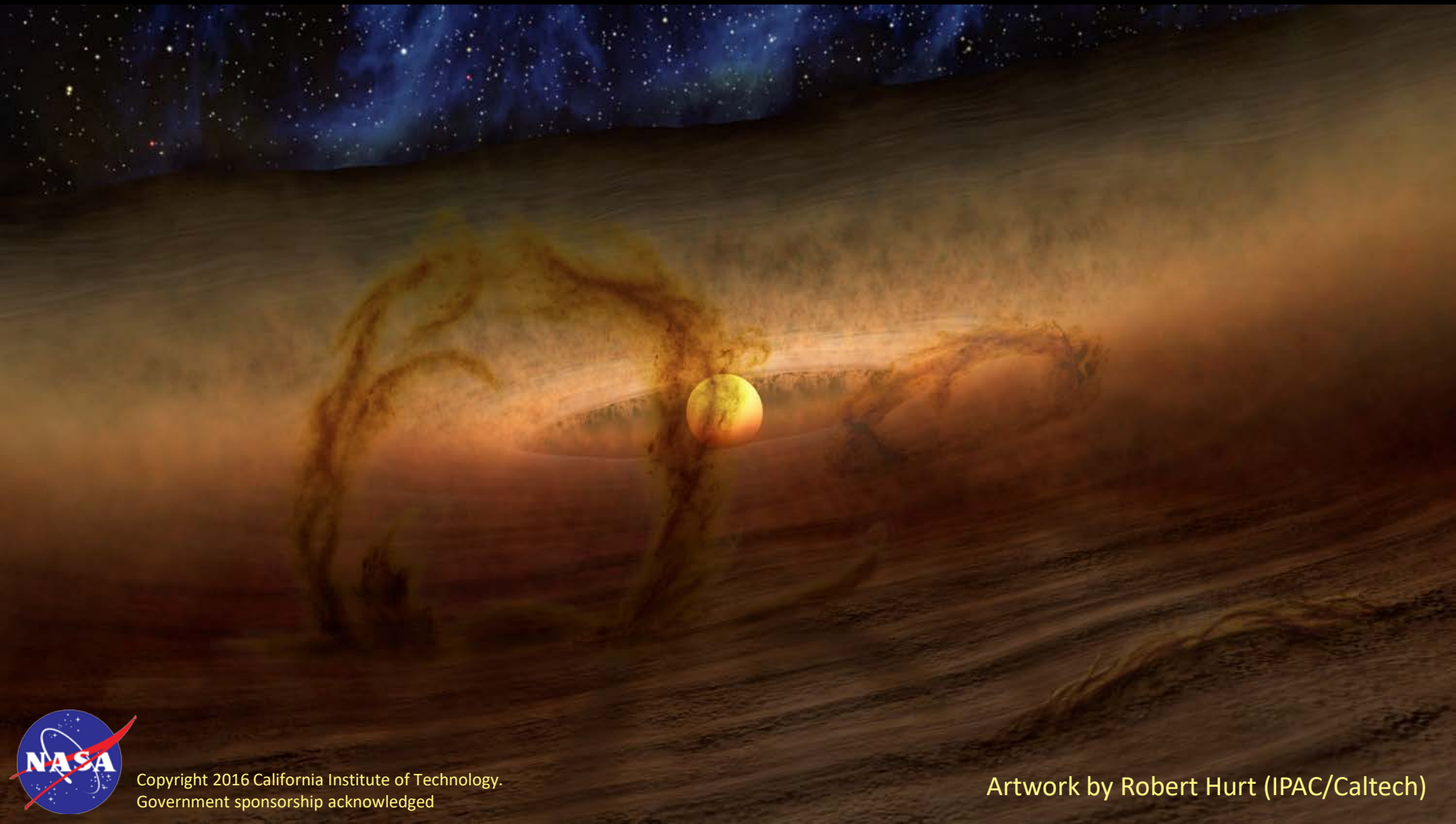
Protostellar Disks' Restless Atmospheres

Neal Turner (JPL/Caltech) with C. Dullemond, S. Hirose, M. Benisty



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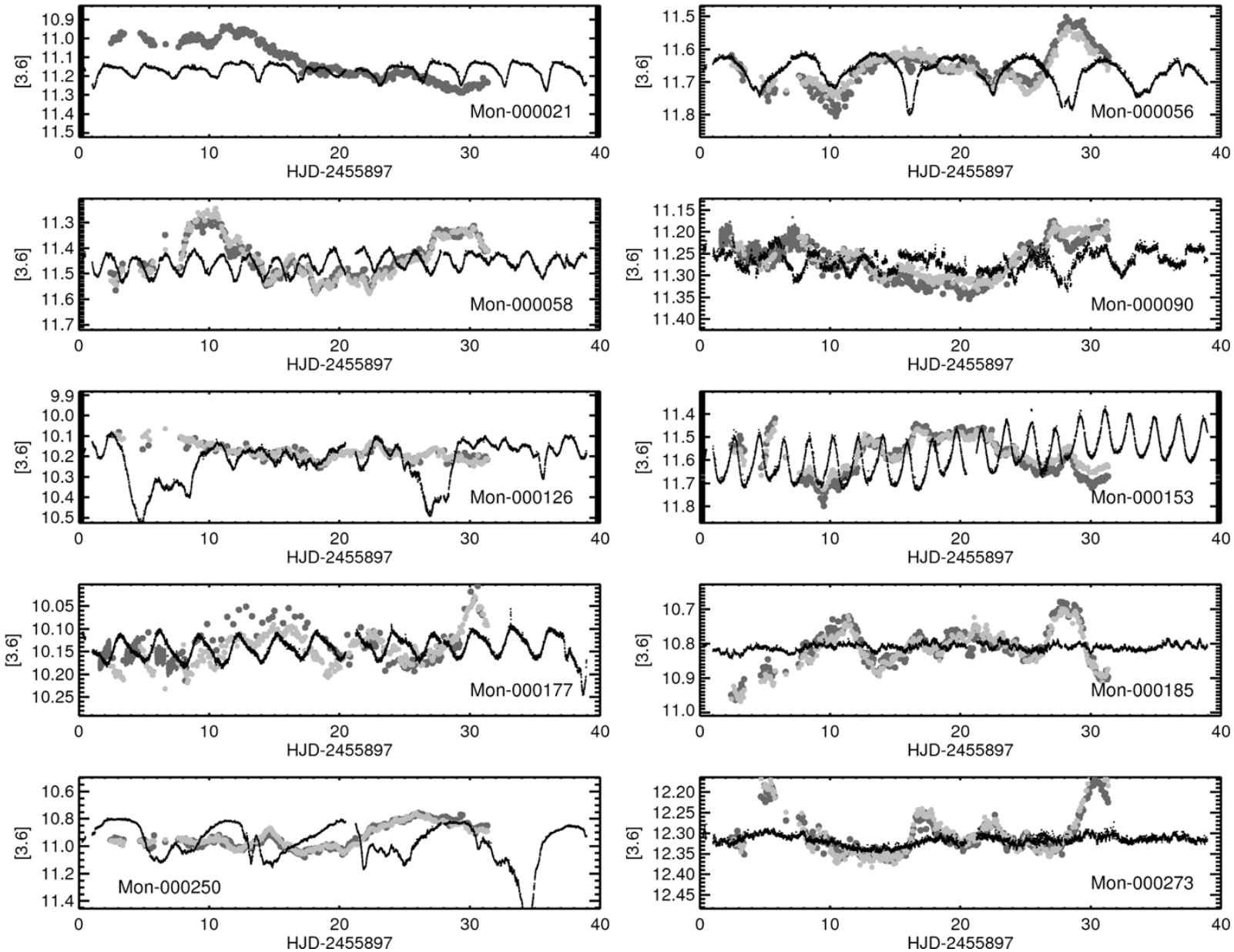
Artwork by Robert Hurt (IPAC/Caltech)

CoRoT
CNES & European Space Agency

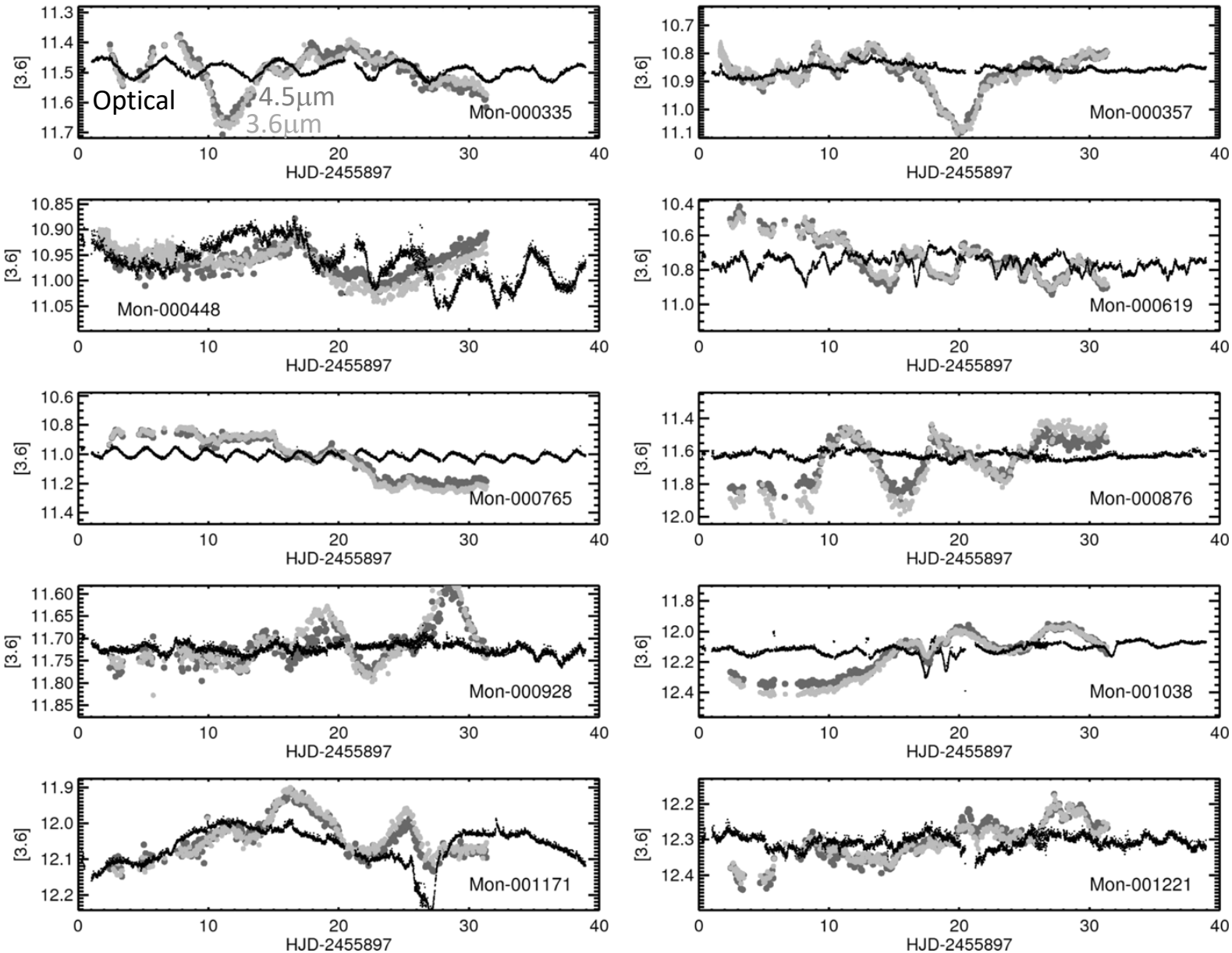
National Aeronautics and Space Administration

Uncorrelated Optical & IR Changes



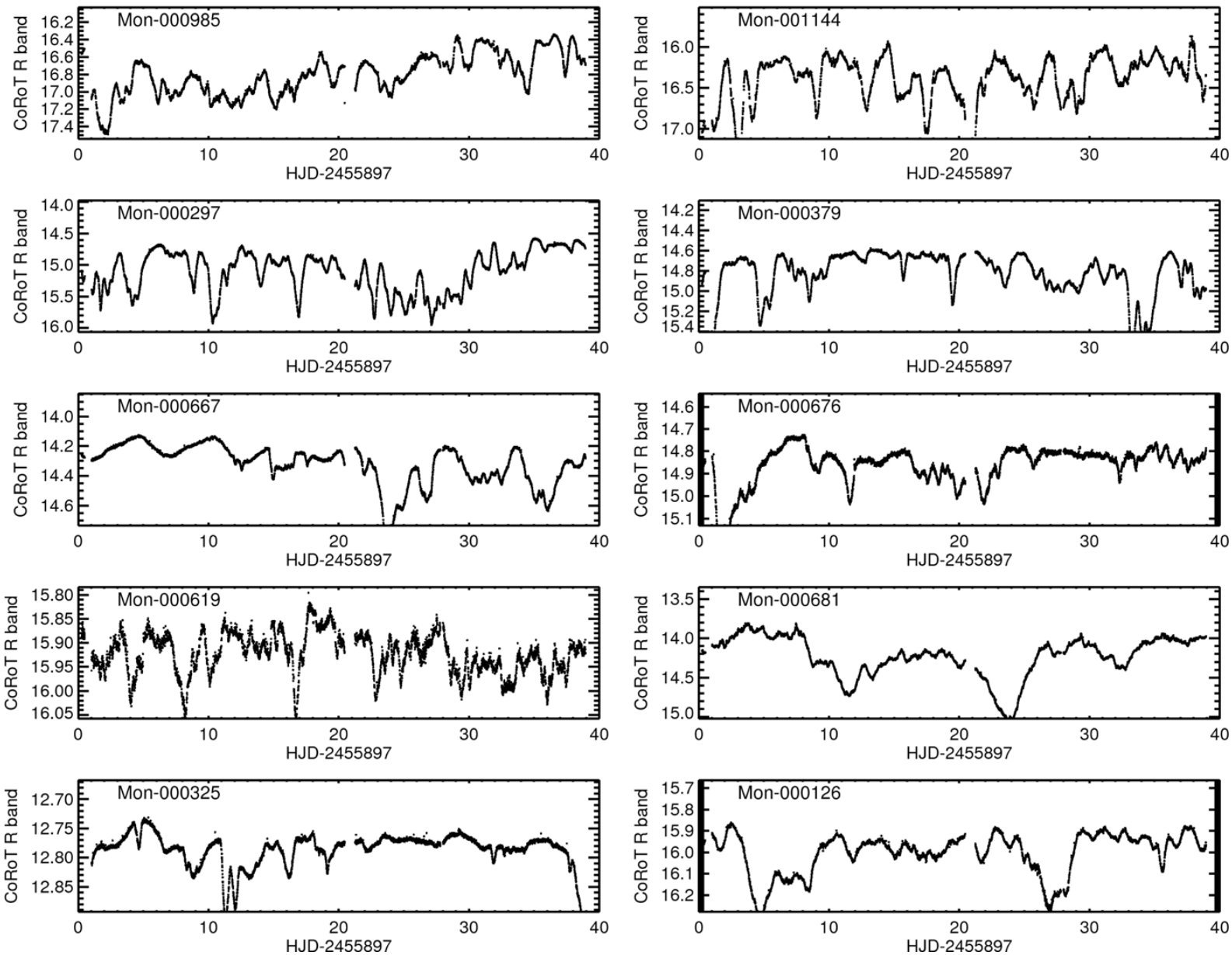
A. M. Cody et al. 2014

Uncorrelated Optical & IR Changes



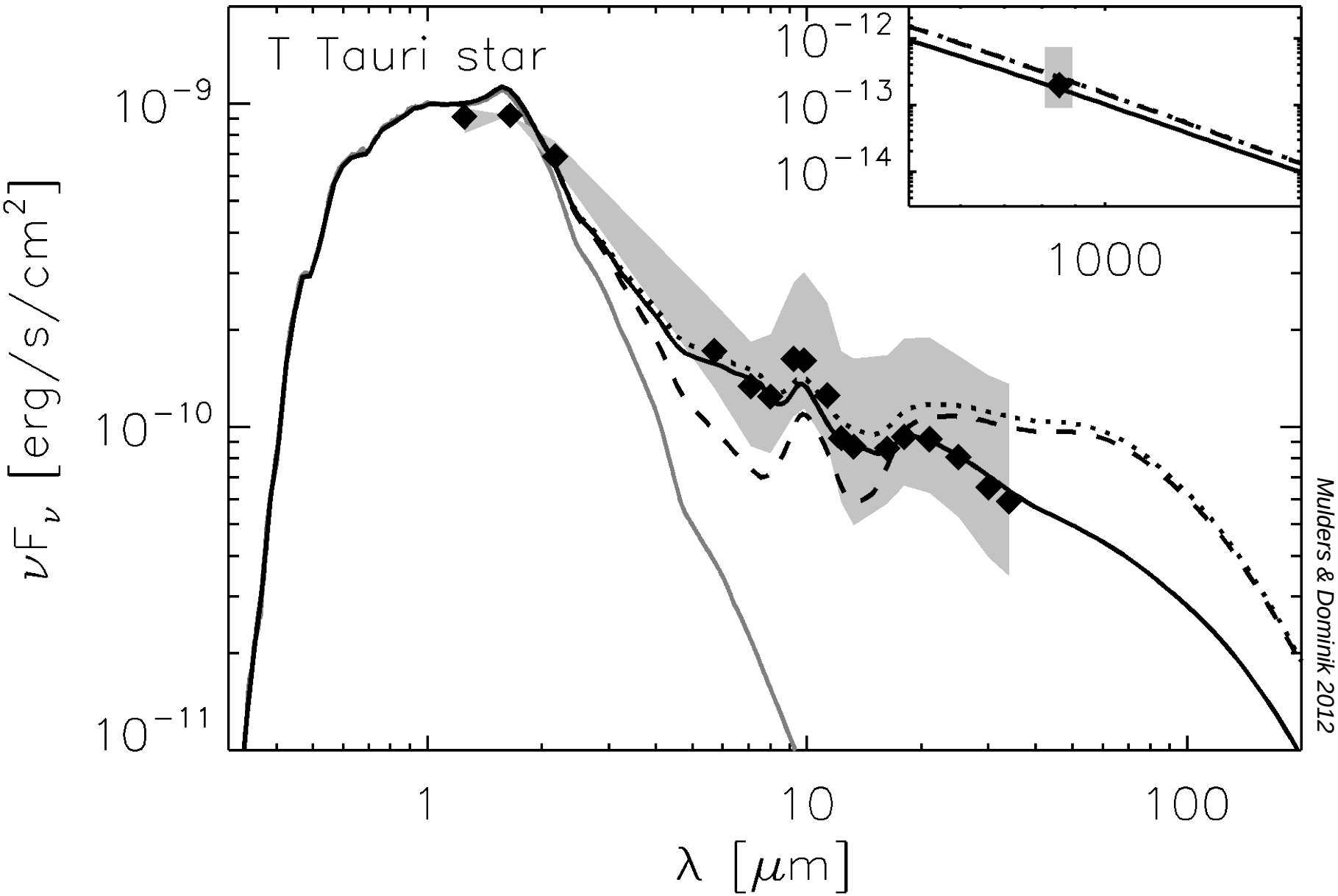
A. M. Cody et al. 2014

Erratic Dips Due to Variable Extinction



A. M. Cody et al. 2014

Median CTTS Has NIR Excess Too Large



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

McClure et al. 2013

Flux λF_λ / erg cm^{-2} s^{-1}

Star

Observed

Excess
Components

Wavelength / μm

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.

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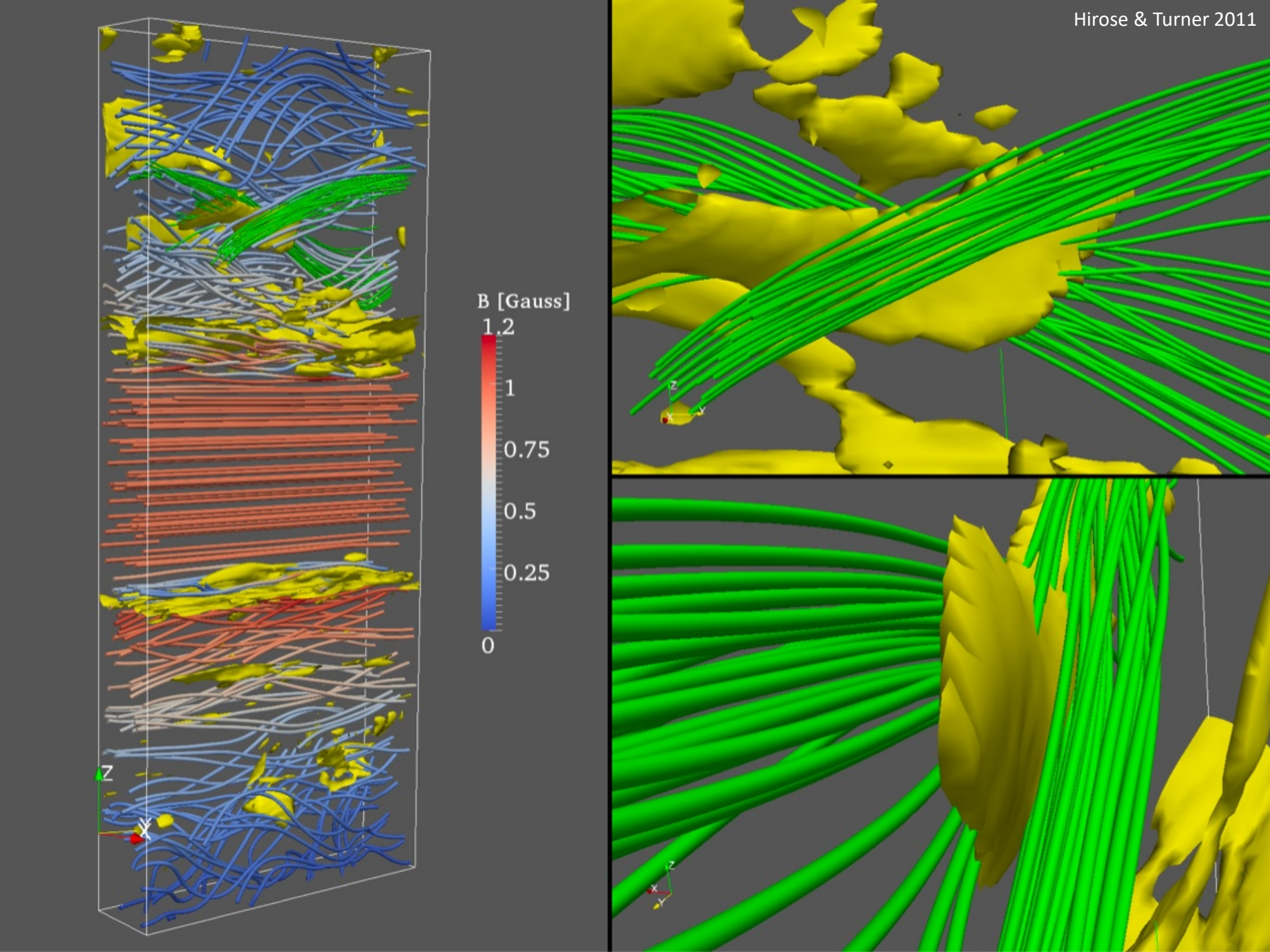
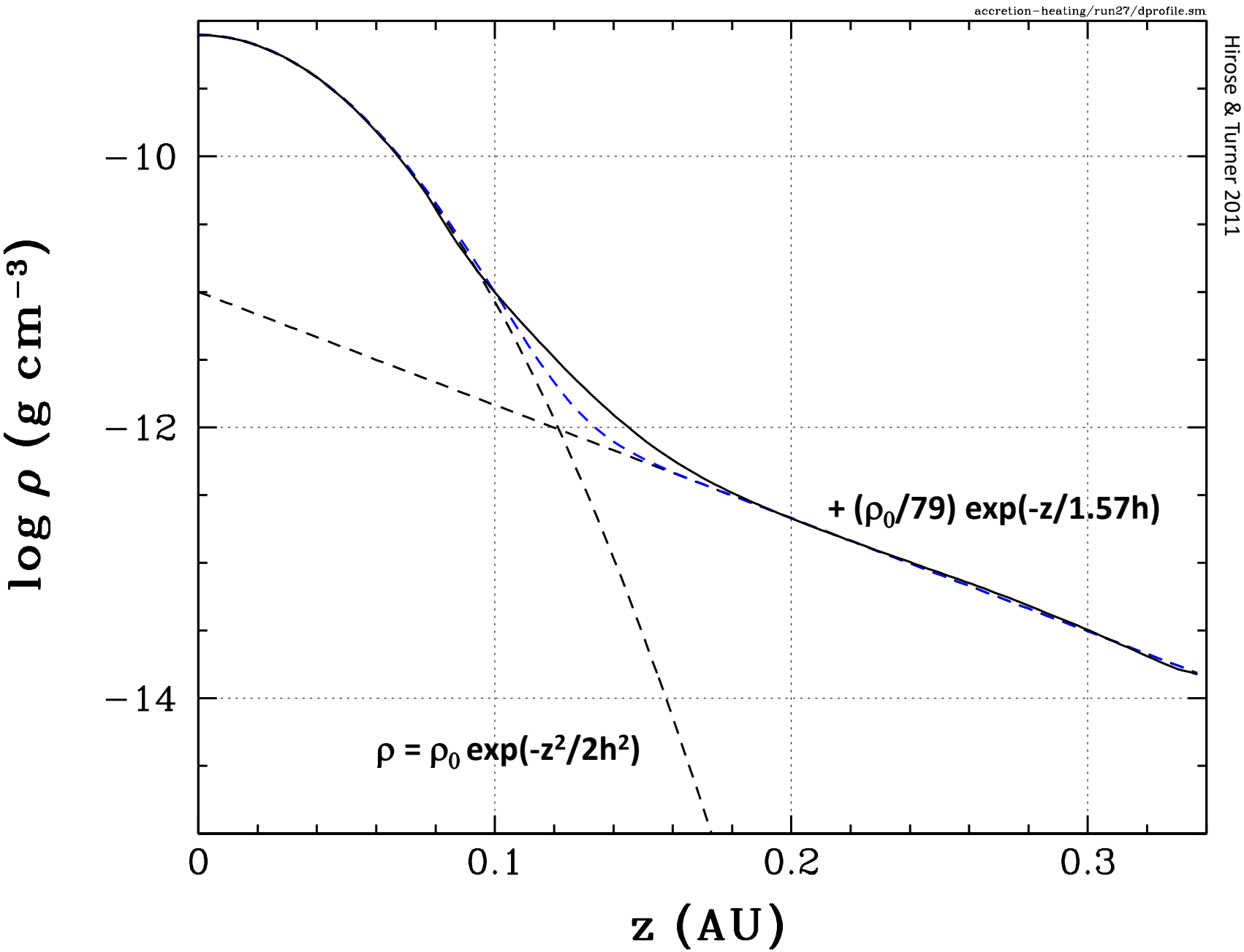
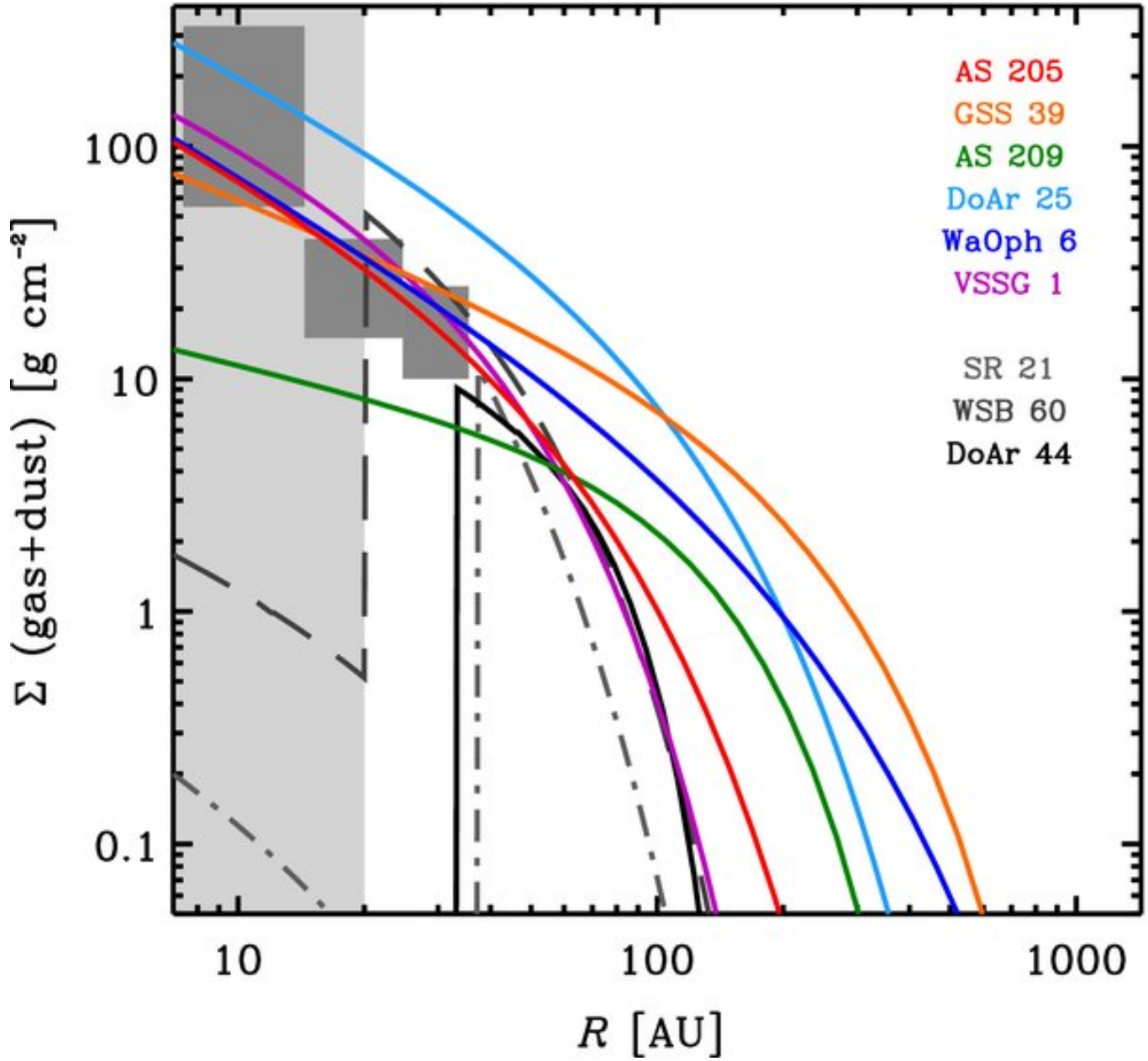
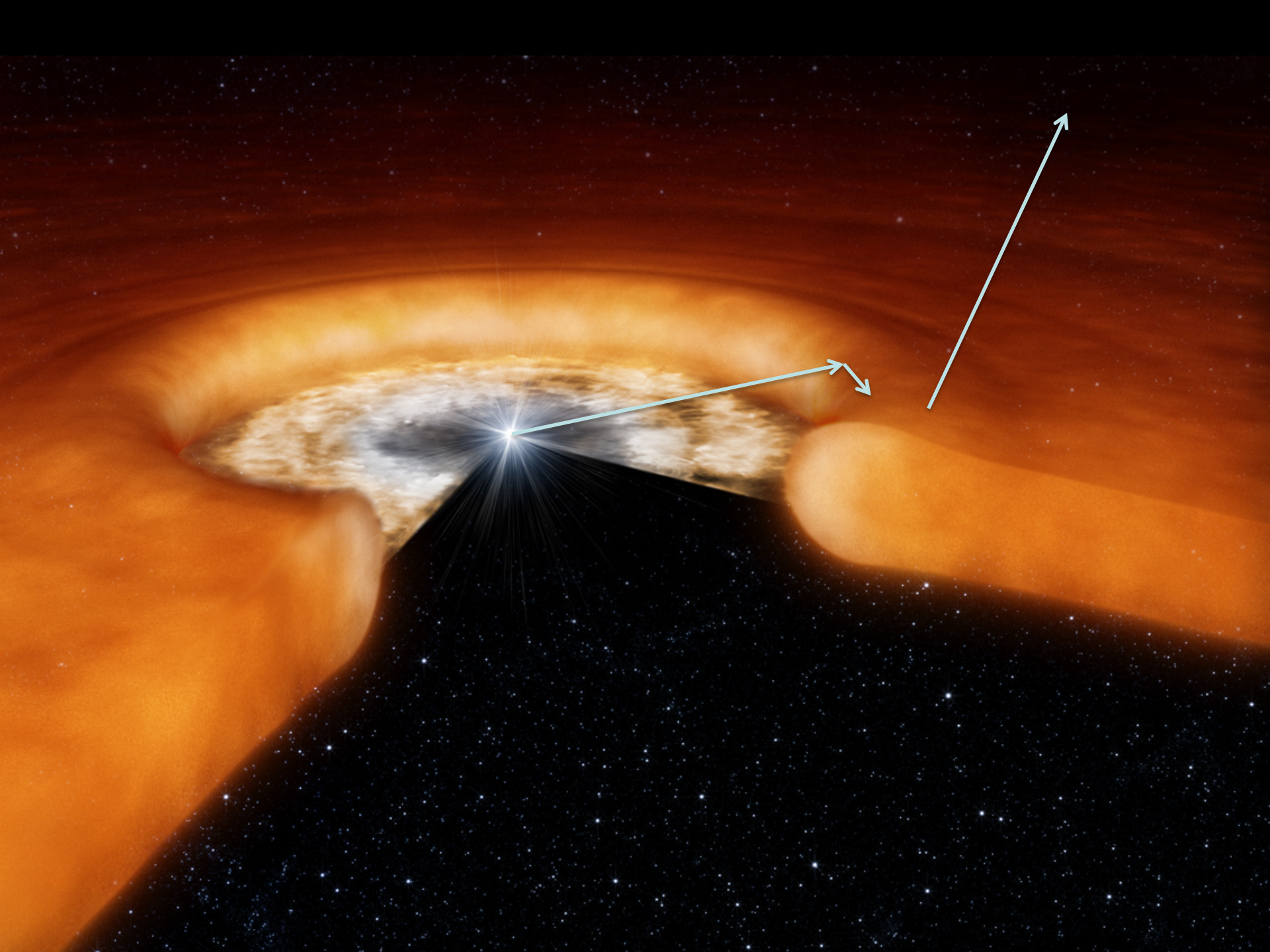
Hirose & Turner 2011




accretion−heating/run27/dprofile.sm
Hirose & Turner 2011
log ρ (g cm⁻³)
−10
−12
−14
0
0.1
0.2
0.3
z (AU)
+ (ρ0/79) exp(-z/1.57h)
ρ = ρ0 exp(-z²/2h²)

Andrews et al. 2009





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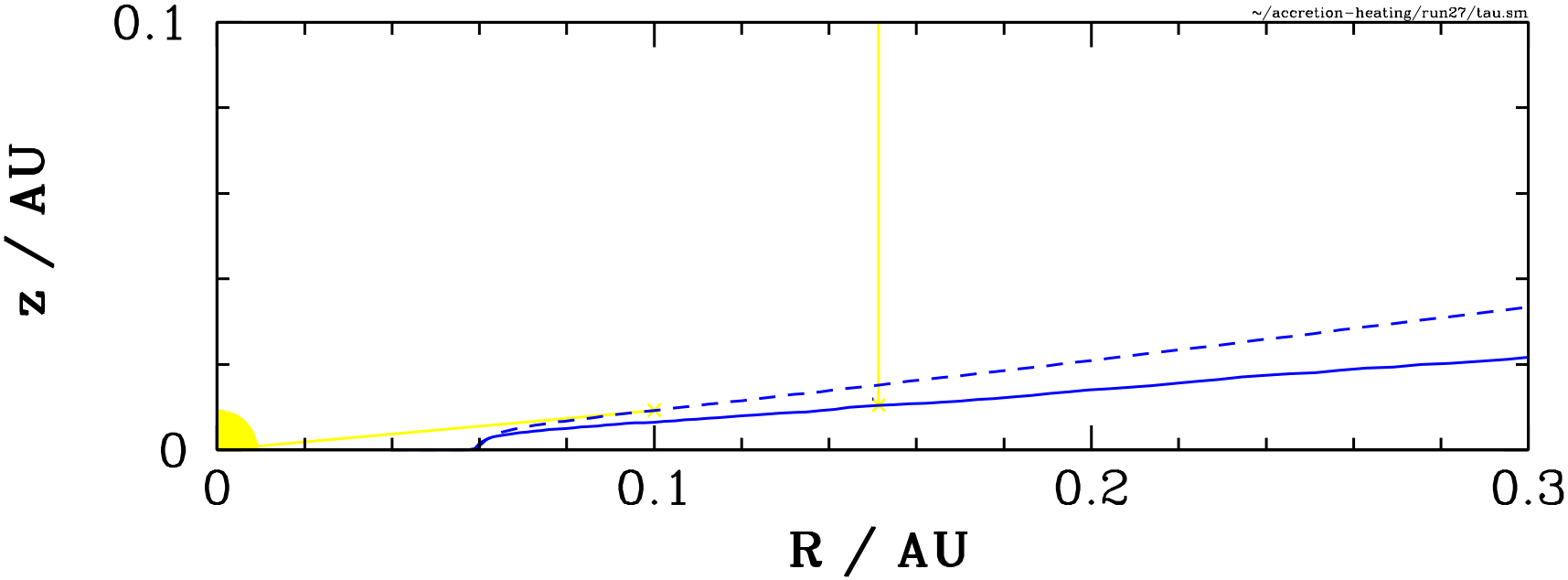
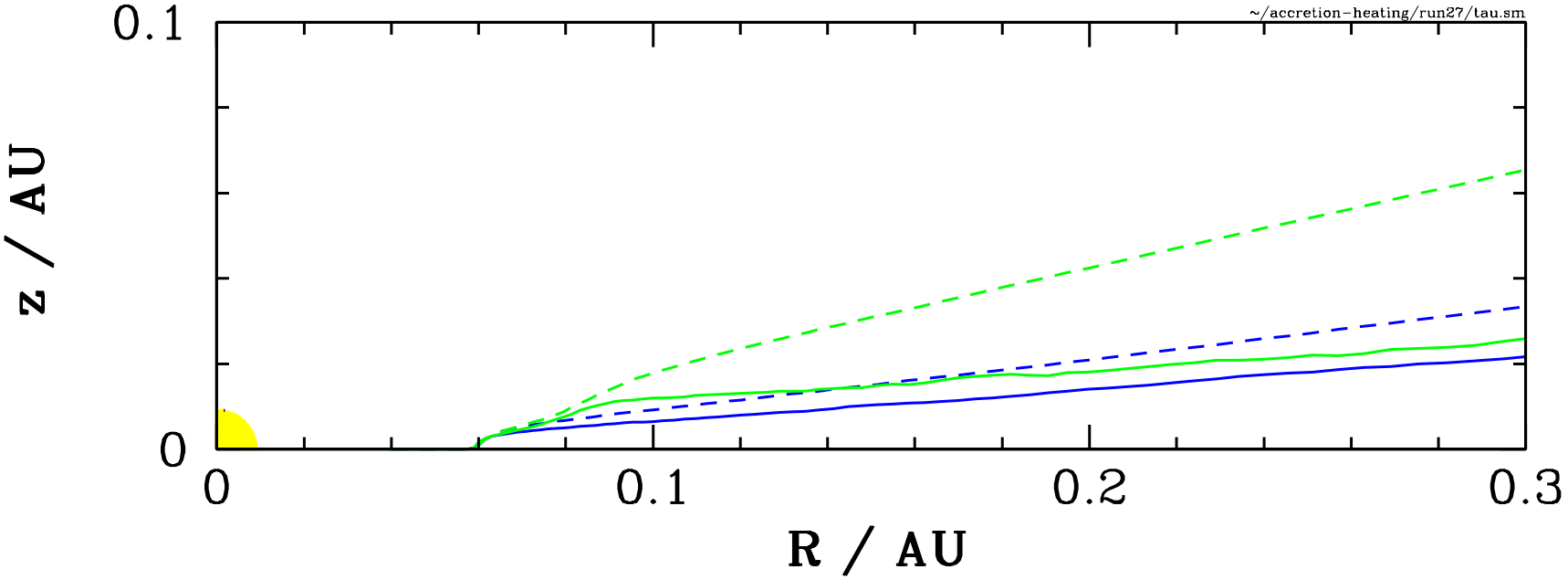
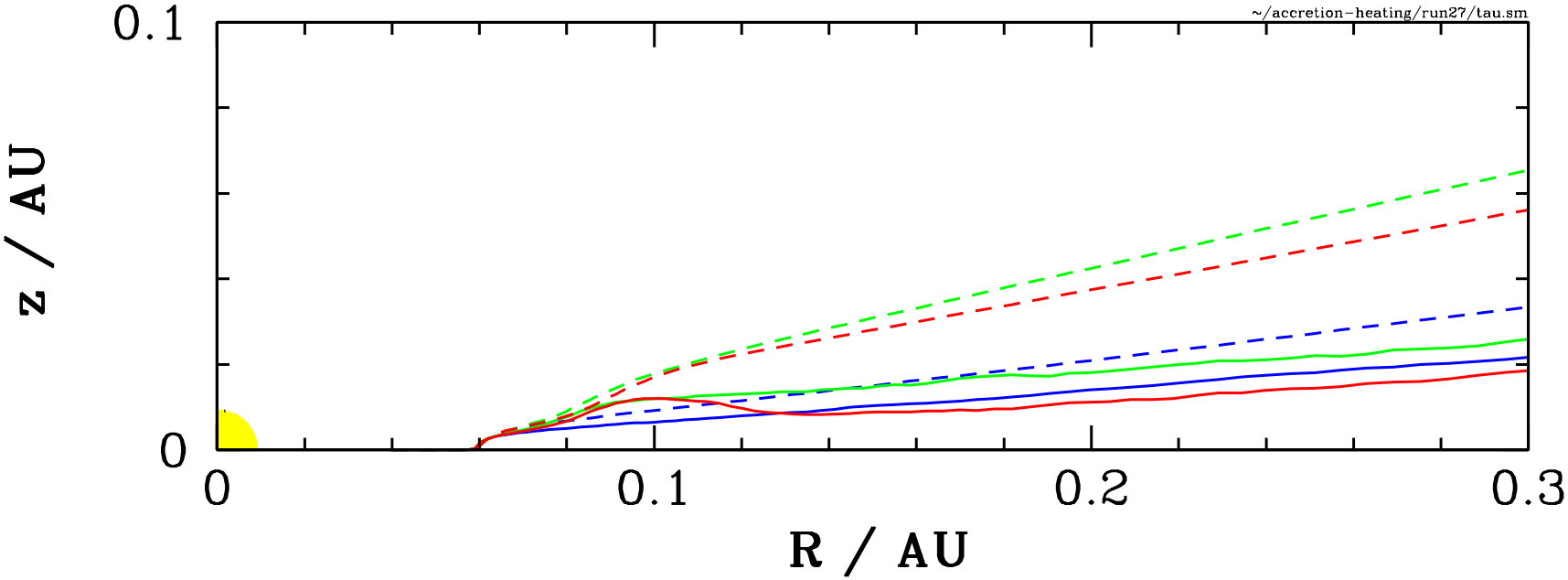
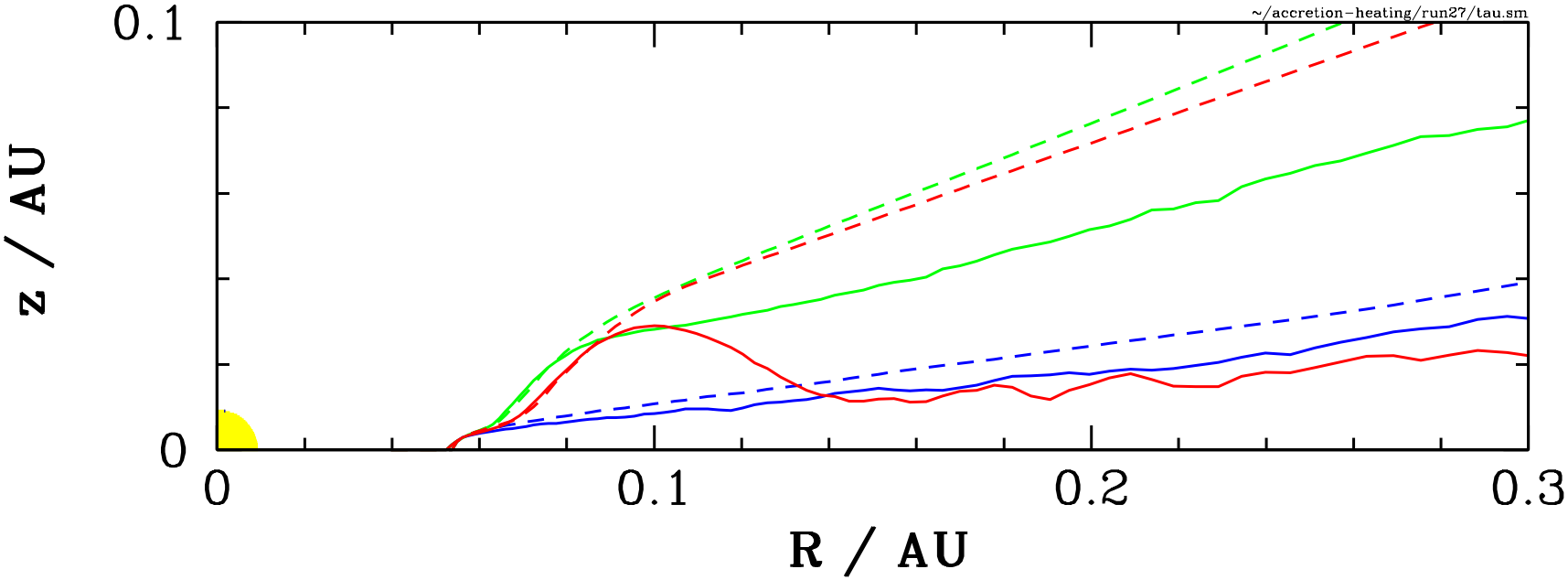

~/accretion-heating/run27/tau.sm
0.1
0
z / AU
0
0.1
0.2
0.3
R / AU


~/accretion-heating/run27/tau.sm
0.1
0
z / AU
0
0.1
0.2
0.3
R / AU


~/accretion-heating/run27/tau.sm
0.1
0
z / AU
0
0.1
0.2
0.3
R / AU


~/accretion-heating/run27/tau.sm
0.1
0
z / AU
0
0.1
0.2
0.3
R / AU

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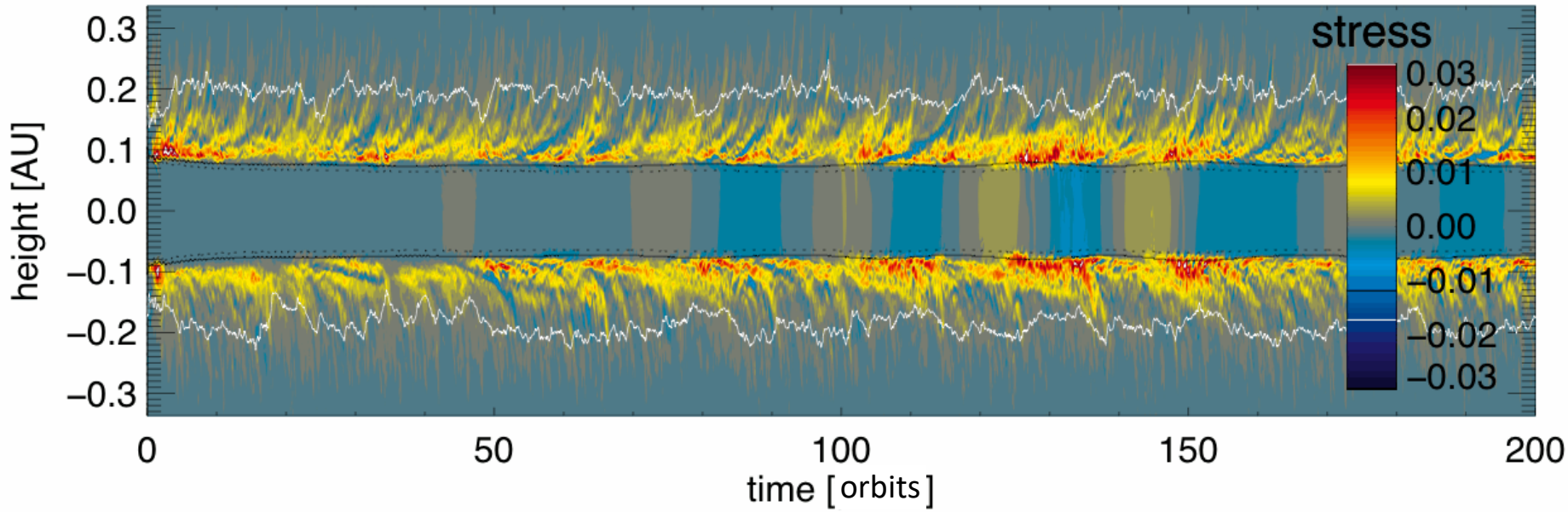
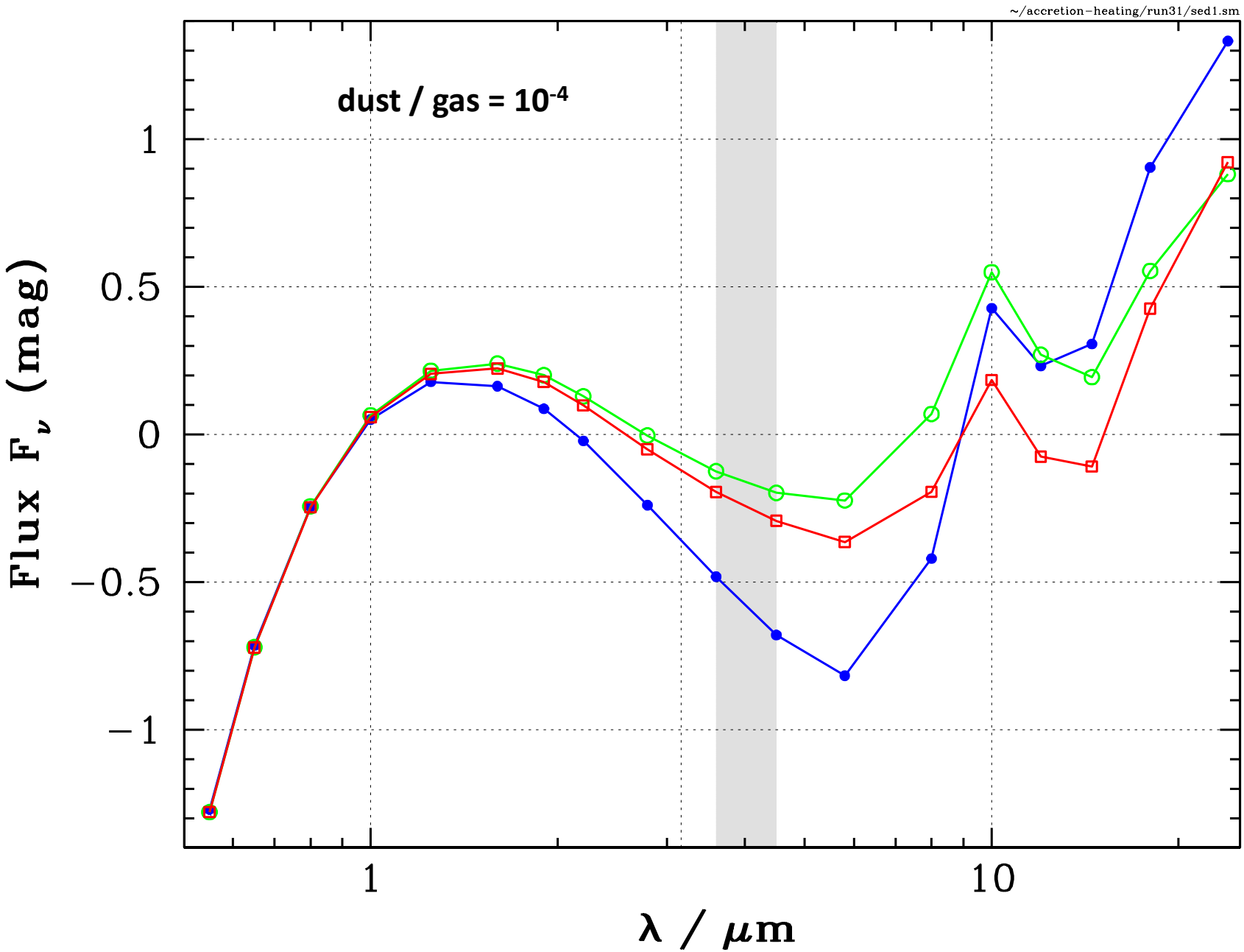
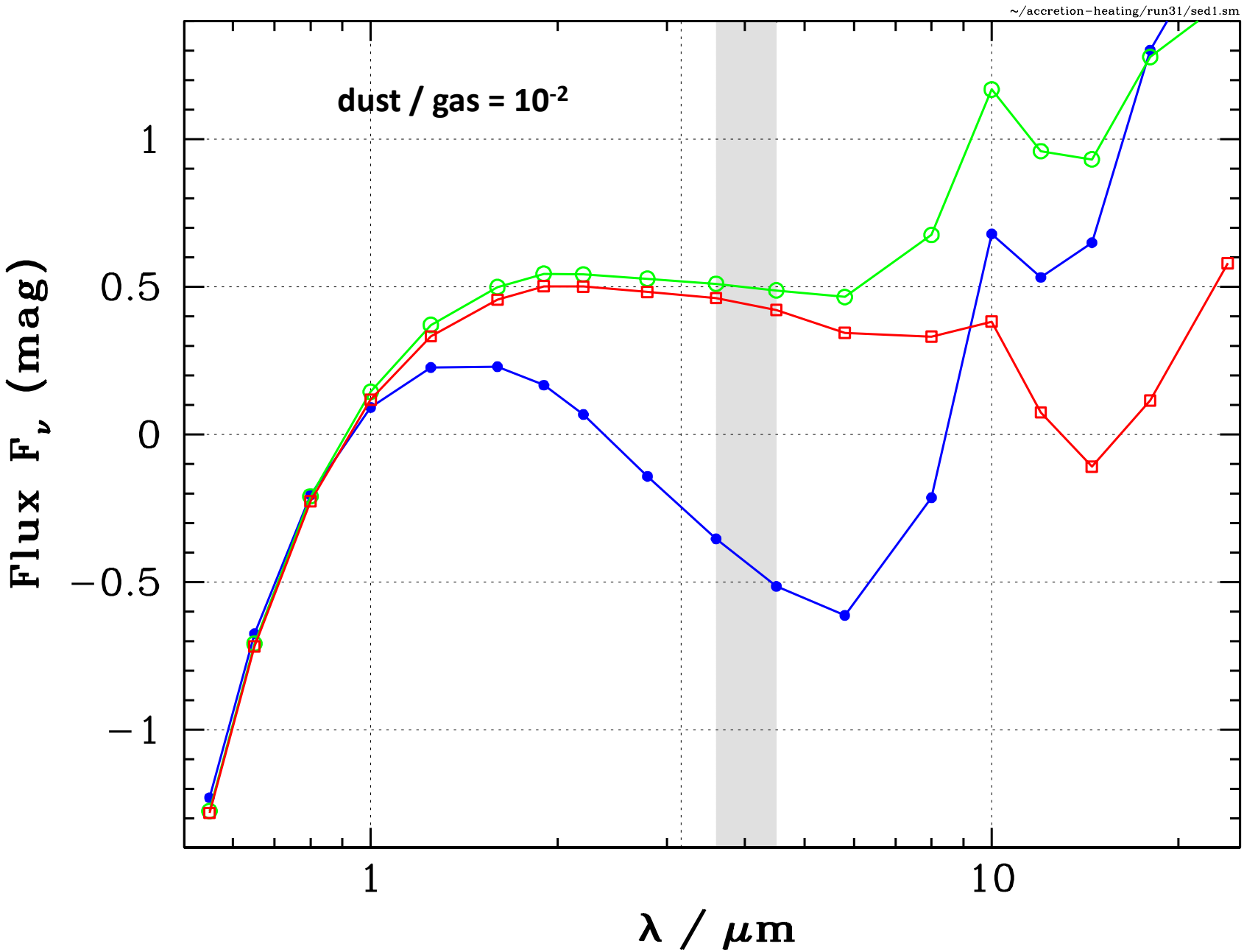


Hirose & Turner 2011


~/accretion-heating/run31/sed1.sm
dust / gas = 10-4
1
0.5
0
−0.5
−1
Flux Fν (mag)
1
10
λ / μm


~/accretion-heating/run31/sed1.sm
dust / gas = 10-2
1
0.5
0
−0.5
−1
Flux Fν (mag)
1
10
λ / μm

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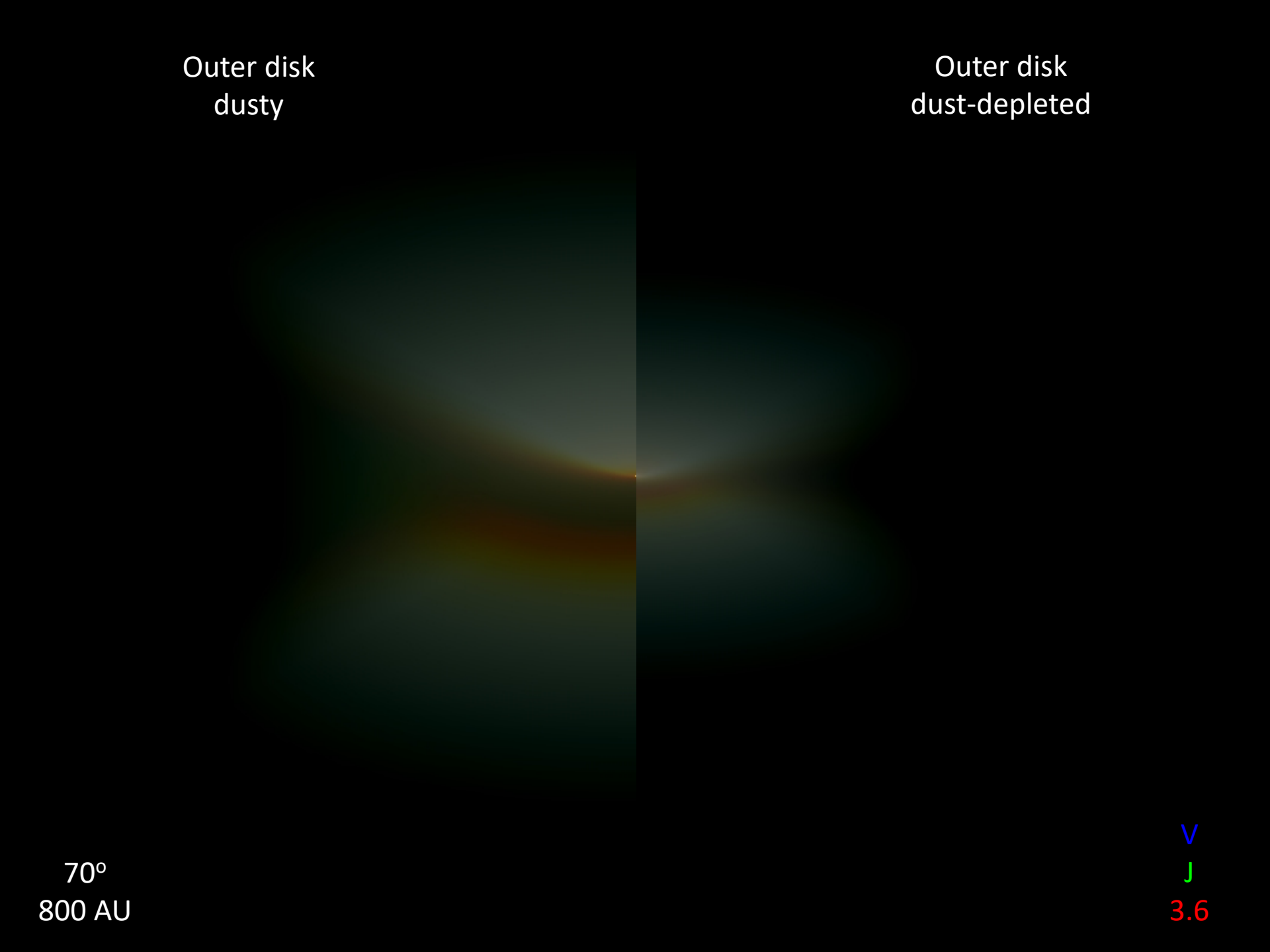
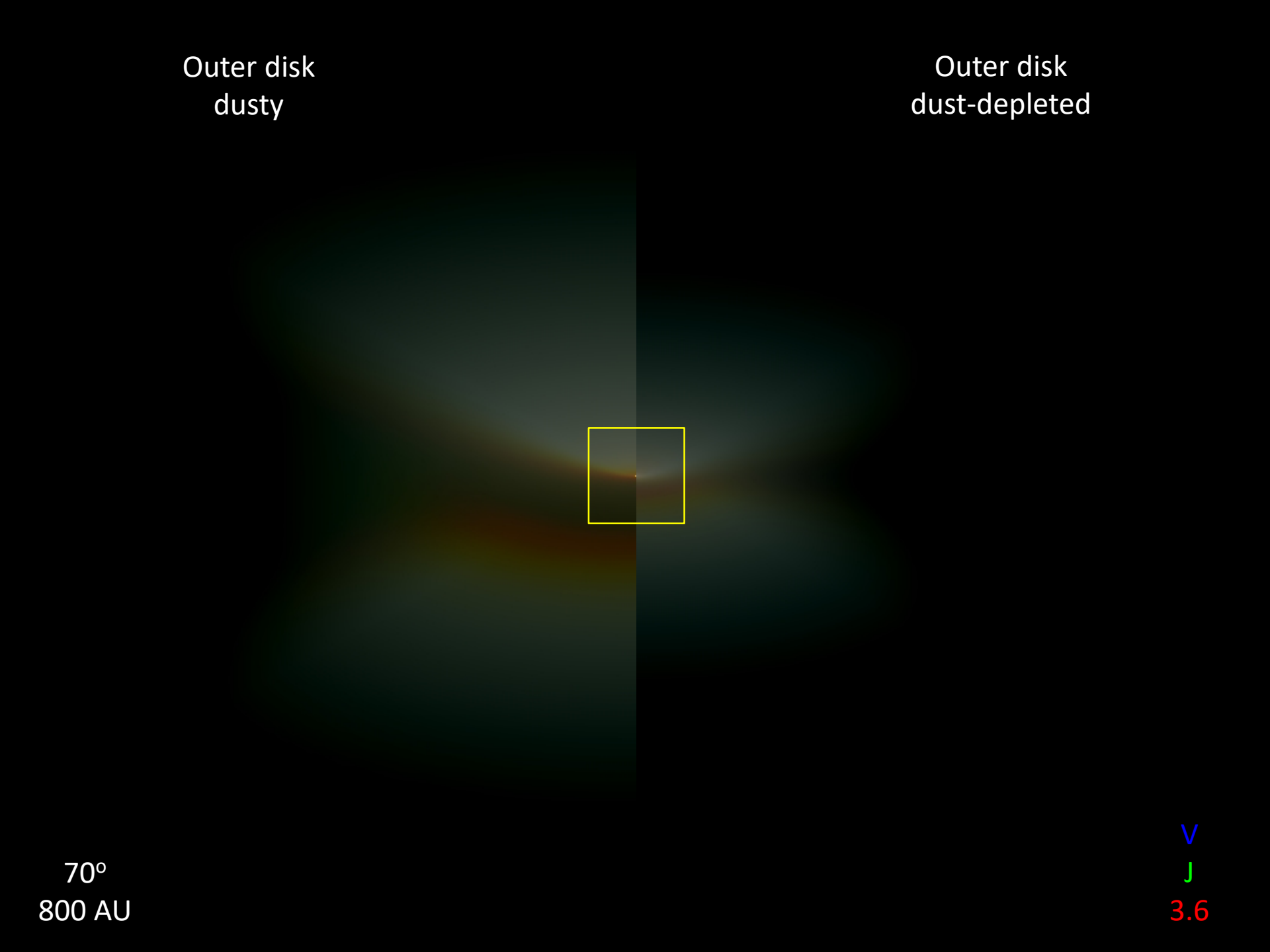

Outer disk
dusty
Outer disk
dust-depleted
70°
800 AU
V
J
3.6


Outer disk
dusty
Outer disk
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70°
800 AU
V
J
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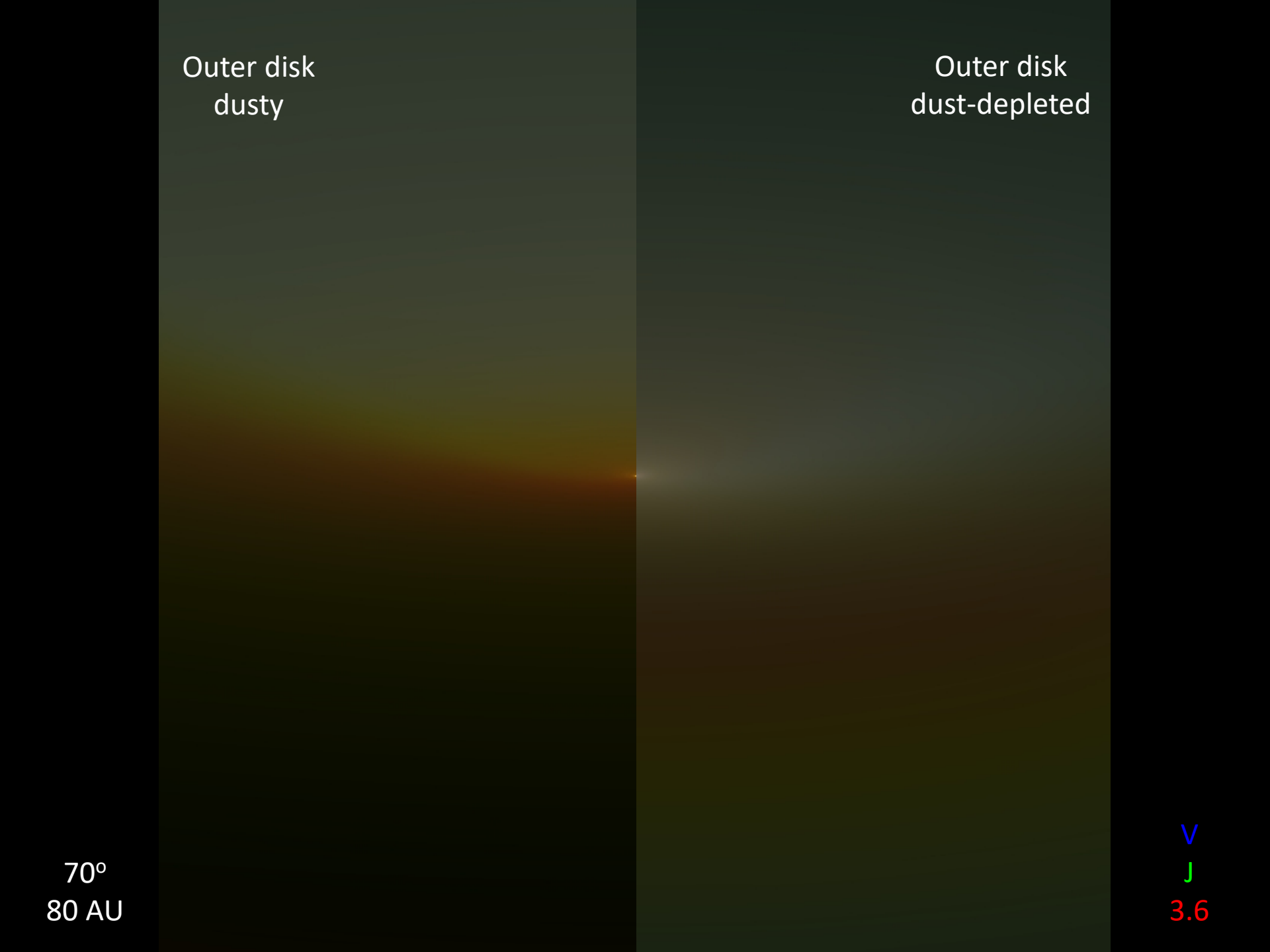
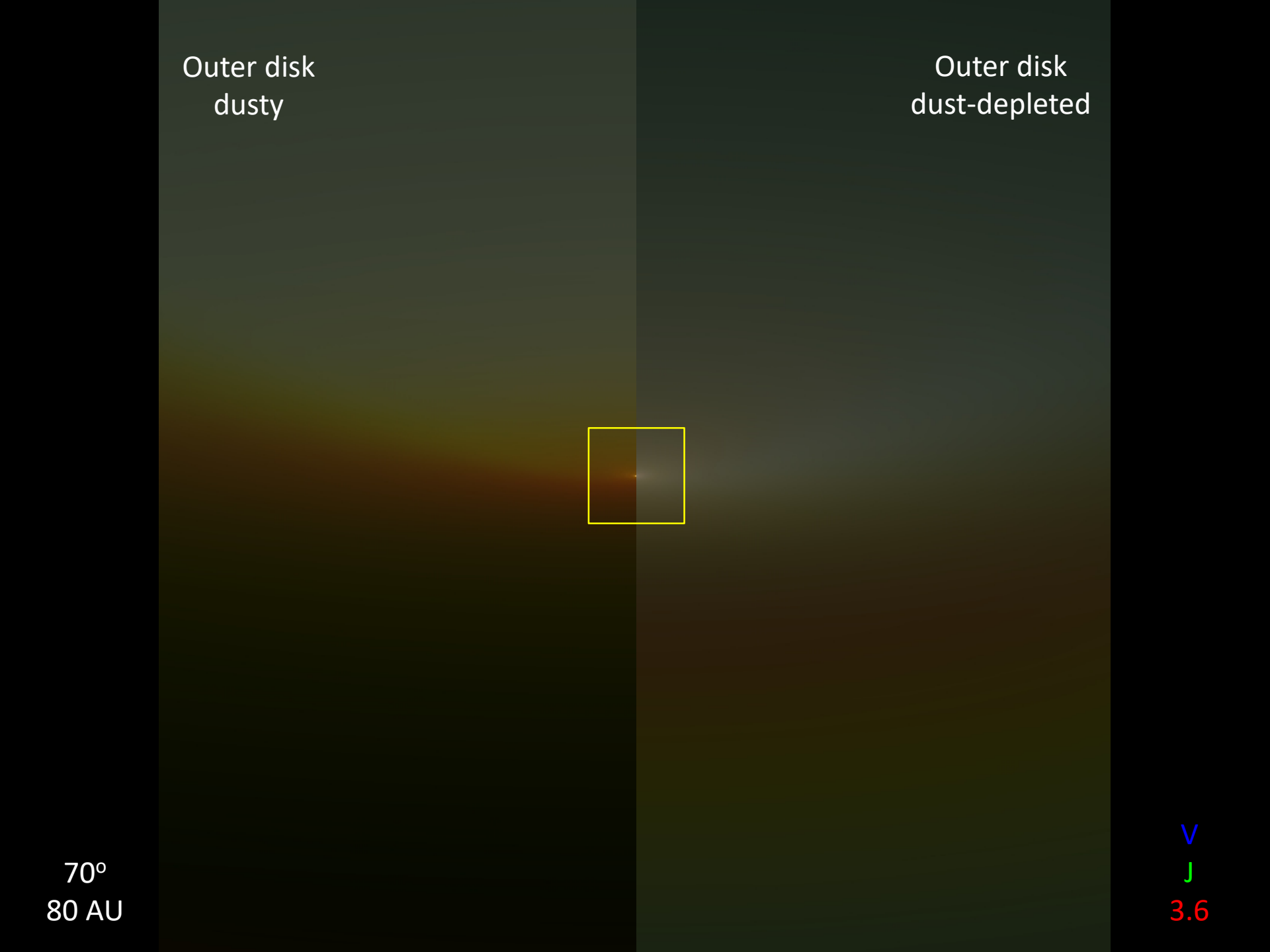
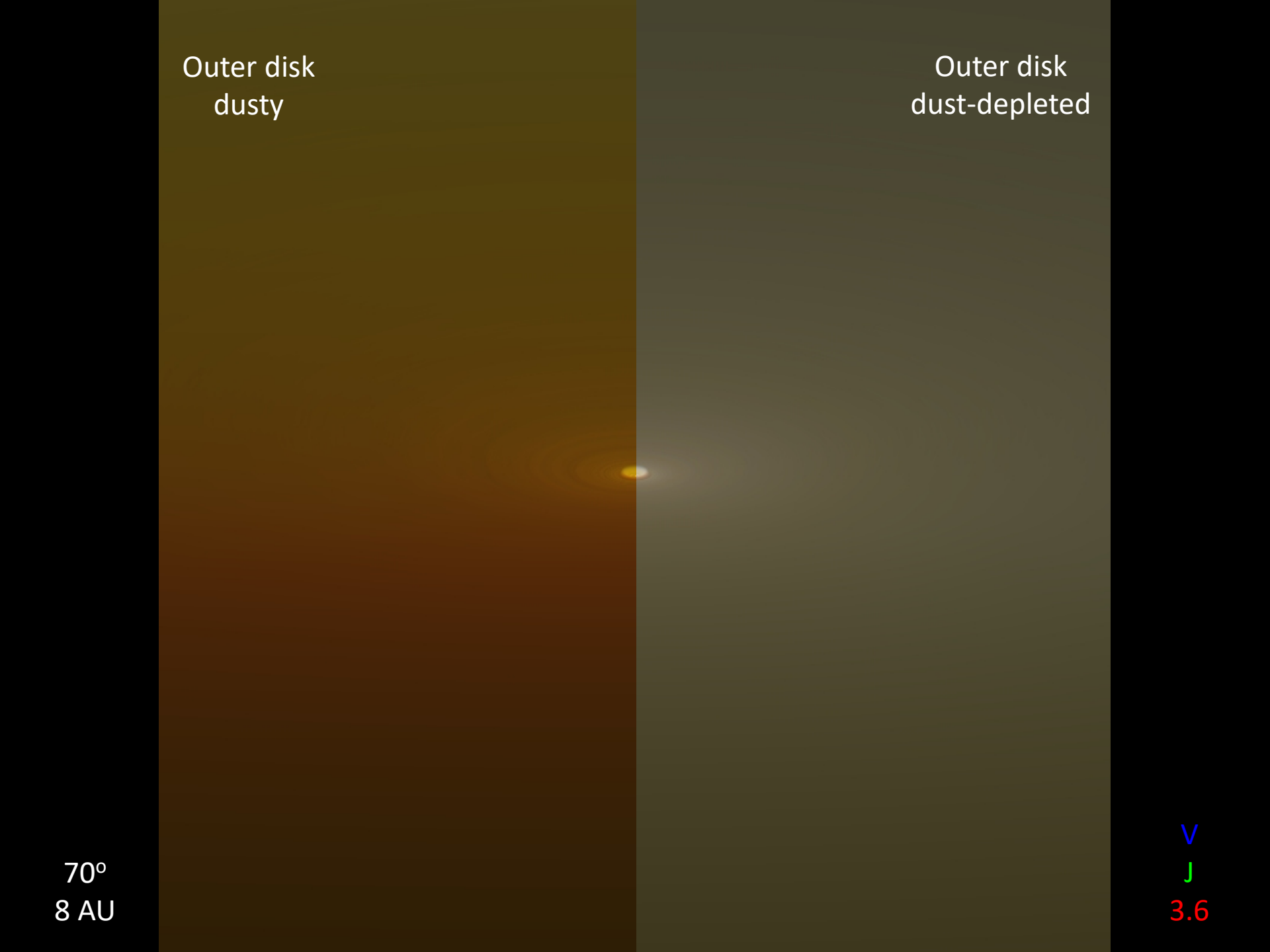
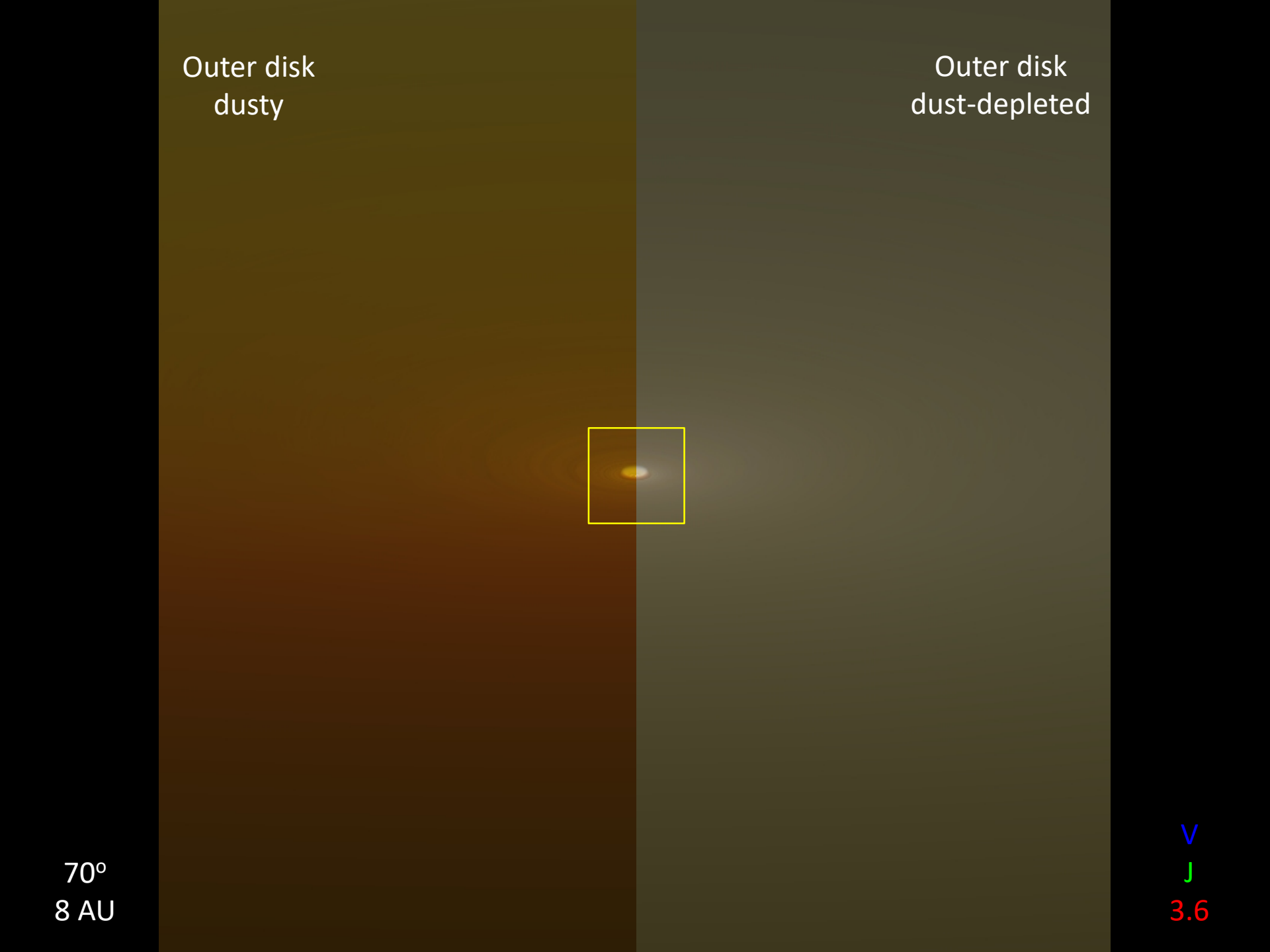
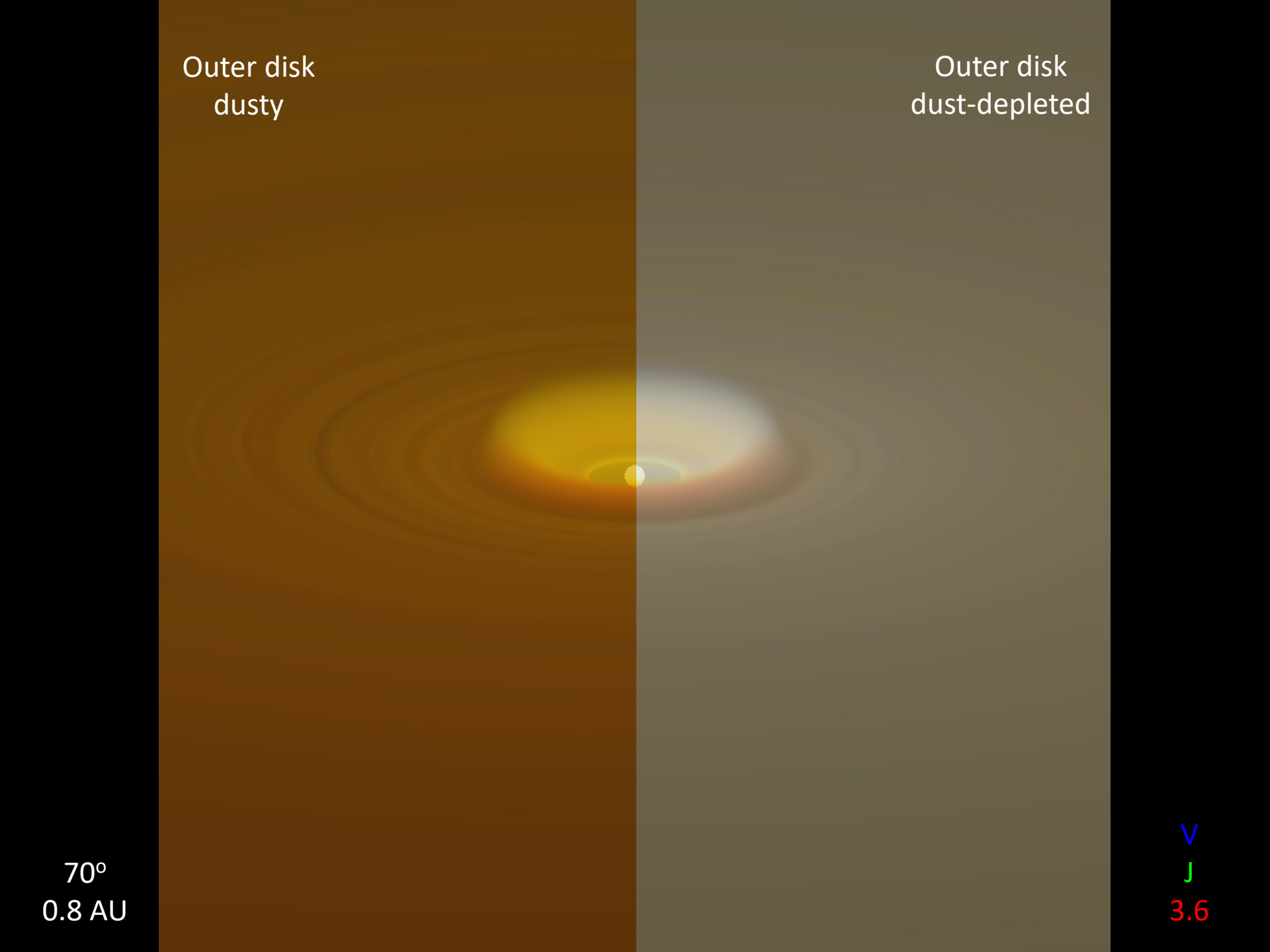
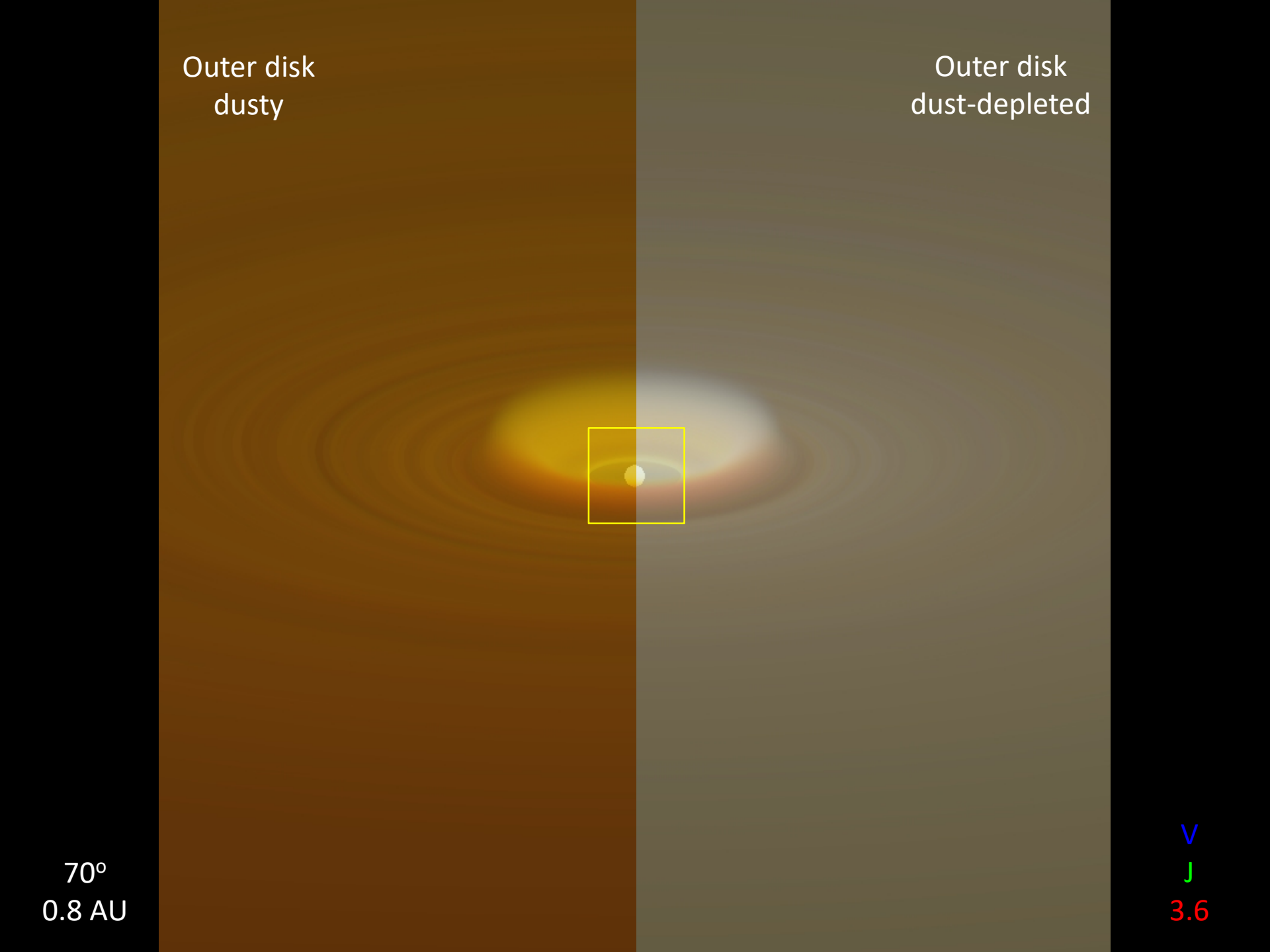

Outer disk
dusty
Outer disk
dust-depleted
70°
80 AU
V
J
3.6

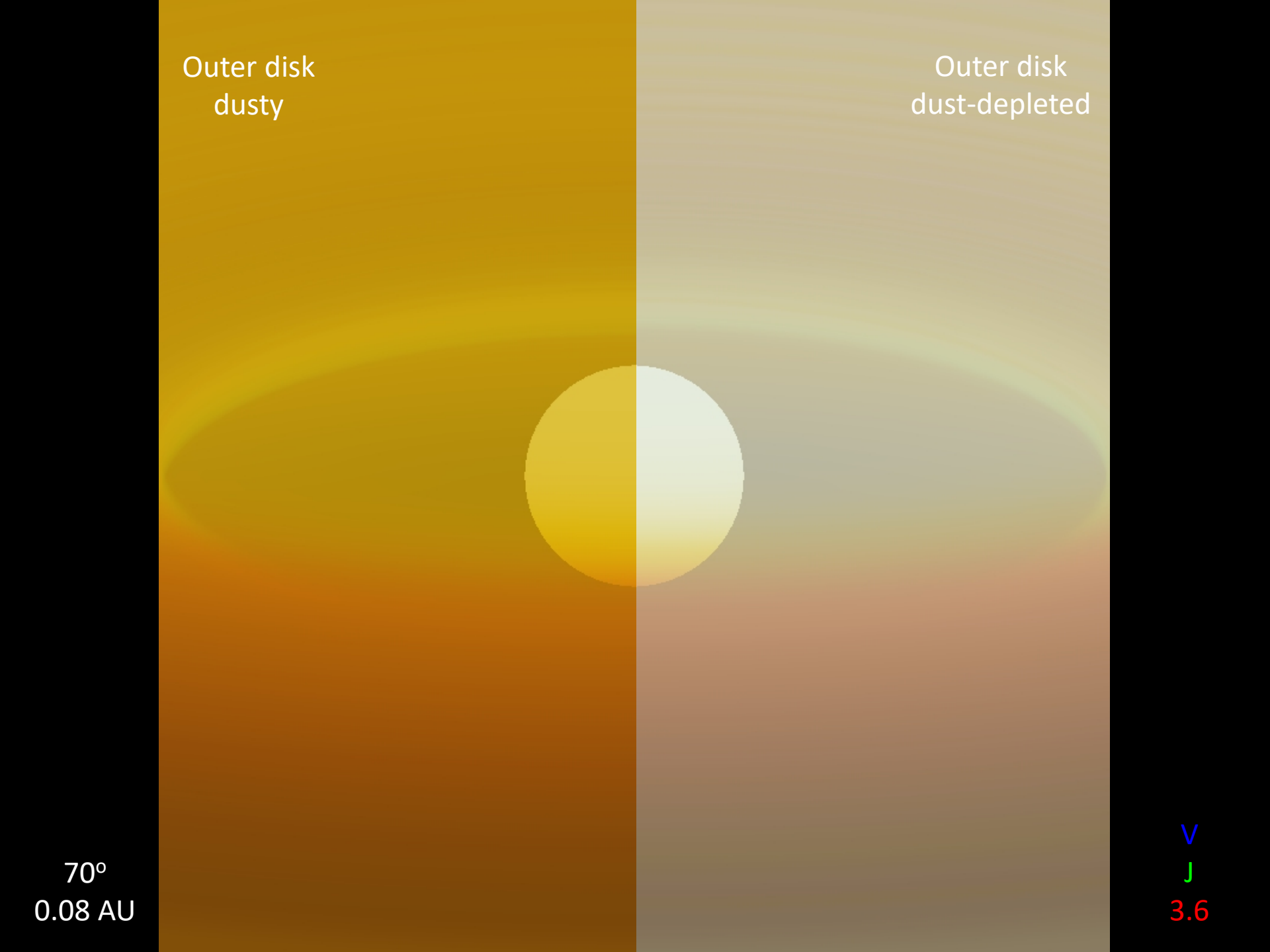

Outer disk
dusty
Outer disk
dust-depleted
70°
80 AU
V
J
3.6

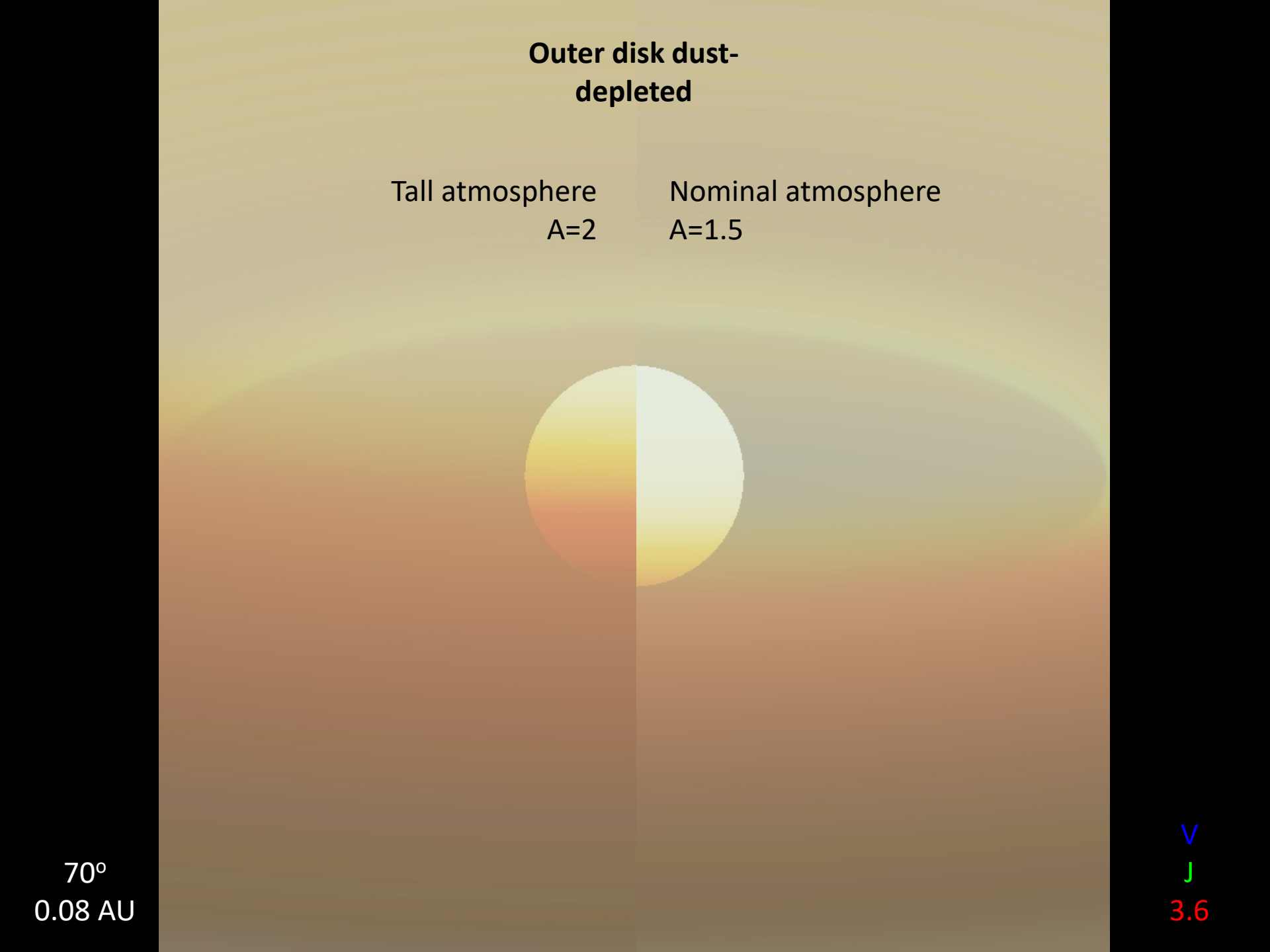

Outer disk
dusty
Outer disk
dust-depleted
70°
8 AU
V
J
3.6

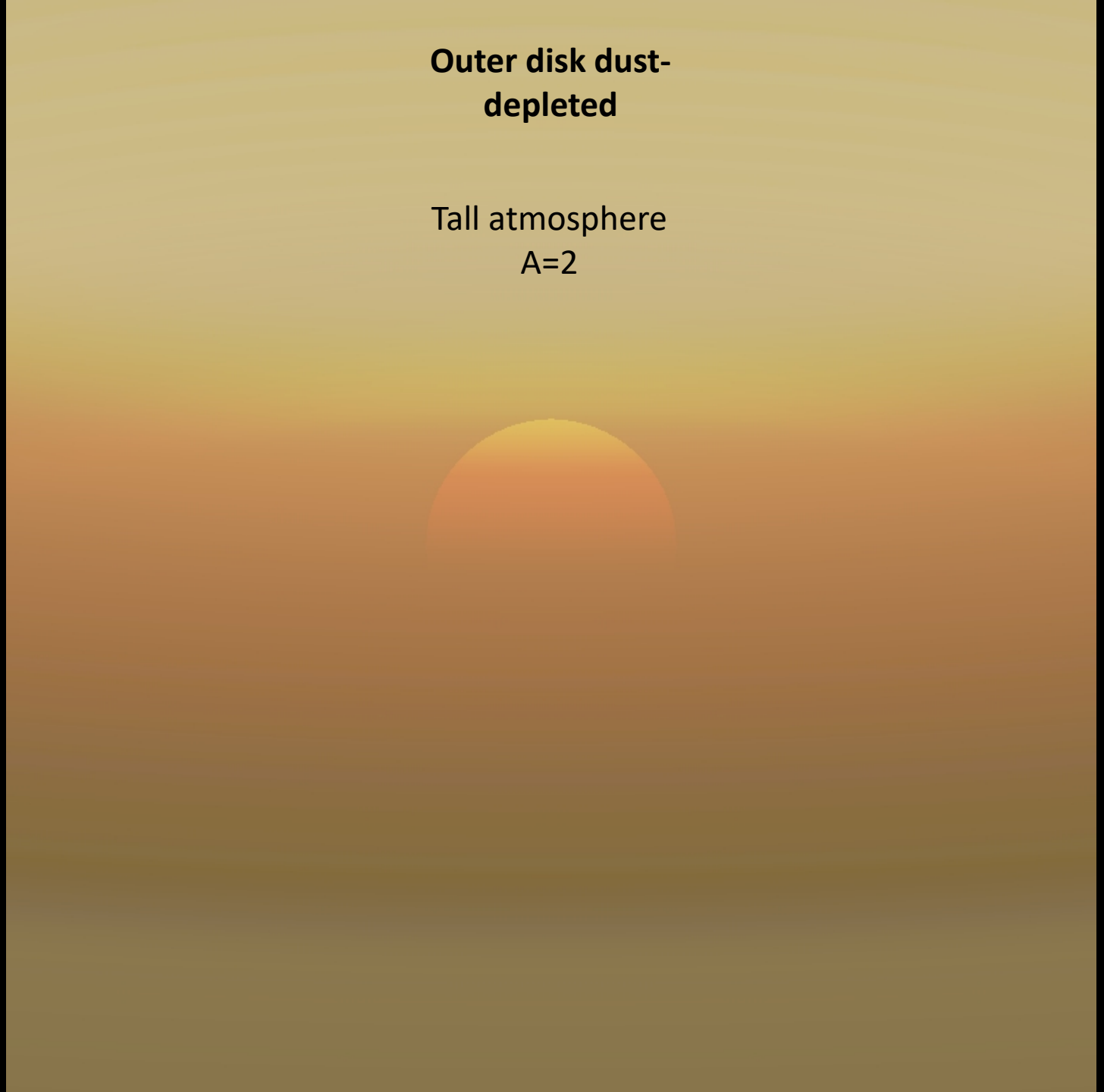

Outer disk
dusty
Outer disk
dust-depleted
70°
8 AU
V
J
3.6


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

http://flickr.com/photos/jeffstewartphotos

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.