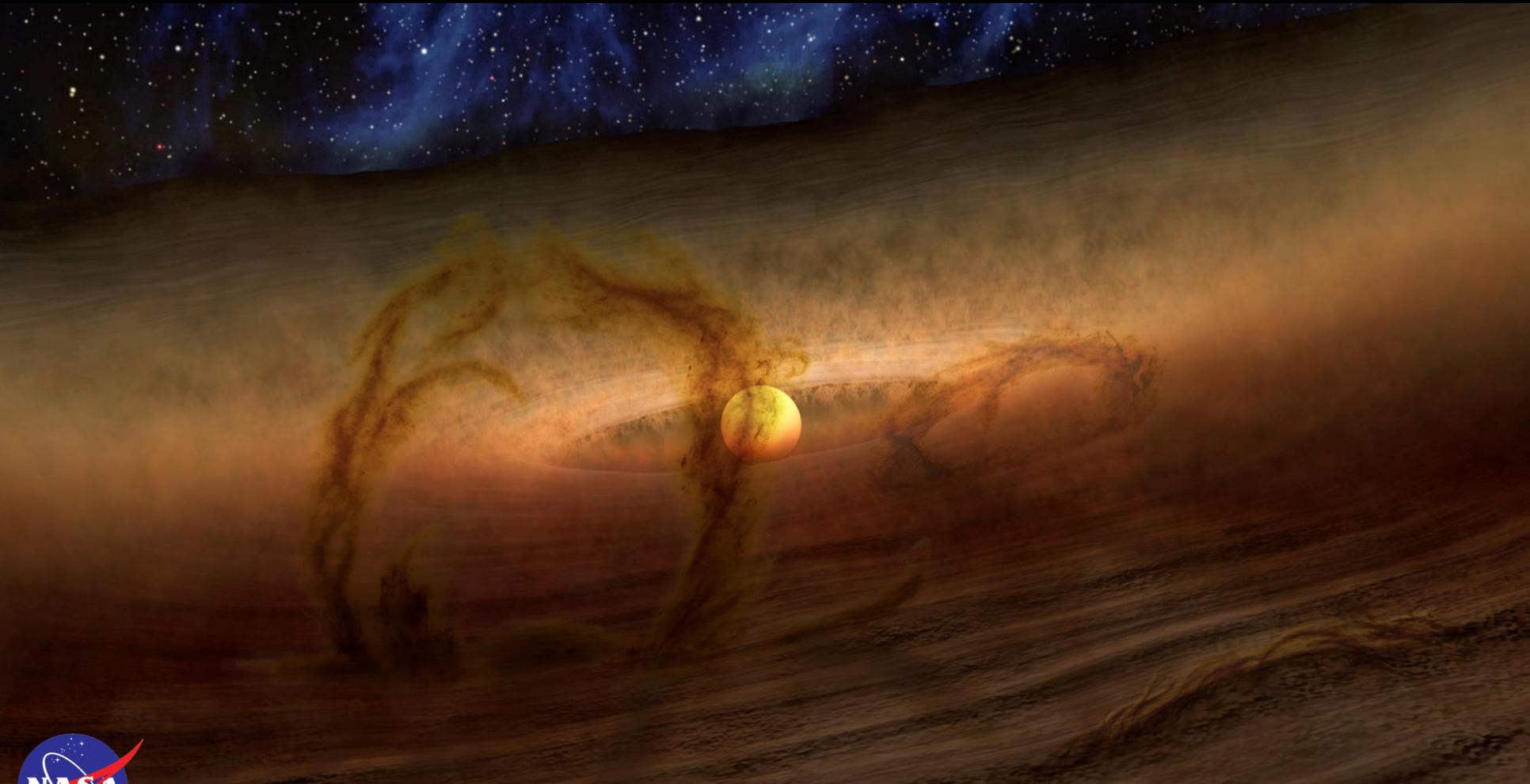


Protostellar Disks' Restless Atmospheres

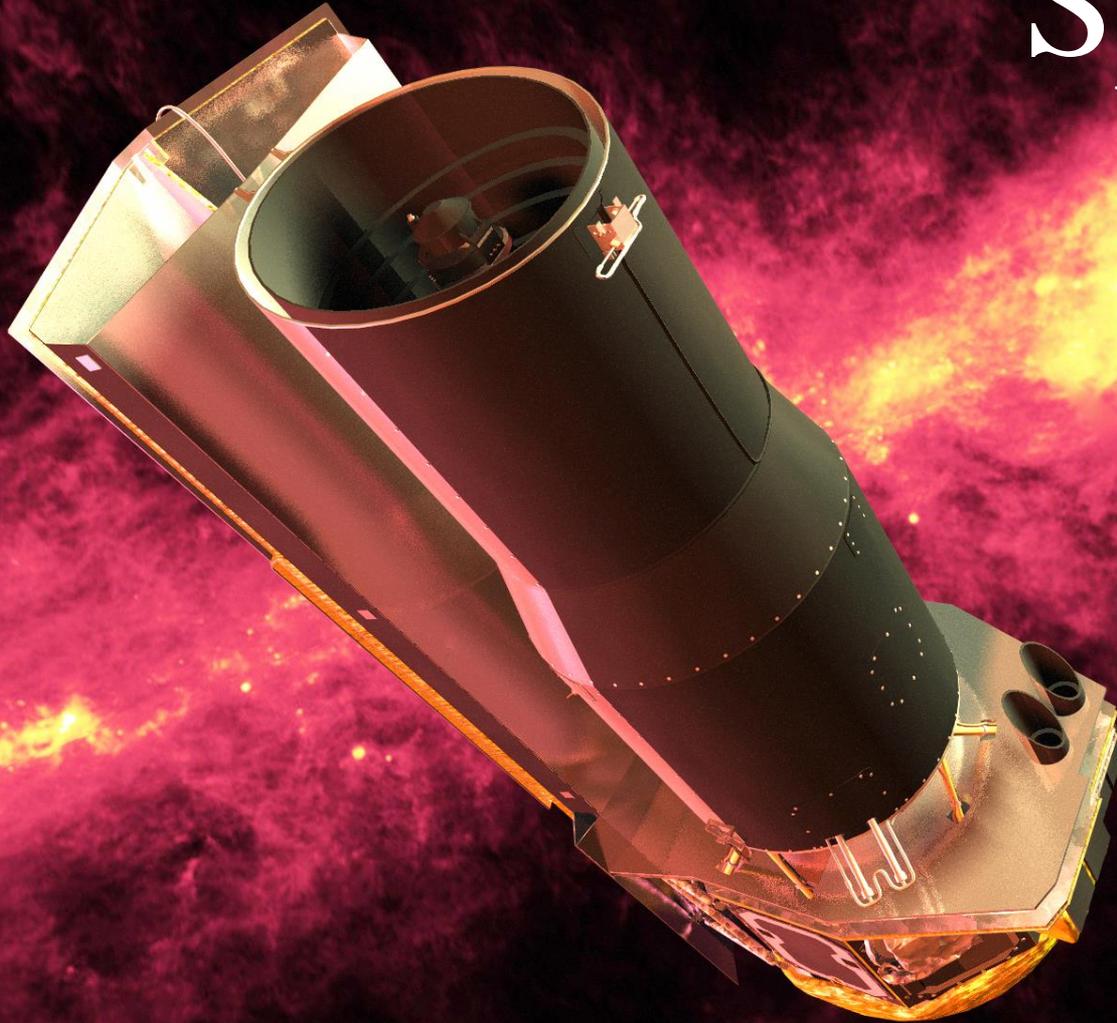
*Neal Turner (JPL/Caltech) with M. Flock (JPL/Caltech), S. Fromang (Saclay), S. Hirose (JAMSTEC),
C. Dullemond (Heidelberg), M. Benisty (Grenoble), J. Stauffer (IPAC/Caltech)*



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Artwork by Robert Hurt (IPAC/Caltech)

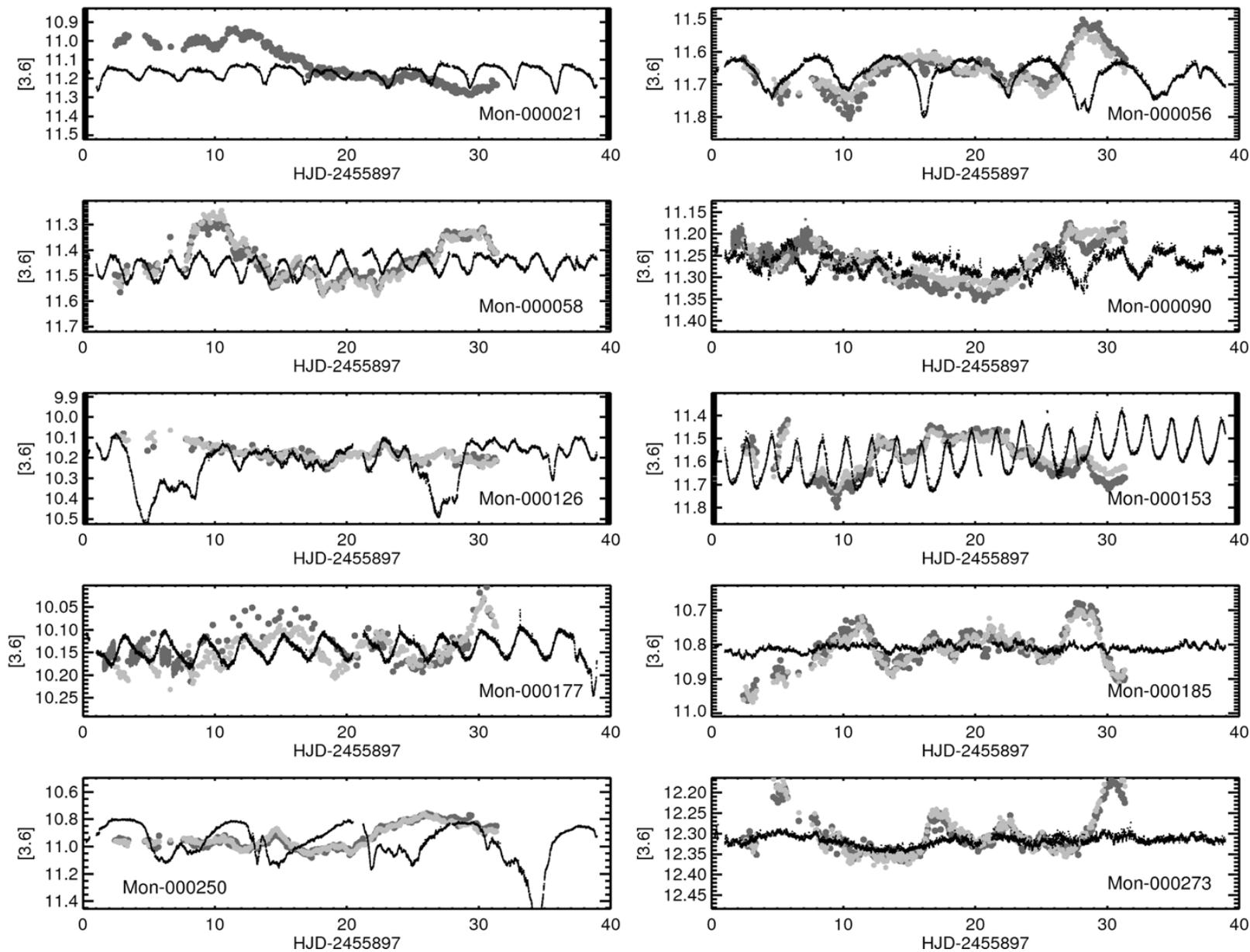
Spitzer



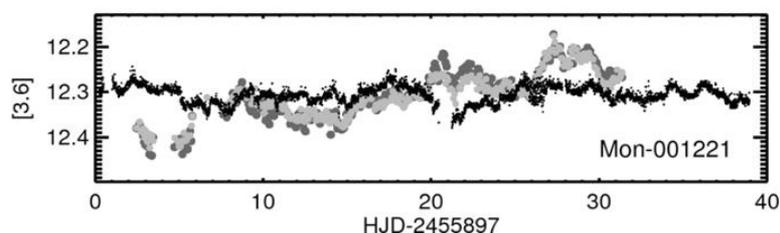
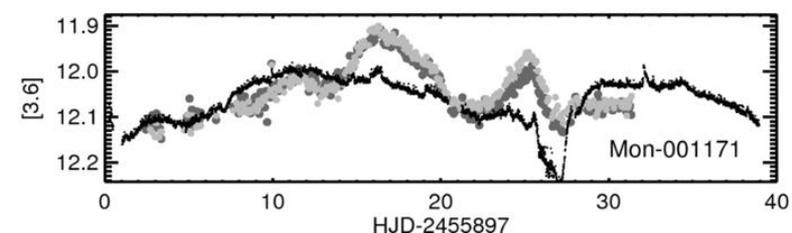
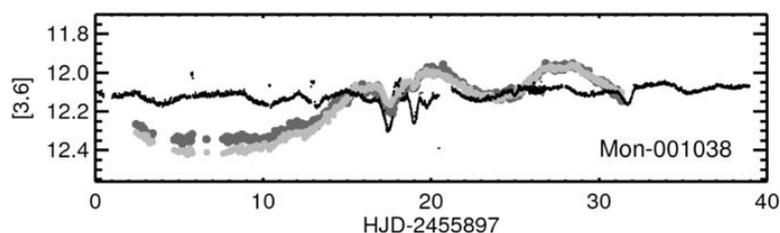
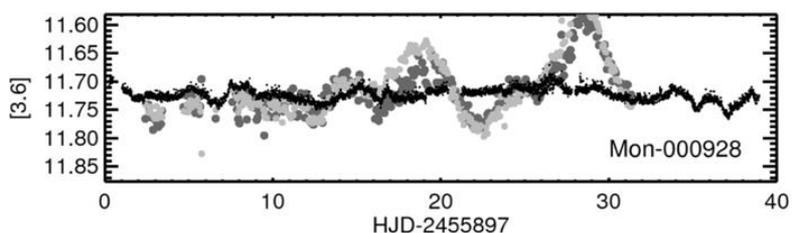
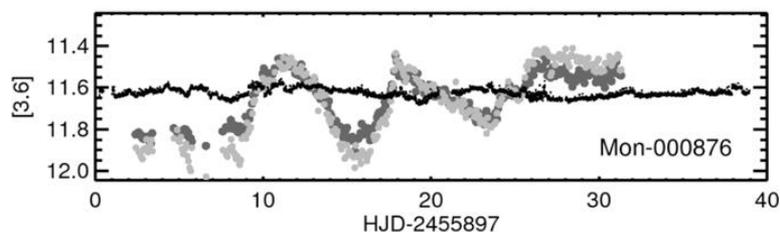
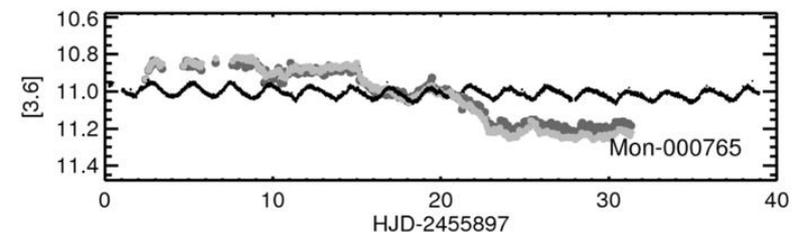
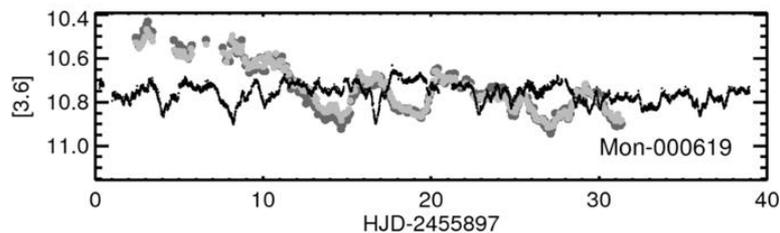
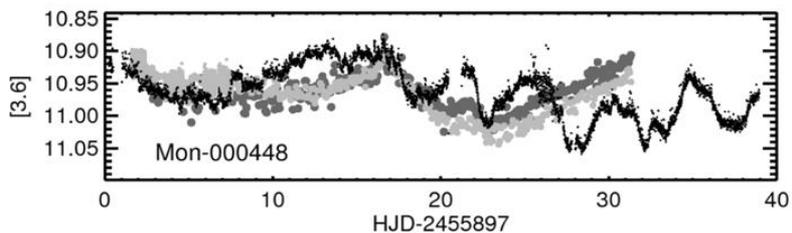
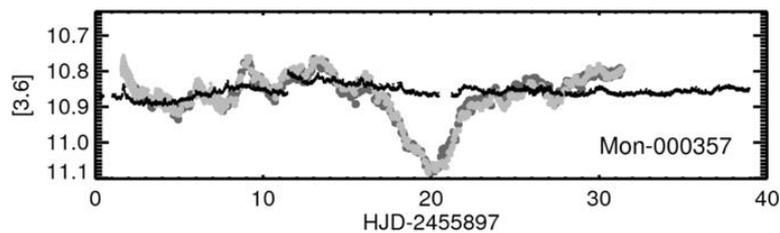
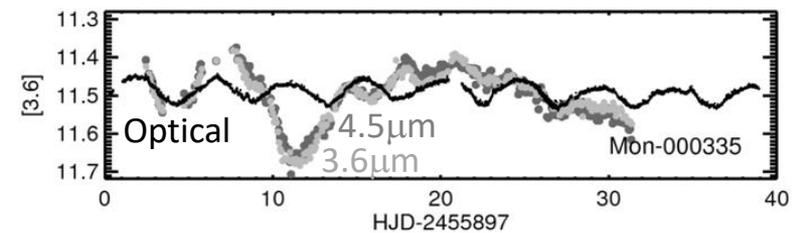
CoRoT (ESA)



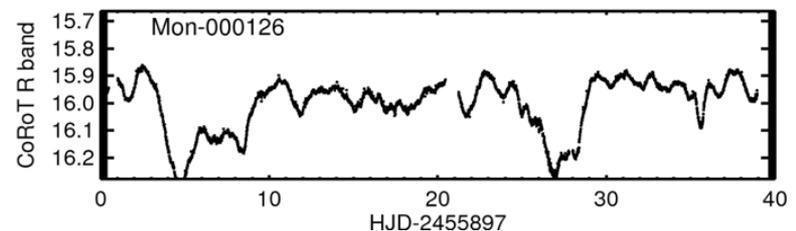
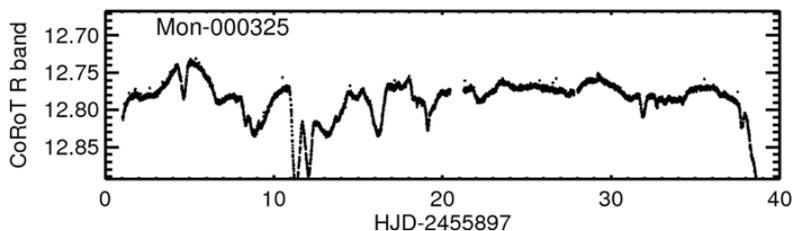
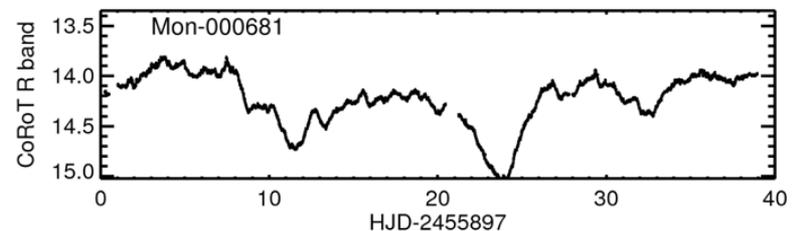
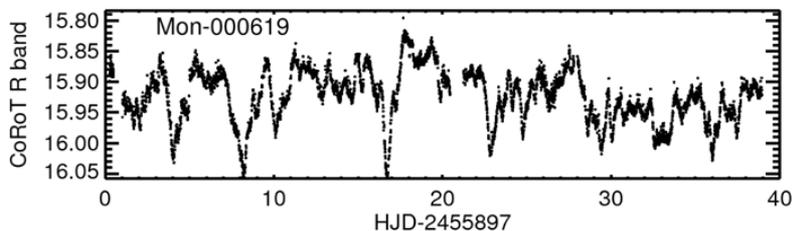
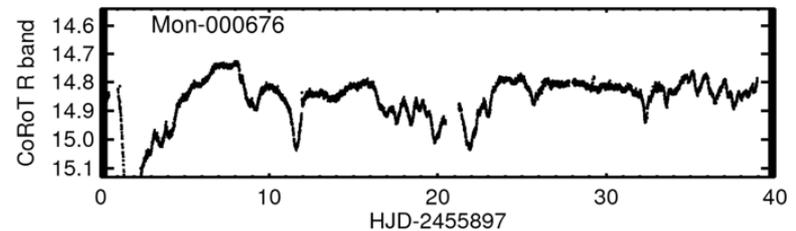
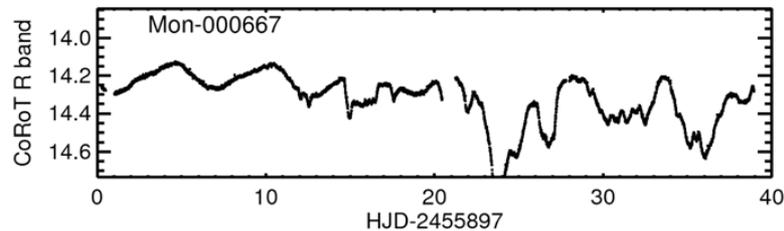
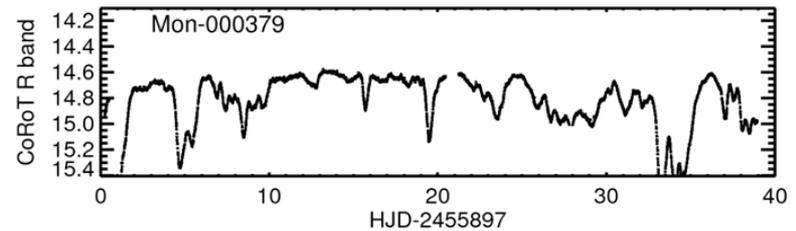
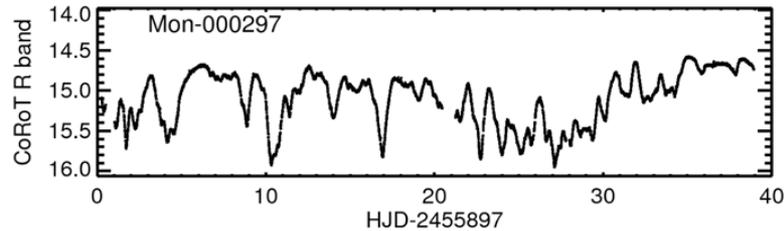
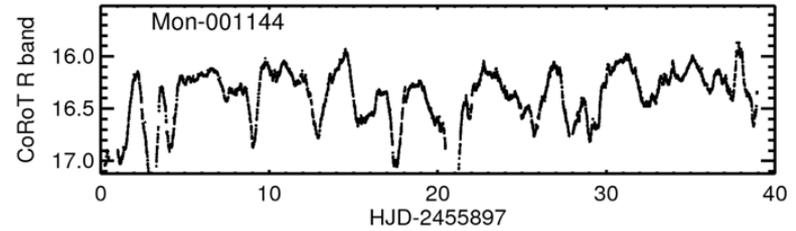
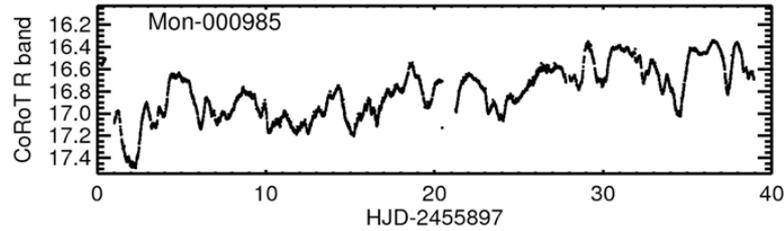
Uncorrelated Optical & IR Changes



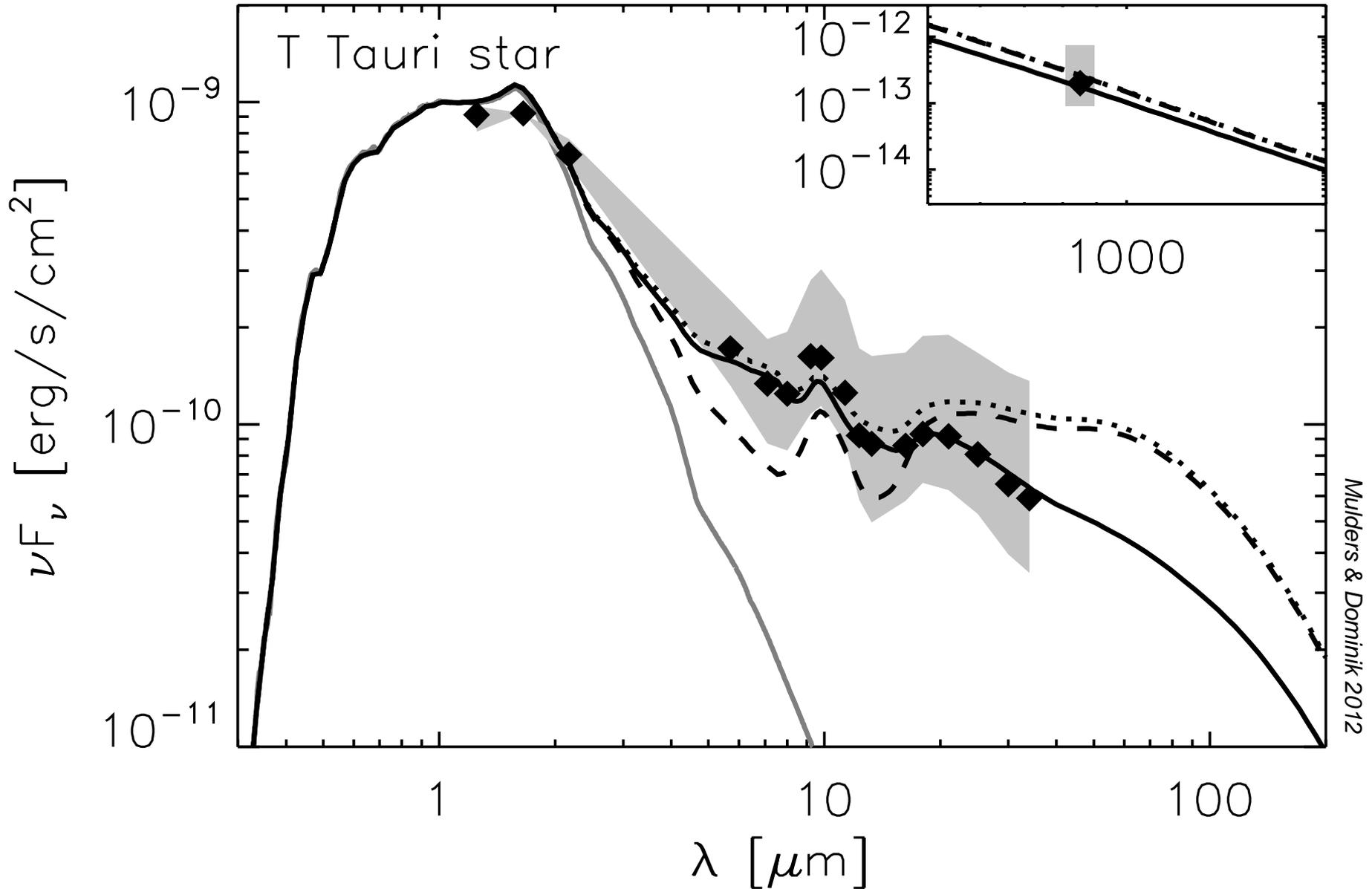
Uncorrelated Optical & IR Changes



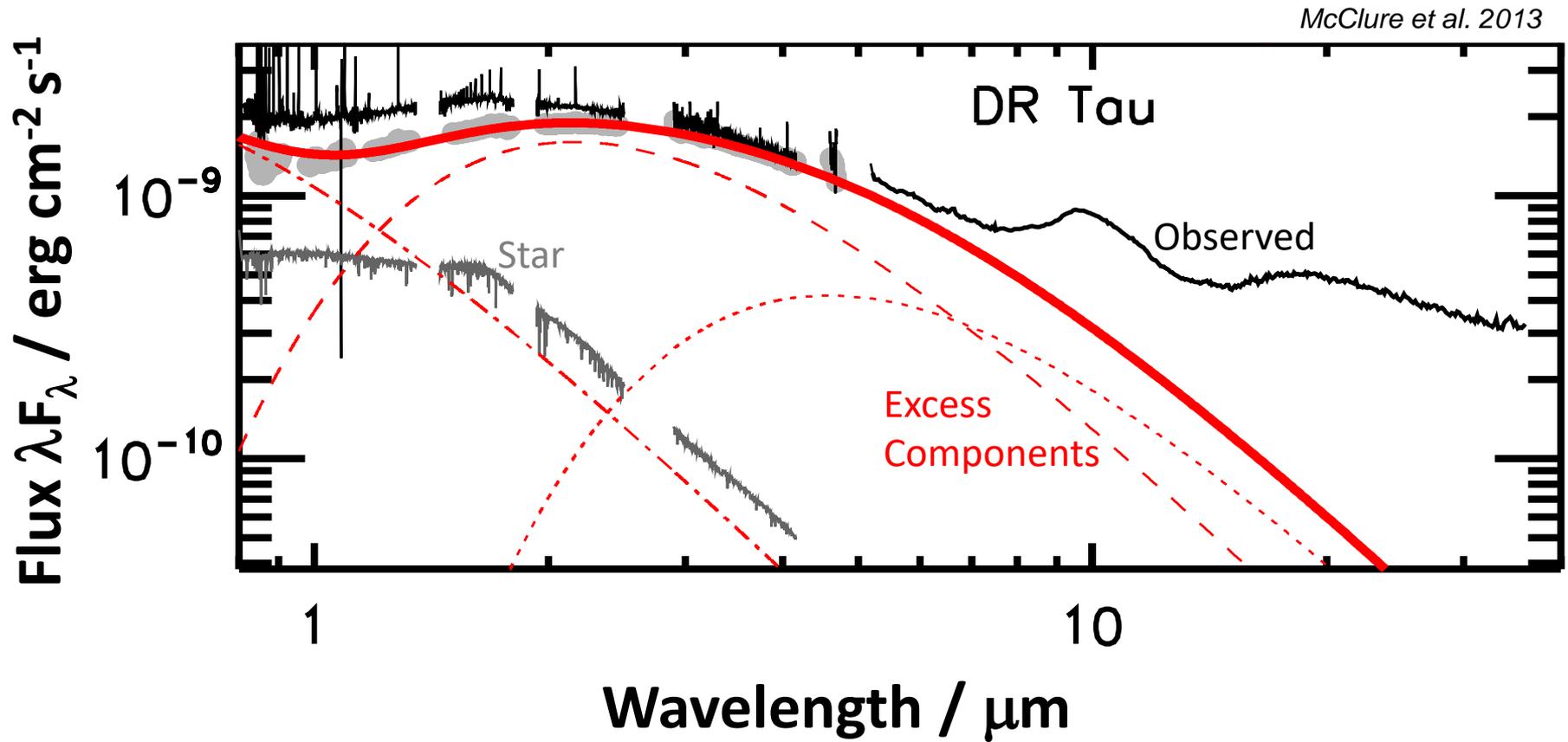
Erratic Dips Due to Variable Extinction



Median CTTS Has NIR Excess Too Large



NIR Excess has $T \sim T_{\text{subl}}$ and L up to $0.17L_*$!

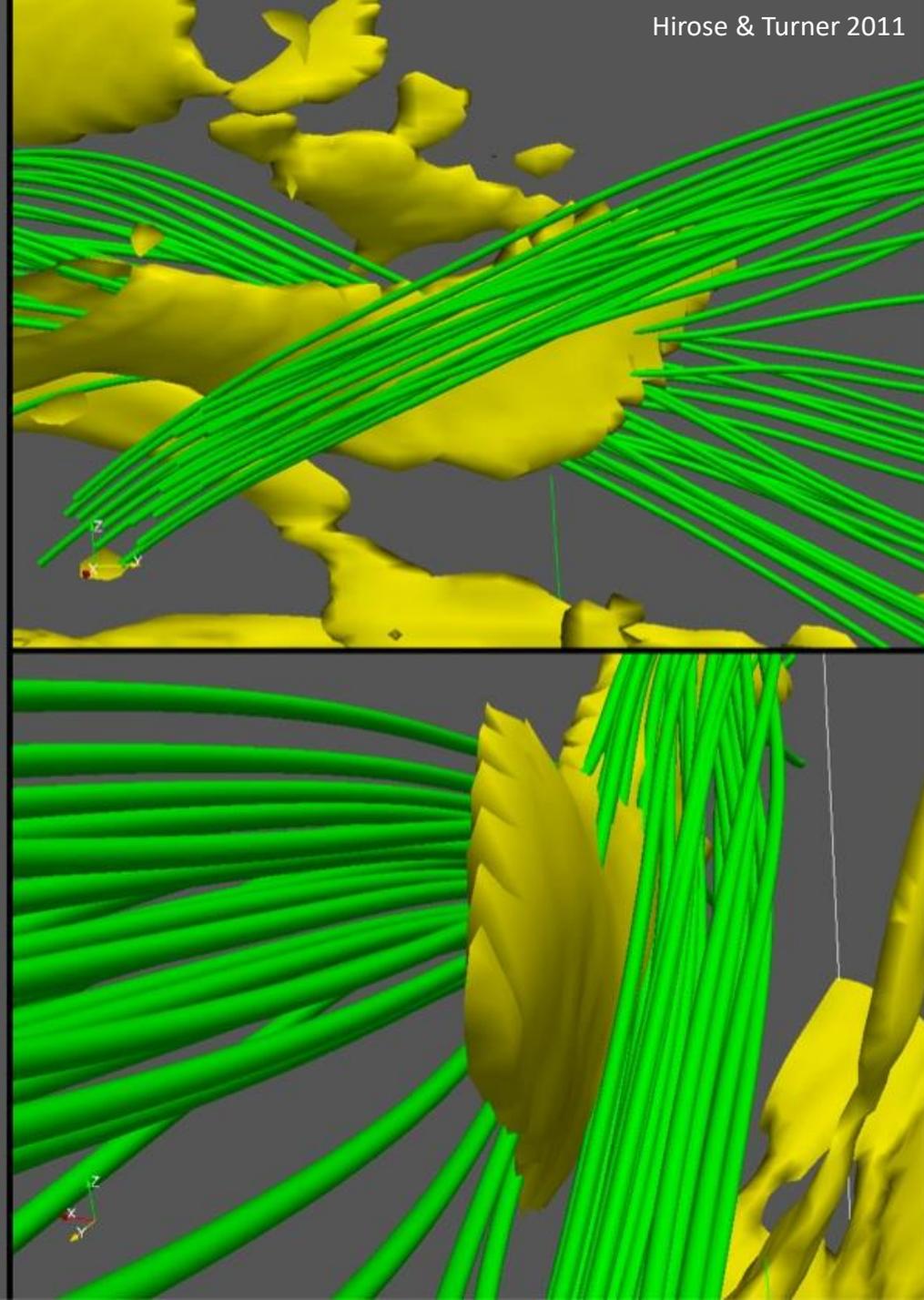
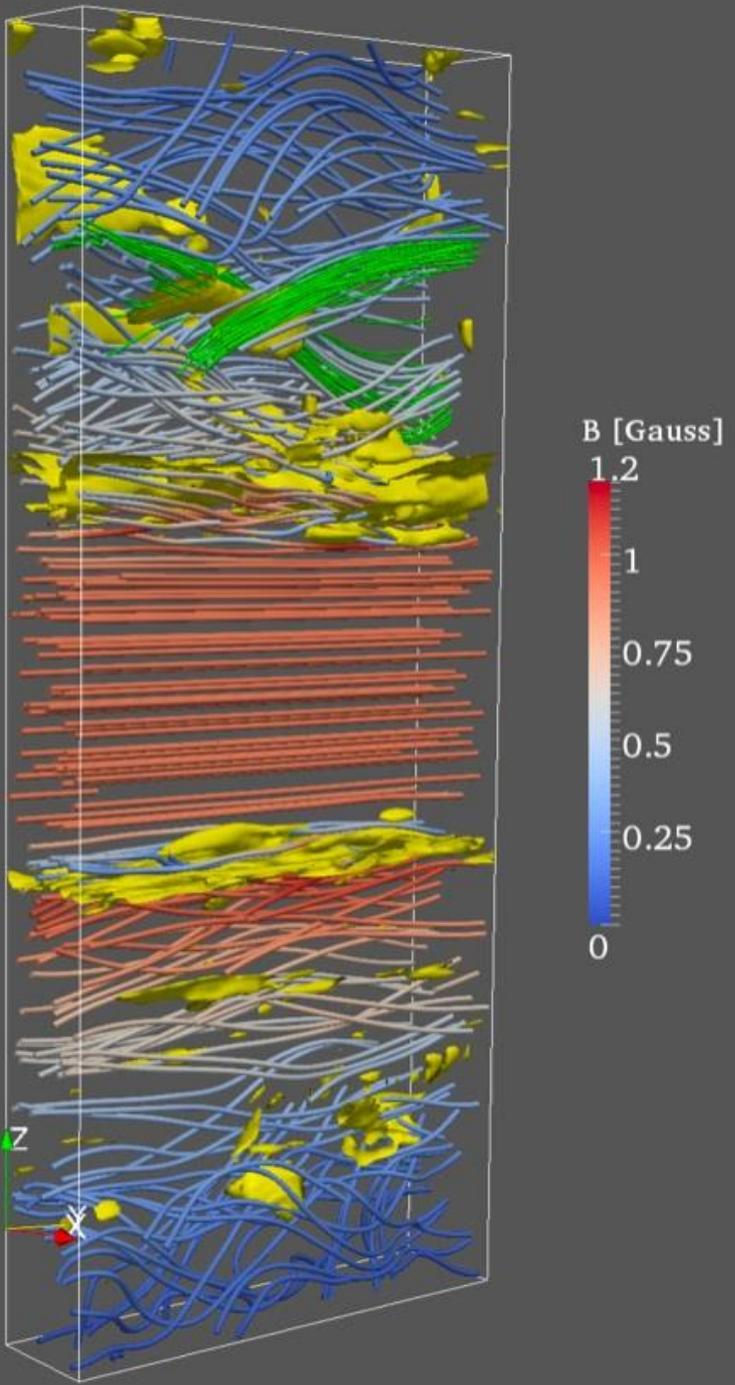


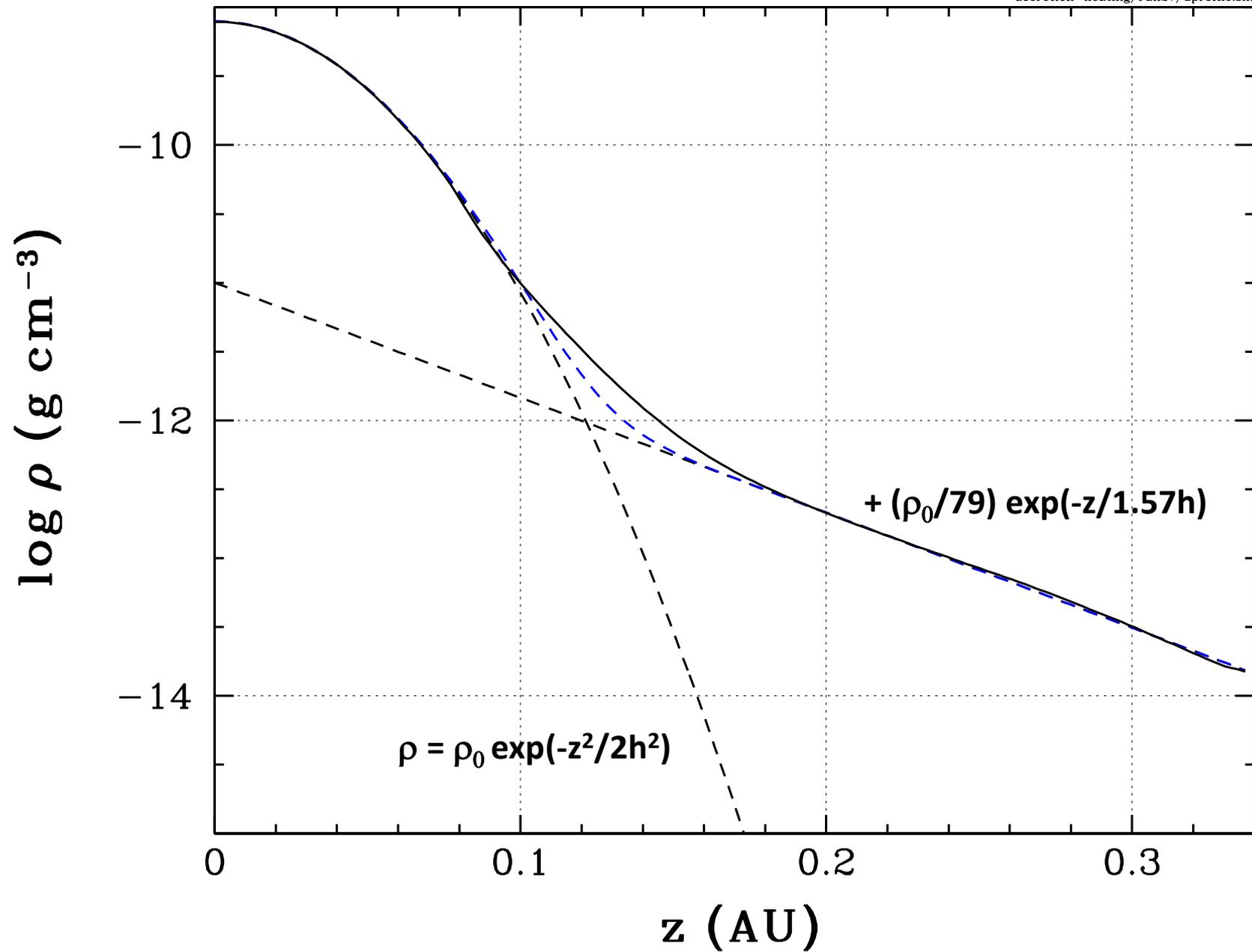
Outline

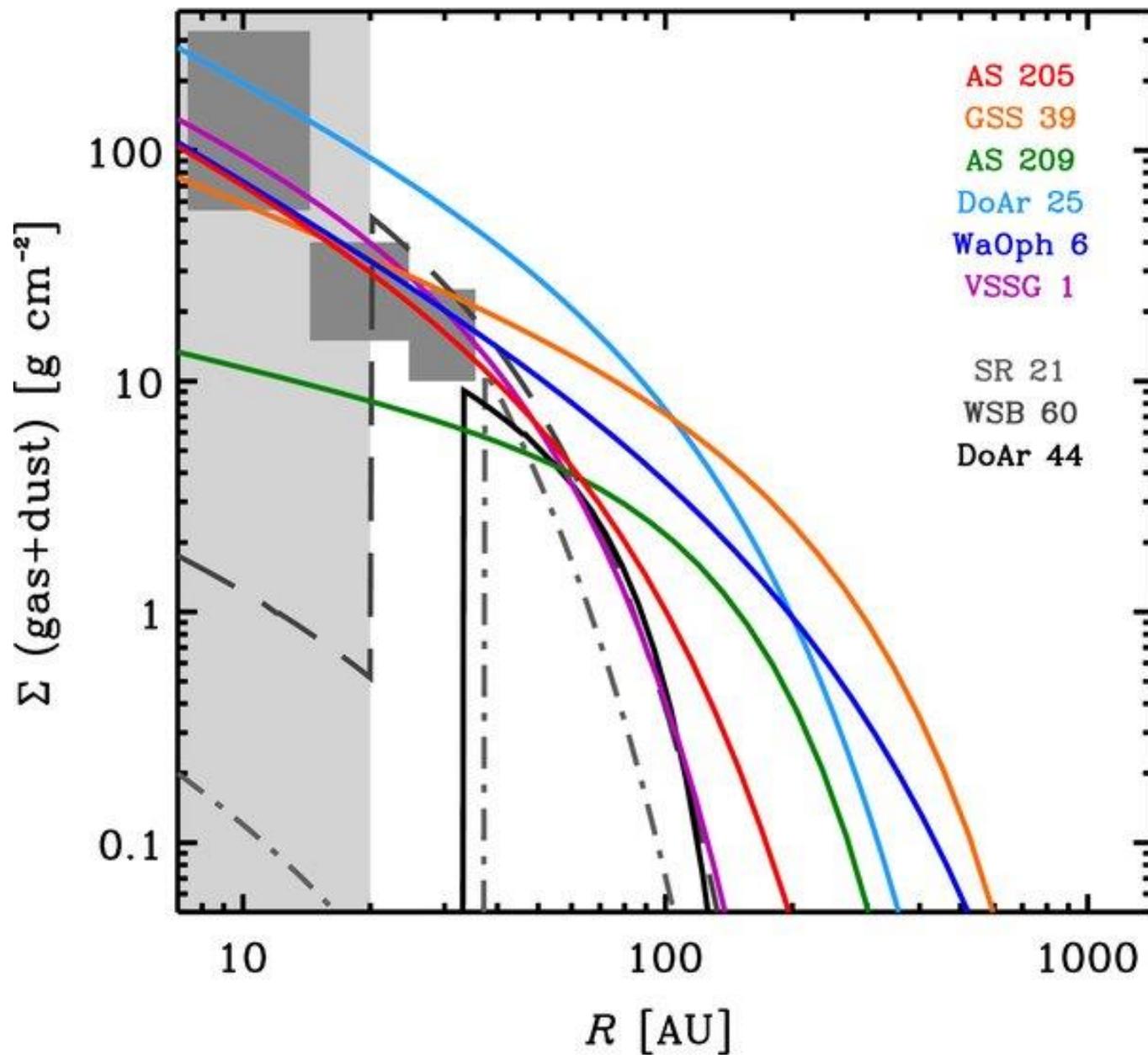
1. Magnetic fields support an extended disk atmosphere,
 1. Which absorbs enough starlight to cause the IR excess.
 1. Fluctuating fields yield big-enough brightness changes.
 1. The atmosphere can intermittently obscure the star.

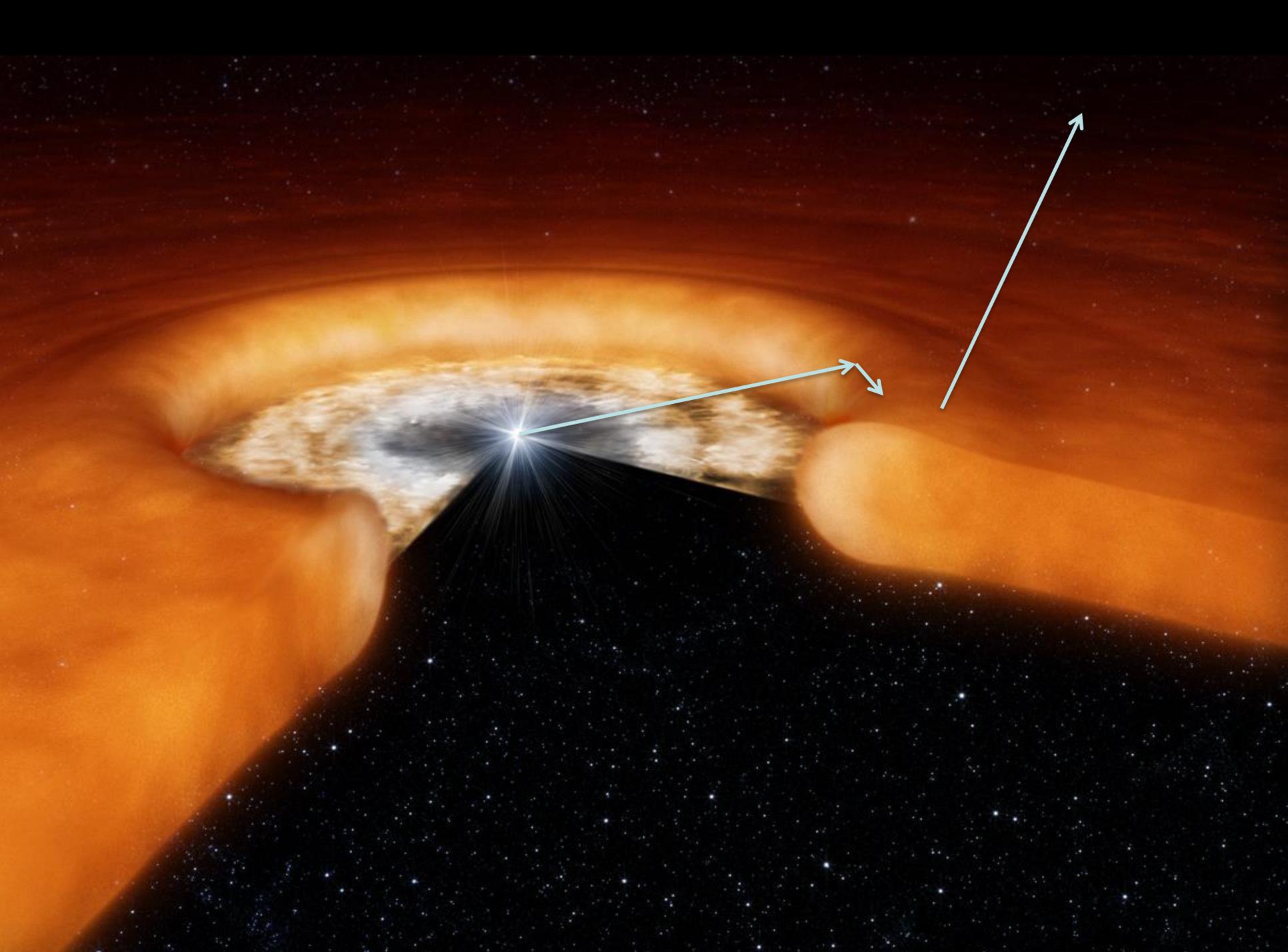
Outline

1. **Magnetic fields support an extended disk atmosphere,**
 1. **Which absorbs enough starlight to cause the IR excess.**
 1. **Fluctuating fields yield big-enough brightness changes.**
 1. **The atmosphere can intermittently obscure the star.**



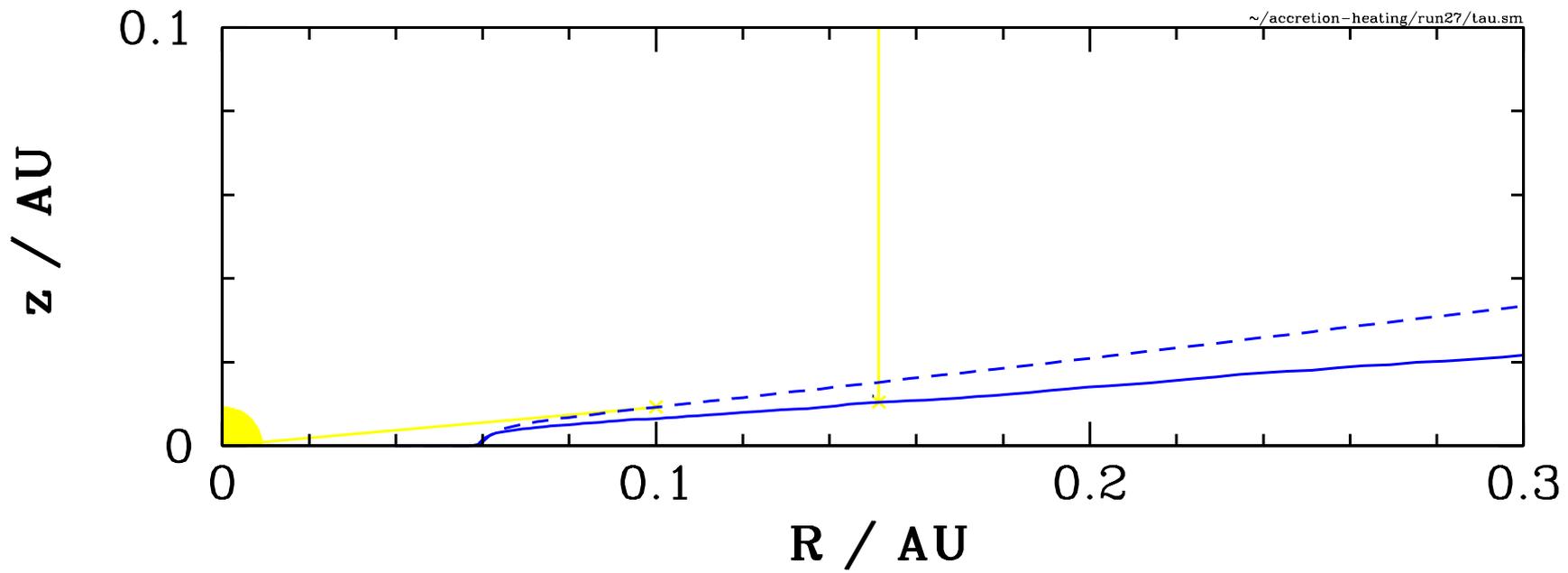


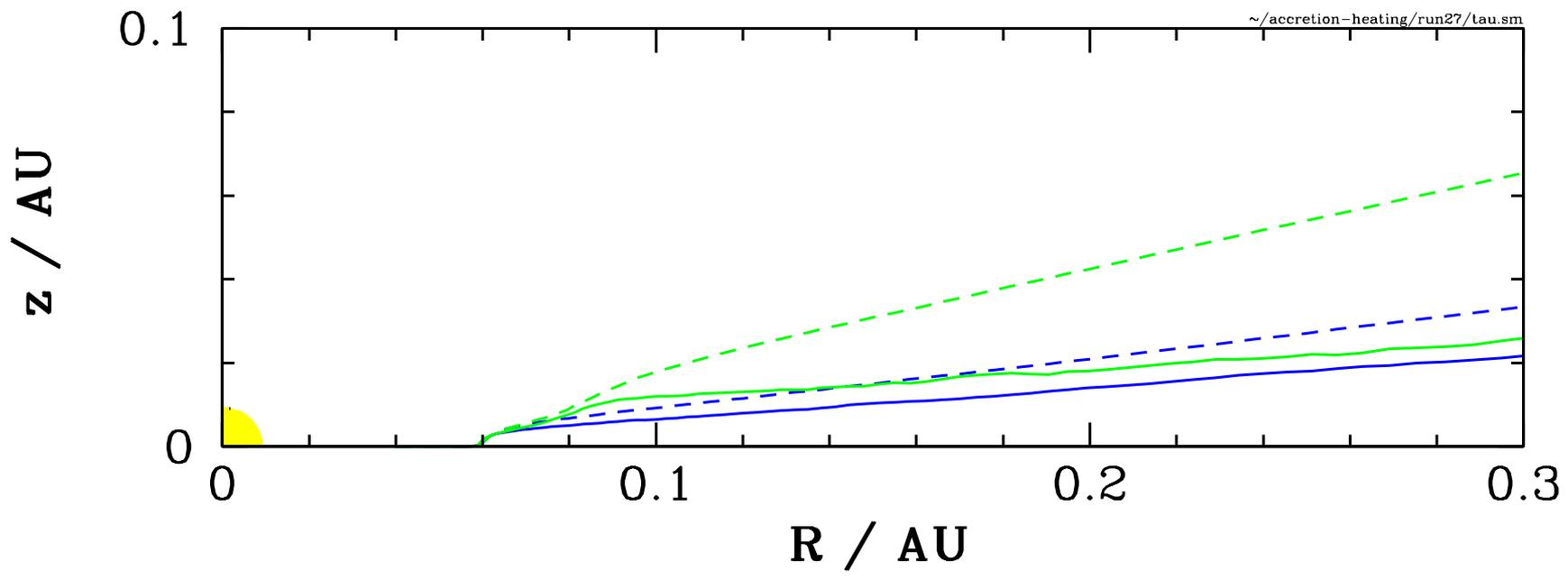


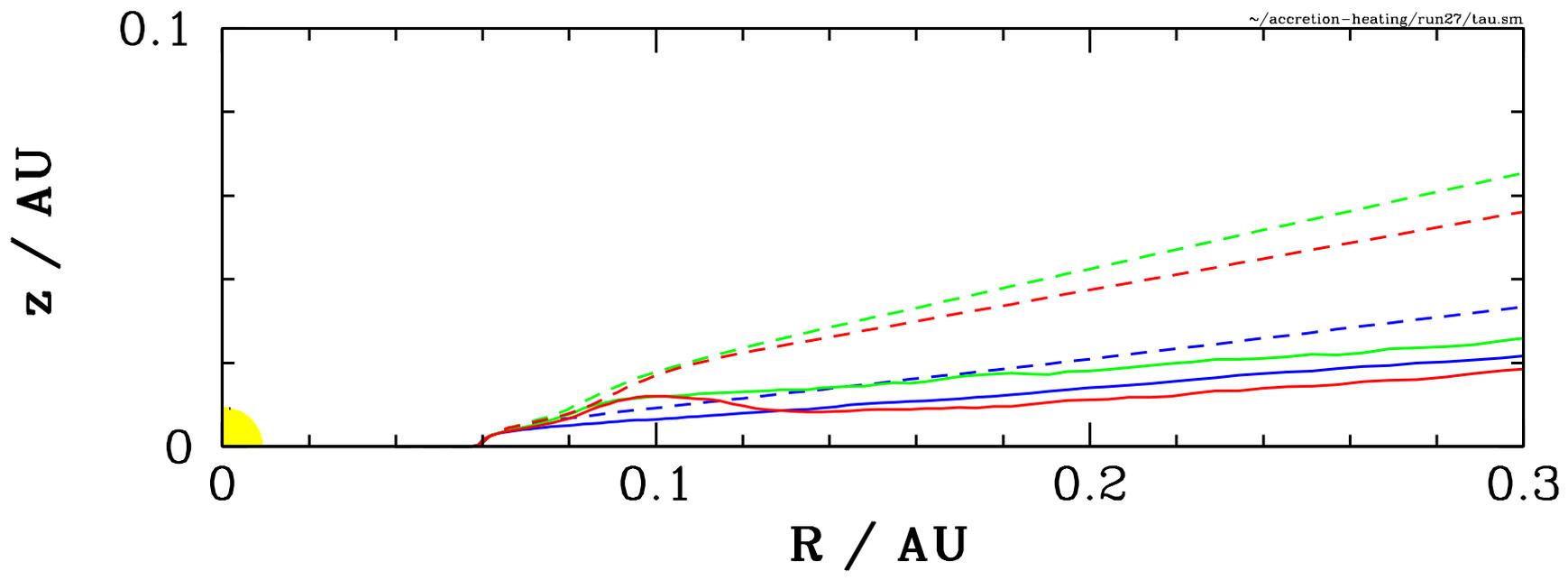


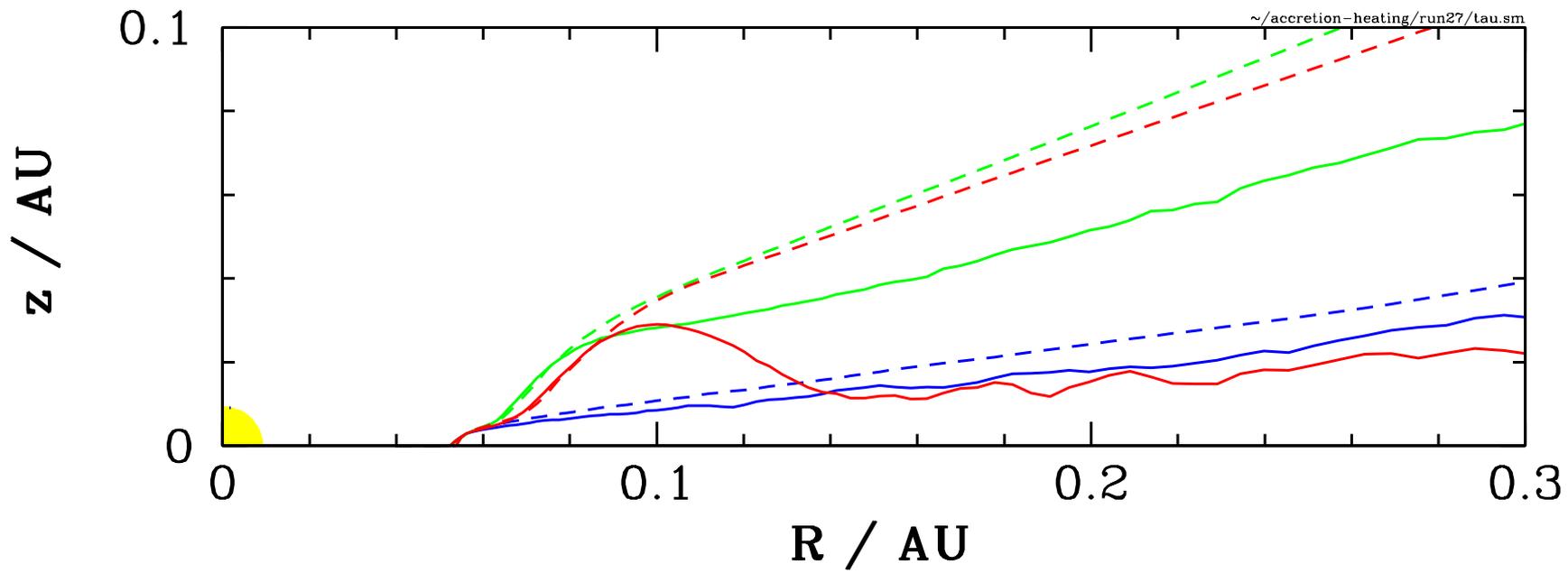
Outline

1. Magnetic fields support an extended disk atmosphere,
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 1. Fluctuating fields yield big-enough brightness changes.
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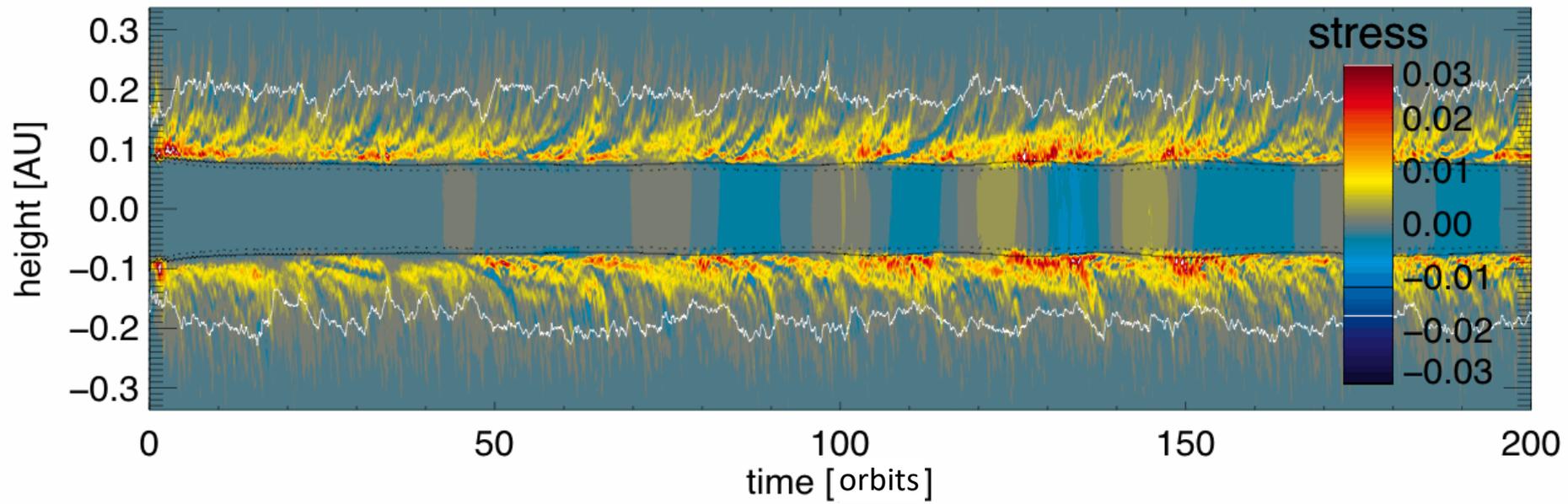






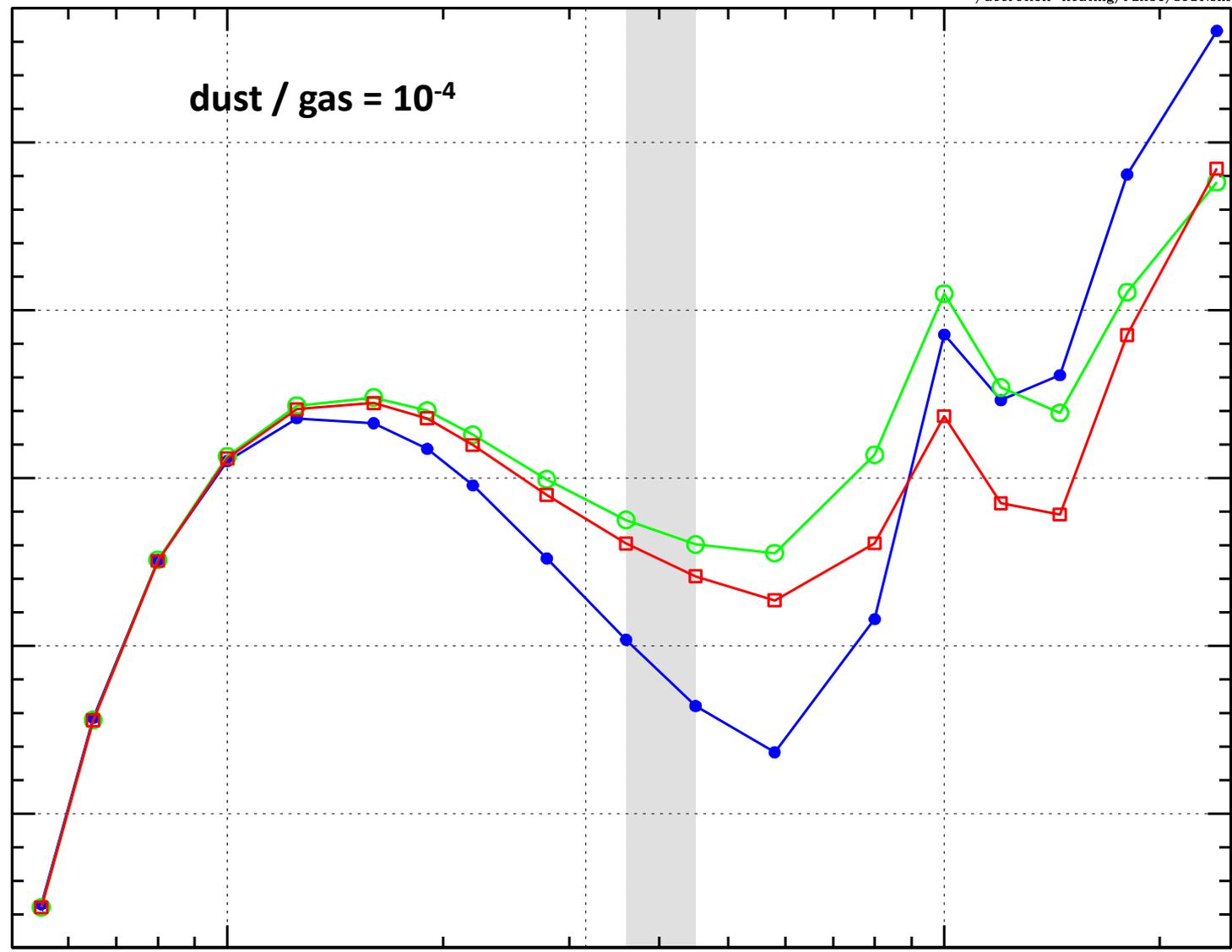
Outline

1. Magnetic fields support an extended disk atmosphere,
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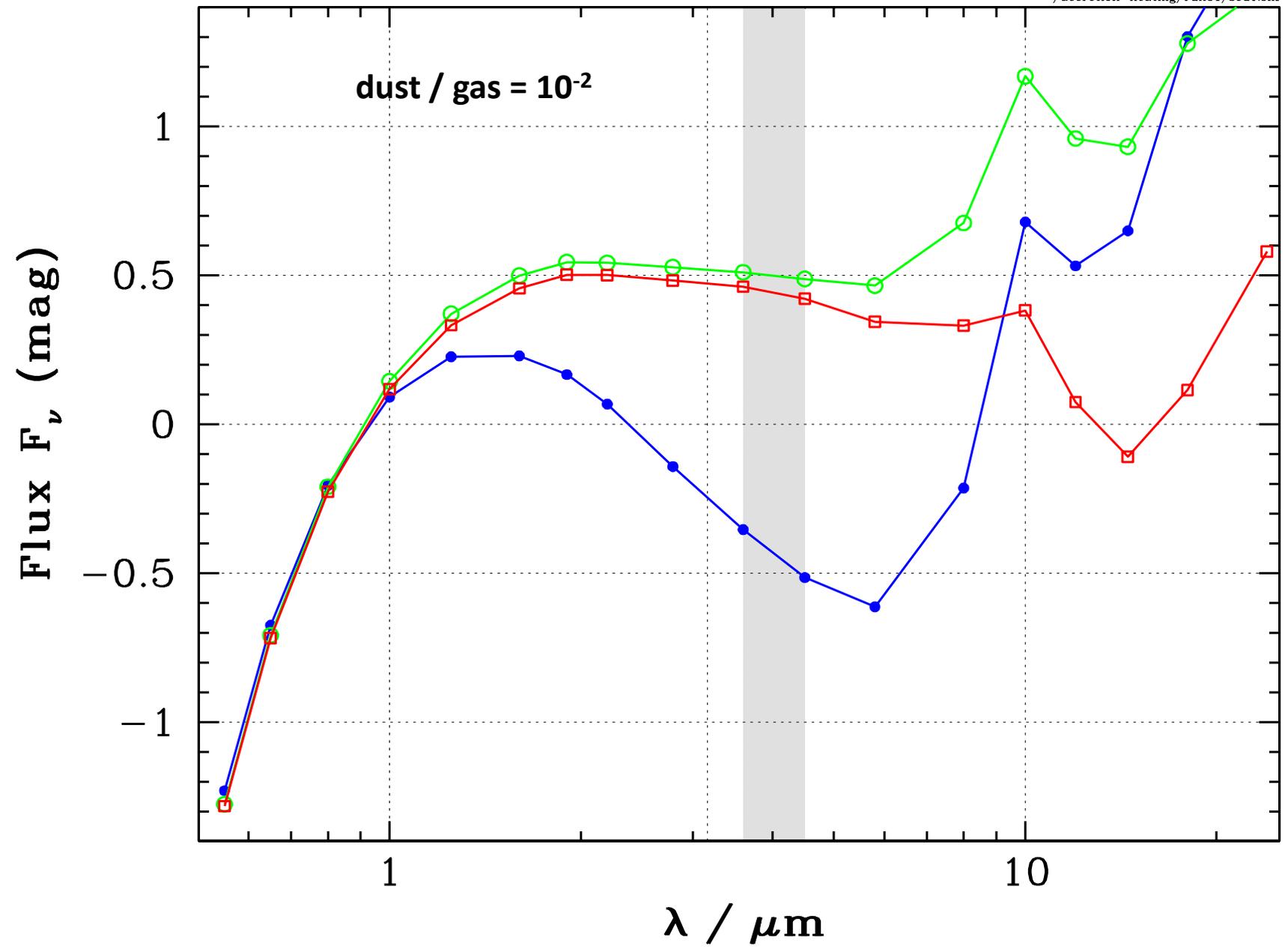


dust / gas = 10^{-4}

Flux F_ν (mag)



$\lambda / \mu\text{m}$



Outline

1. Magnetic fields support an extended disk atmosphere,
 1. Which absorbs enough starlight to cause the IR excess.
 1. Fluctuating fields yield big-enough brightness changes.
 1. The atmosphere can intermittently obscure the star.

Outer disk
dusty

Outer disk
dust-depleted

70°
800 AU

V
J
3.6



Outer disk
dusty

Outer disk
dust-depleted



70°
800 AU

V
J
3.6

Outer disk
dusty

Outer disk
dust-depleted

70°
80 AU

V
J
3.6

Outer disk
dusty

Outer disk
dust-depleted



70°
80 AU

V
J
3.6

Outer disk
dusty

Outer disk
dust-depleted

70°
8 AU

V
J
3.6



Outer disk
dusty

Outer disk
dust-depleted



70°
8 AU

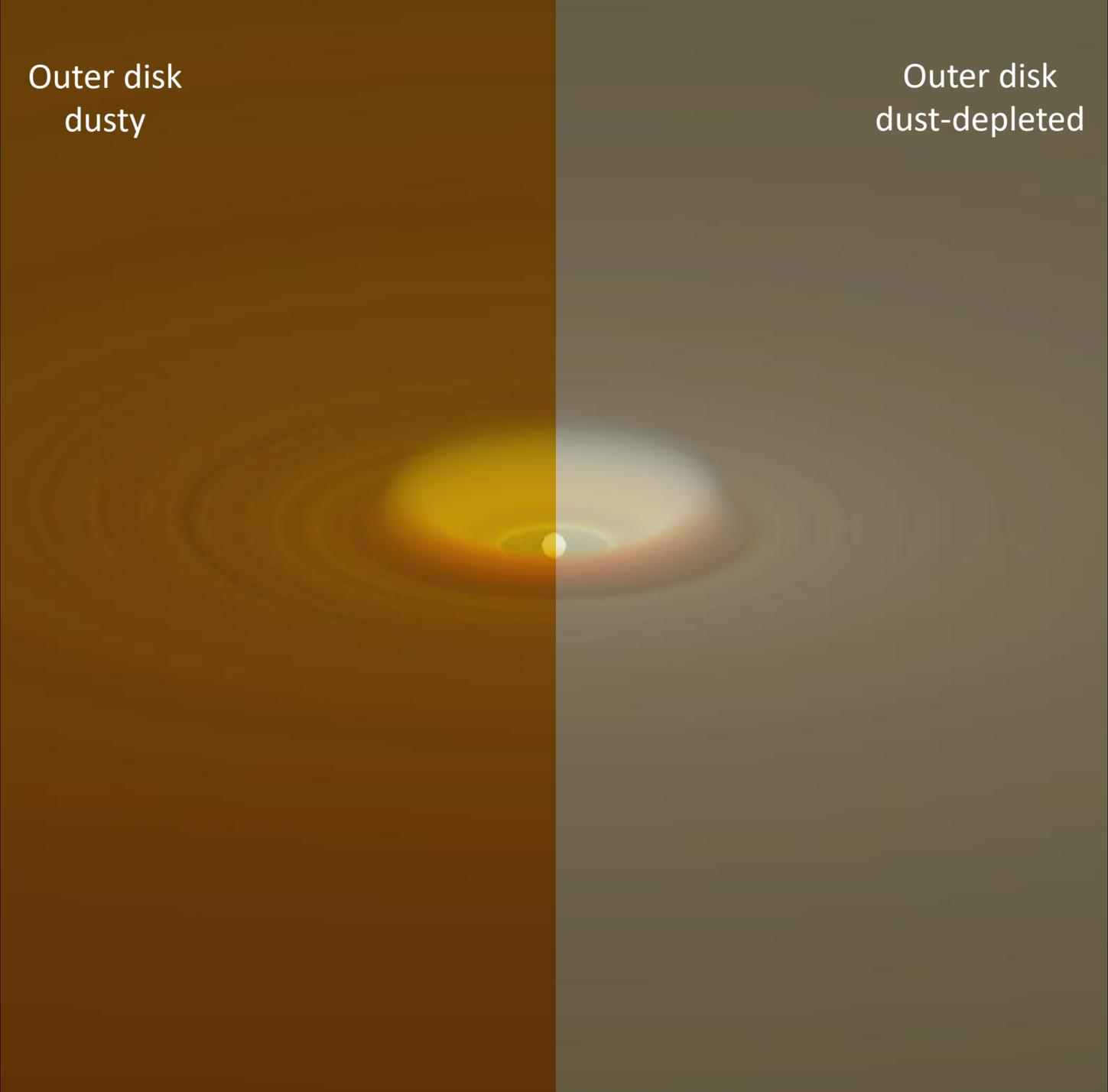
V
J
3.6

Outer disk
dusty

Outer disk
dust-depleted

70°
0.8 AU

V
J
3.6



Outer disk
dusty

Outer disk
dust-depleted



70°
0.8 AU

V
J
3.6

Outer disk
dusty

Outer disk
dust-depleted

70°
0.08 AU

V
J
3.6



Outer disk dust-depleted

Tall atmosphere
A=2

Nominal atmosphere
A=1.5



70°
0.08 AU

V
J
3.6

**Outer disk dust-
depleted**

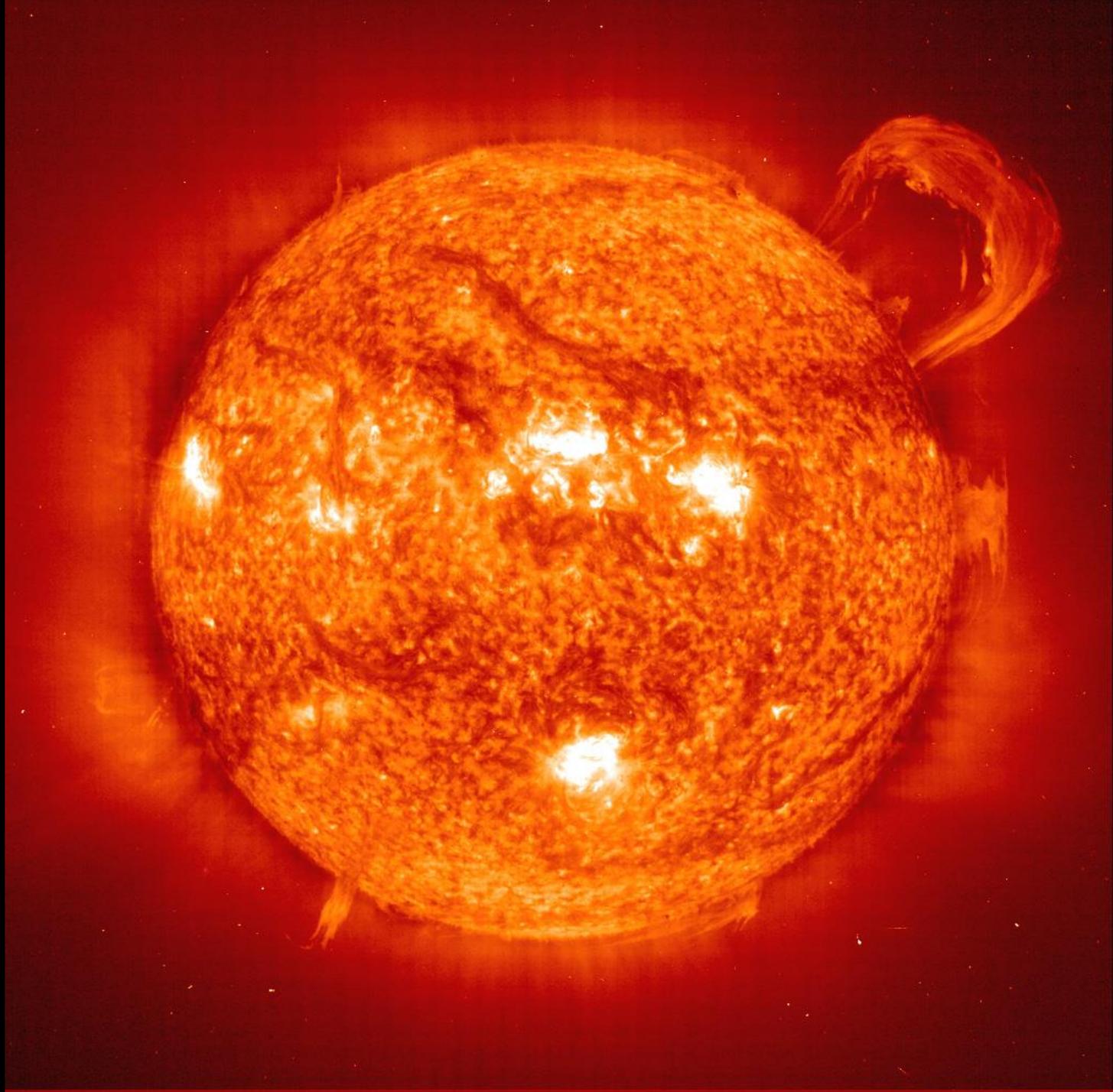
Tall atmosphere
A=2

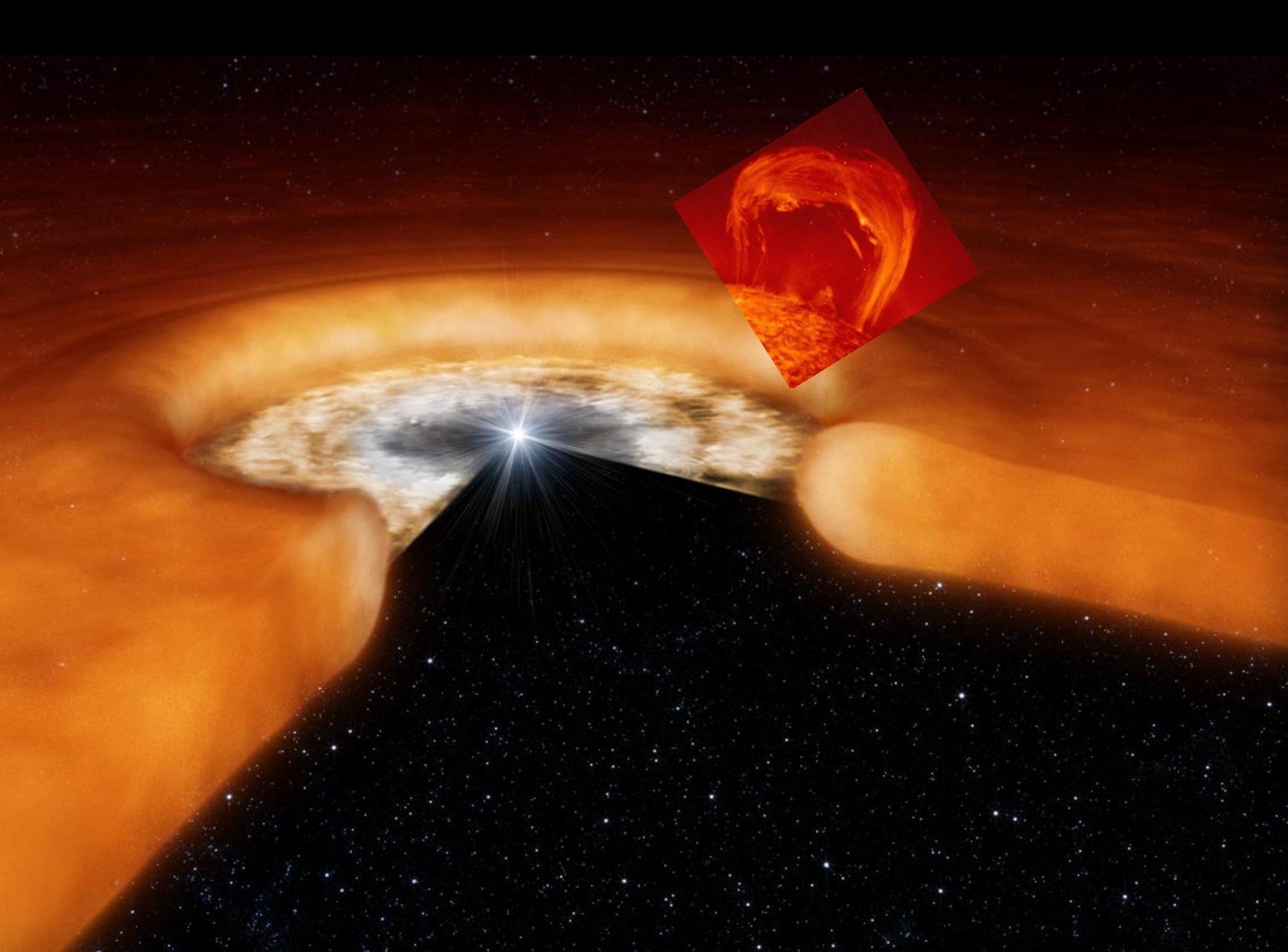


75°
0.08 AU

V
J
3.6

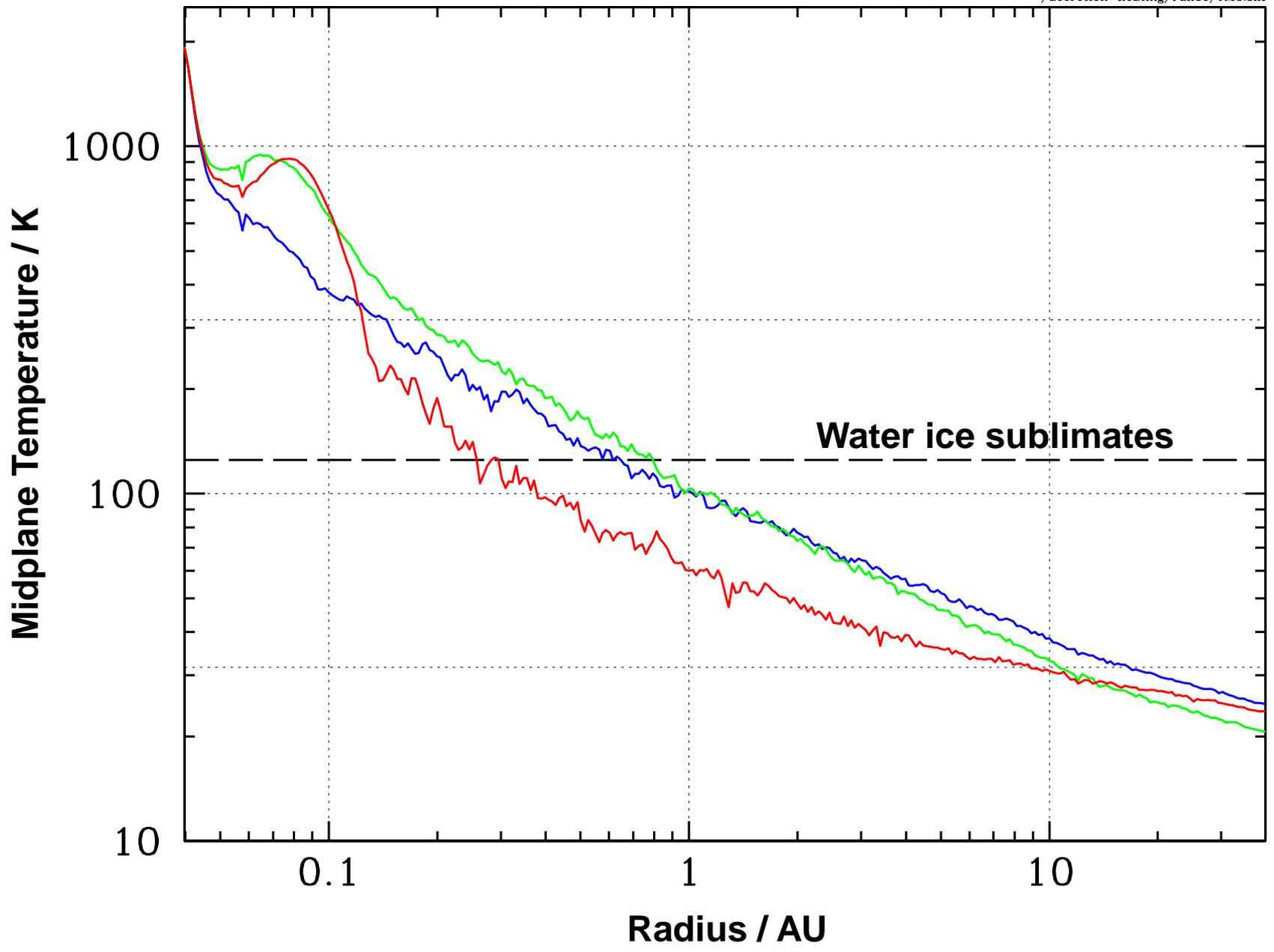
Summary





1. Magnetic fields support an extended disk atmosphere.
2. The atmosphere absorbs enough starlight to cause the IR excess.
3. Fluctuating fields yield brightness changes with amplitudes like those observed.
4. The atmosphere can intermittently obscure the star in systems seen near edge-on, if dust has settled in the disks' outer reaches.

What does it all mean?



1. Most young stars with disks vary in the infrared, some because of starspots and accretion variability.
1. Cases with the optical steady while the IR varies are hard to understand unless the disk's surface moves.
1. Such movements naturally arise in a magnetized disk atmosphere.
1. The atmosphere casts time-varying shadows.
2. The shadows move the snow line in and out.

