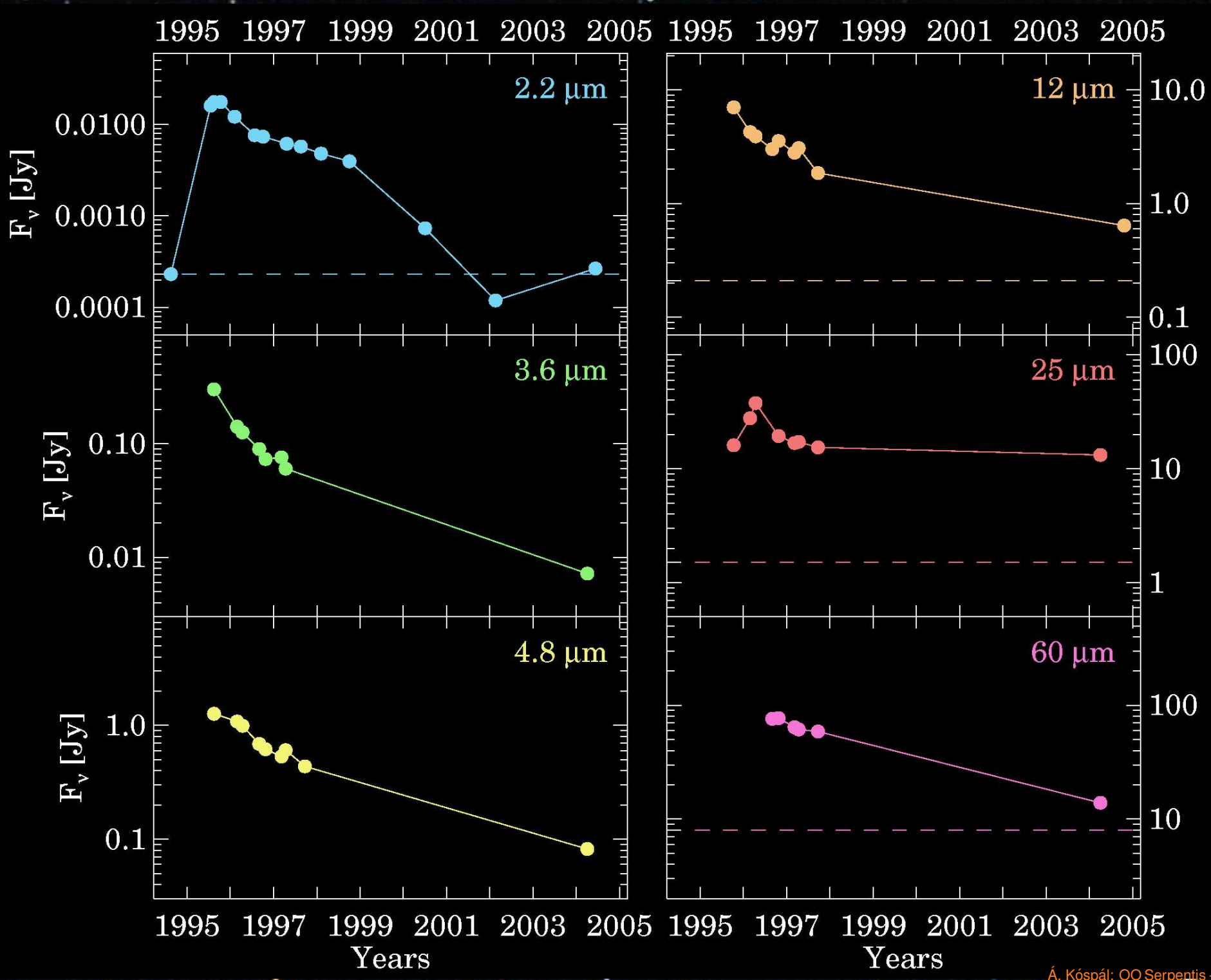
Results: the initial brightening

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1
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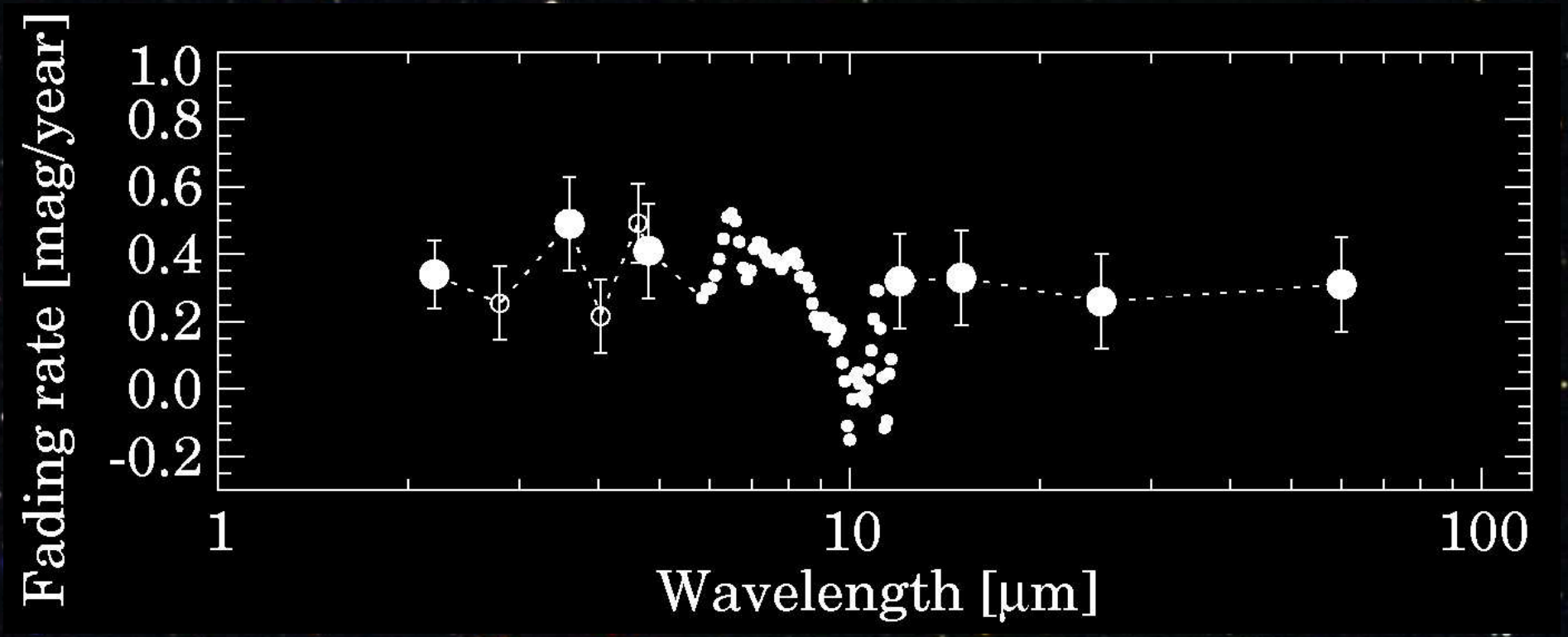
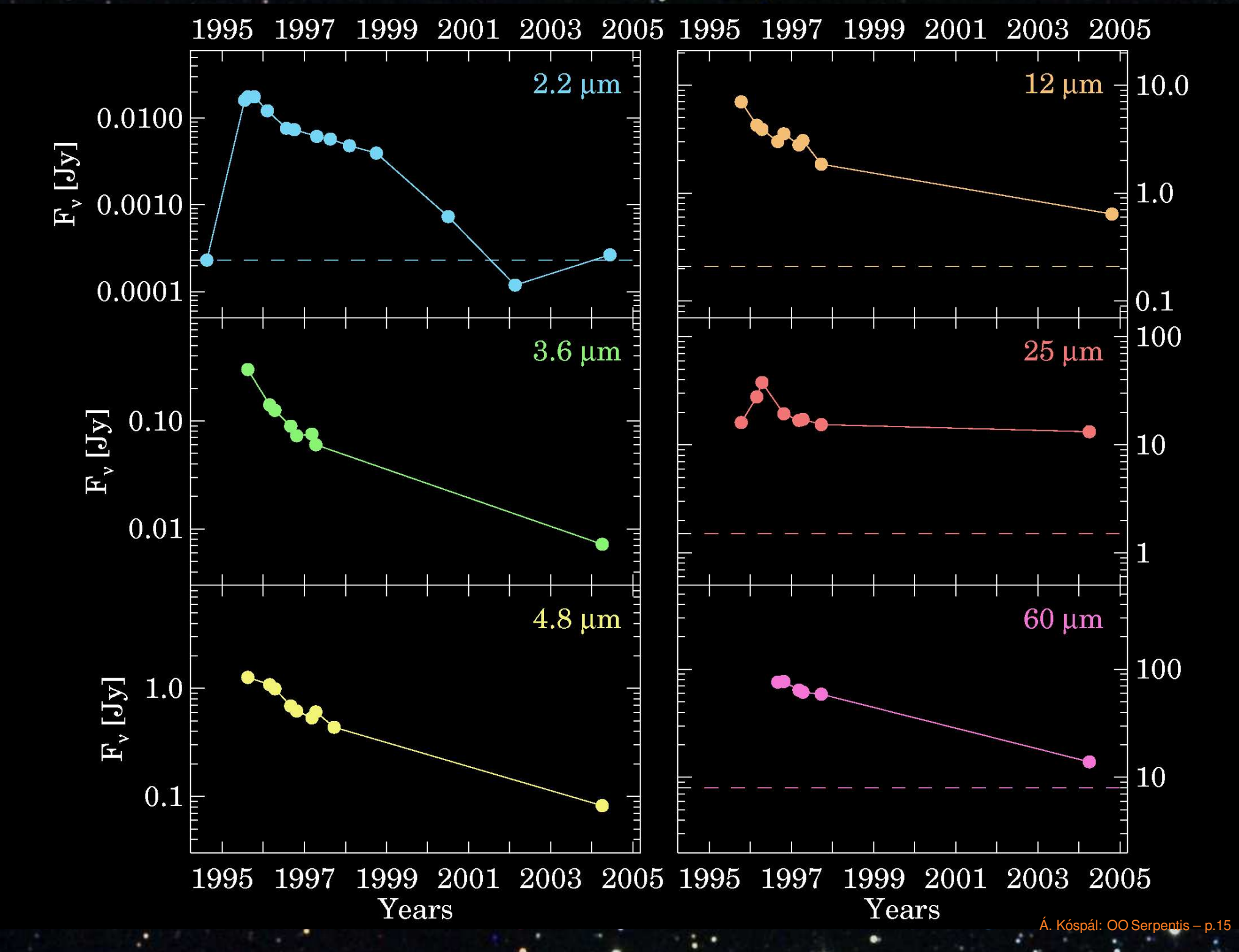
Results: fading

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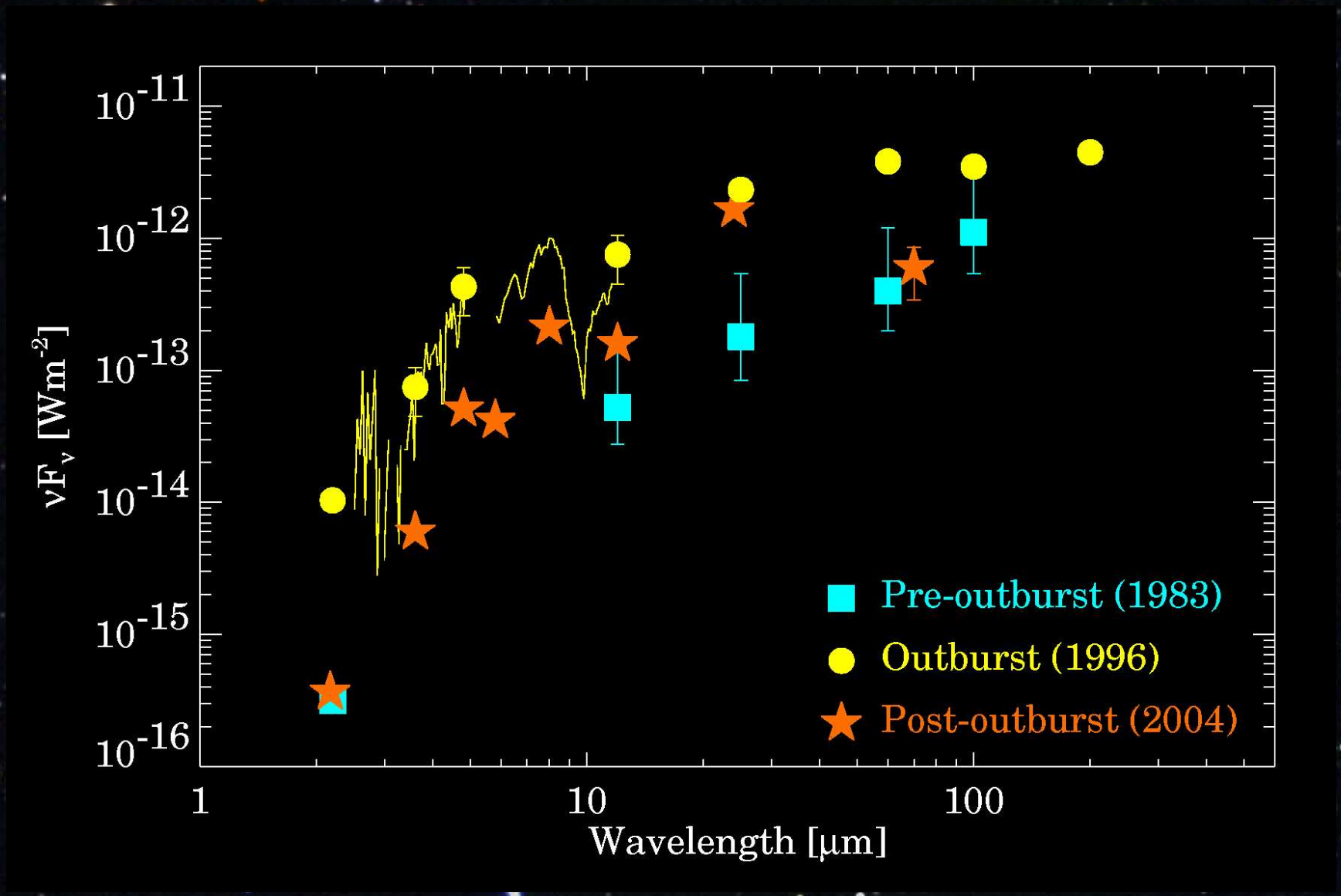
Results: the spectral energy distributions



OO Ser: an intermediate object?

OO Serpentis:

- Outburst: 9 years
- Brightening: $>4\times$

V1647 Orionis:

- Outburst: 2 years
- Brightening: $8\times$

Typical FUor: V1057 Cygni

- Outburst: $\gtrsim$40 years
- Brightening: $\approx 20\times$

Typical EXor: VY Tauri

- Outburst: 0.5–1.5 years
- Brightening: $\approx$6–$20\times$

OO Ser: an input for future modelling