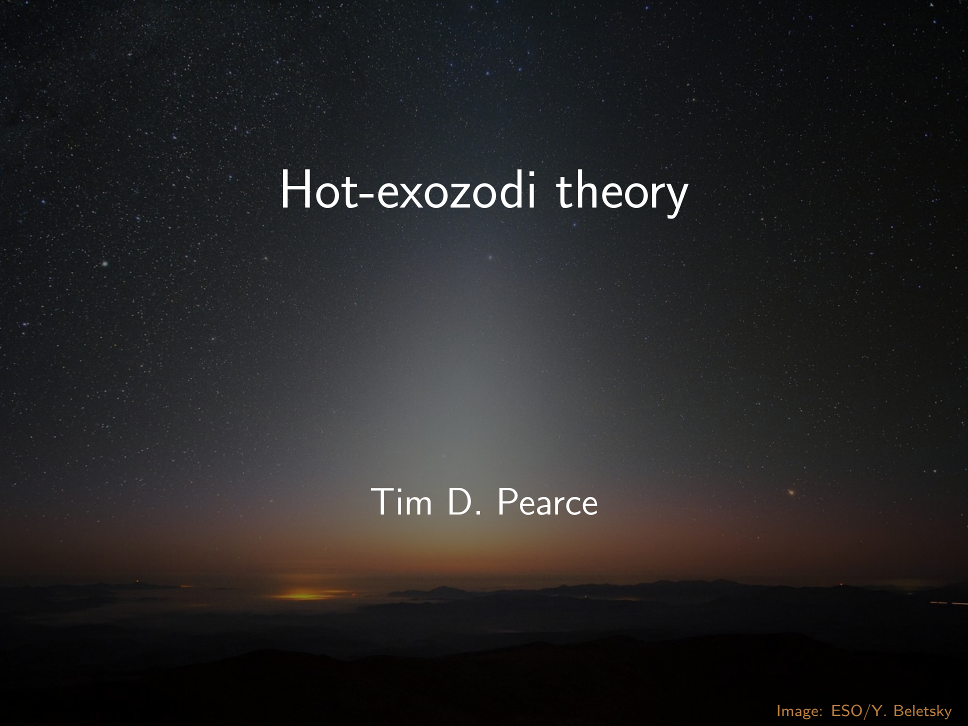
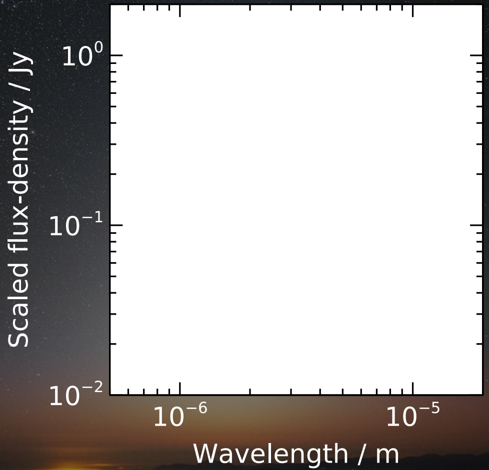


Hot-exozodi theory

Tim D. Pearce

Image: ESO/Y. Beletsky

What we're trying to explain



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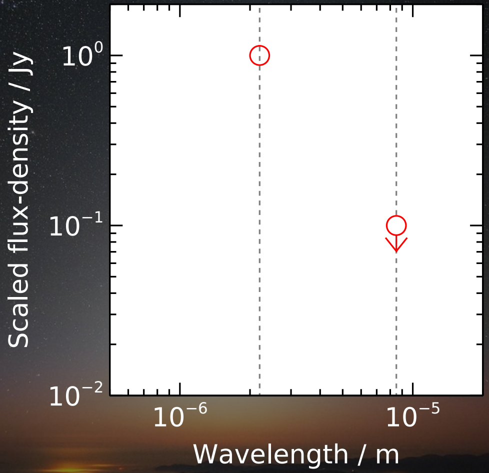

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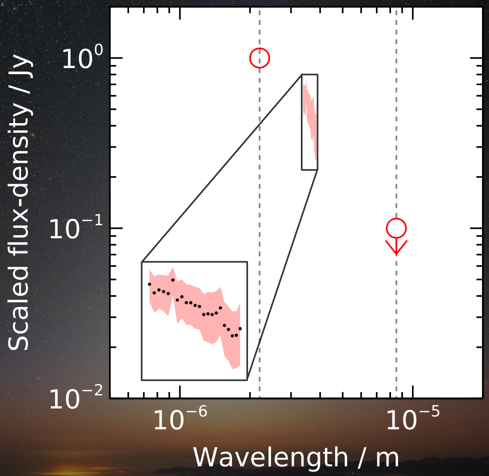

MATISSE data: Kirchschlager et al. 2020

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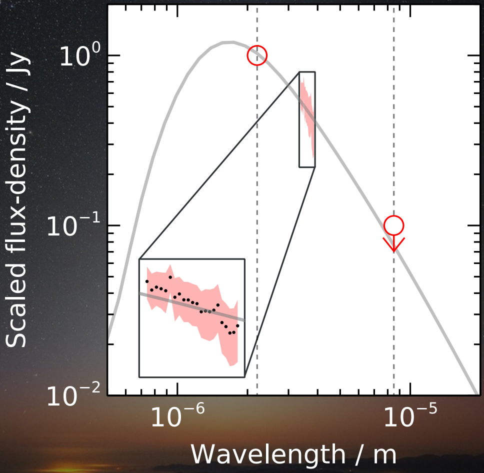

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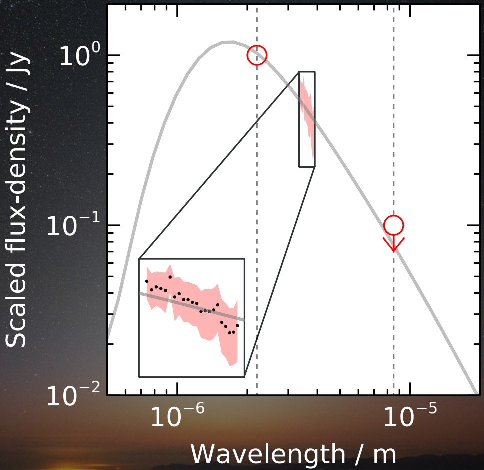

$\Rightarrow$ We often lack detailed data

MATISSE data: Kirchschlager et al. 2020

Model: Pearce et al. 2022

Near-IR observations

H and K band surveys reveal:

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- $\sim$ 20% of main-sequence stars have $\sim$ 1% NIR excess

Absil et al. 2013, 2021; di Folco et al. 2007; Defrère et al. 2012; Ertel et al. 2014, 2016, 2018, 2020; Mennesson et al. 2014; Millan-Gabet et al. 2011; Nuñez et al. 2017...

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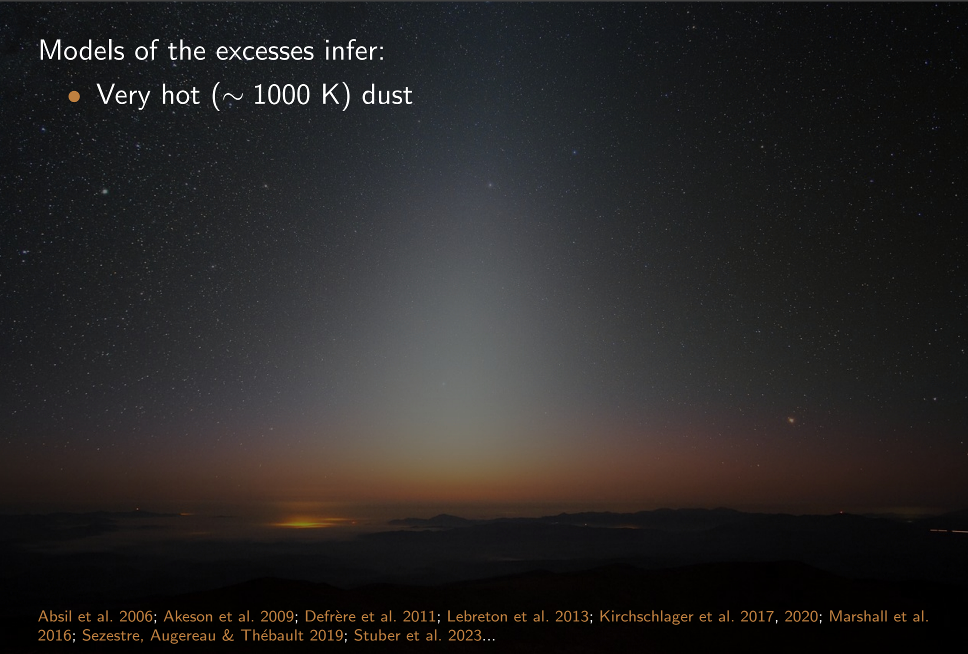

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- Grains are carbon rich (rather than silicate)

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How are small grains sustained
so close to stars?

Models

Two big problems:

Blowout and **Sublimation**

Models

Two big problems:

Blowout and Sublimation

- Blowout: small grains blown away by radiation pressure
- Sublimation: hot grains rapidly turn to gas

$\Rightarrow$ Small, hot grains should not survive long!

PR-drag supply

PR-drag supply

E.g. Krivov, Kimura & Mann 1998, Kobayashi et al. 2008, 2009, van Lieshout et al. 2014, Sezestre, Augereau & Thébault 2019, Pearce, Krivov & Booth 2020

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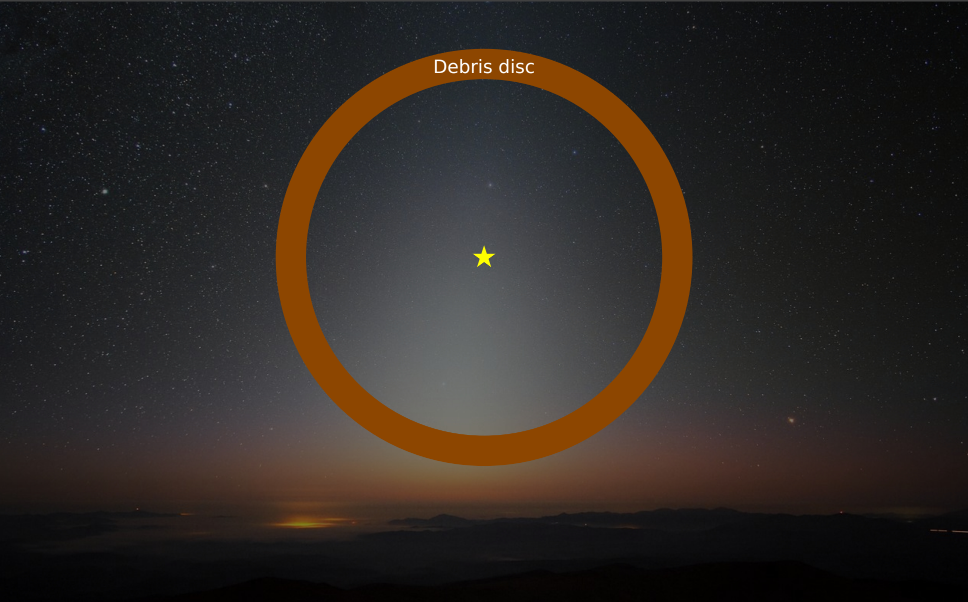

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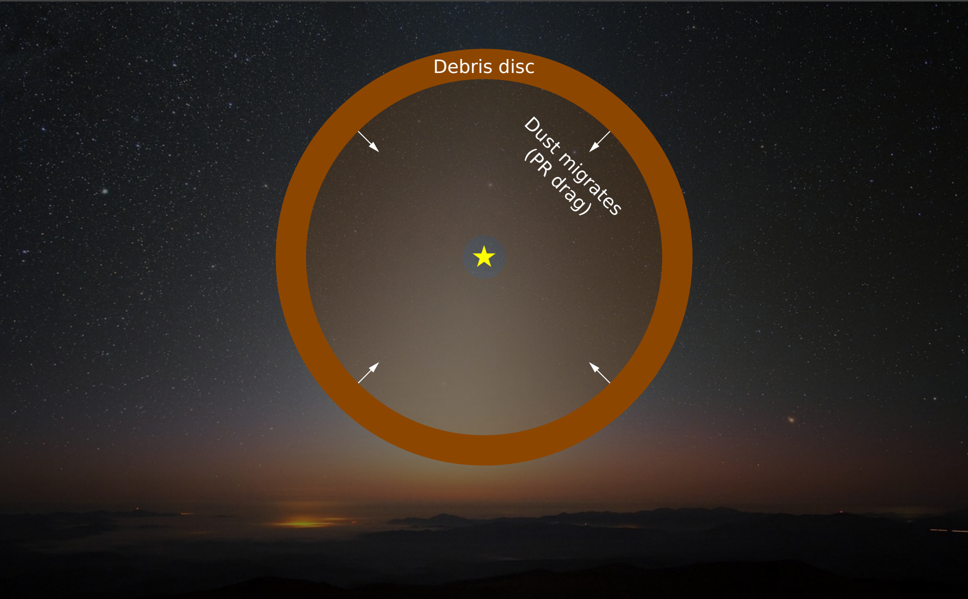

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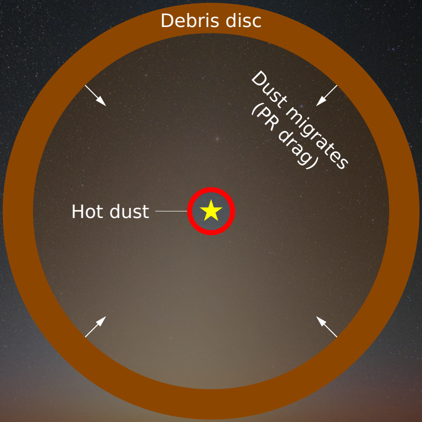

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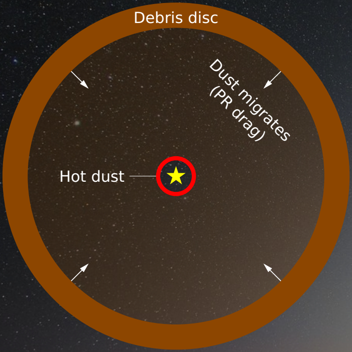

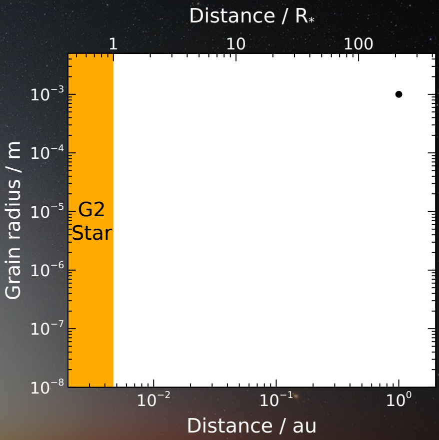

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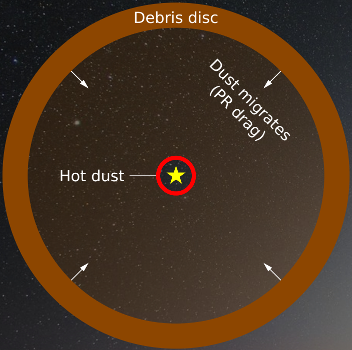

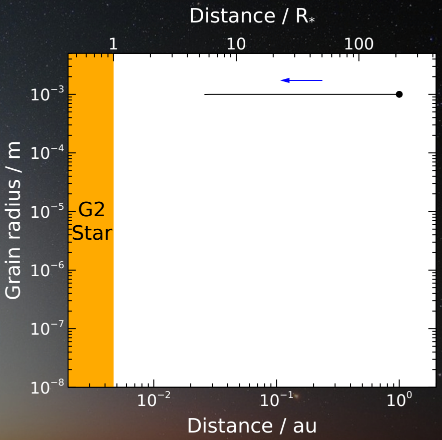

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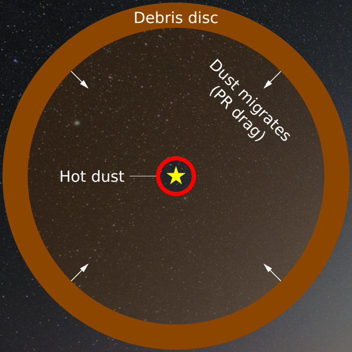

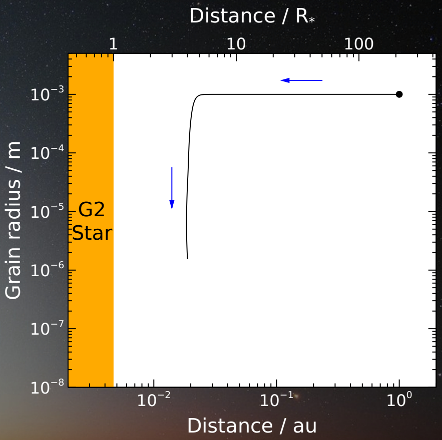

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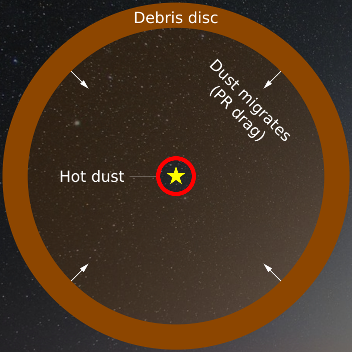

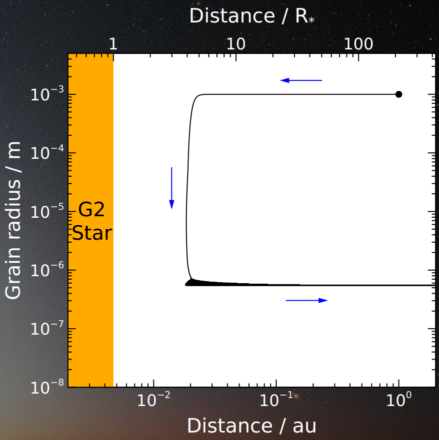

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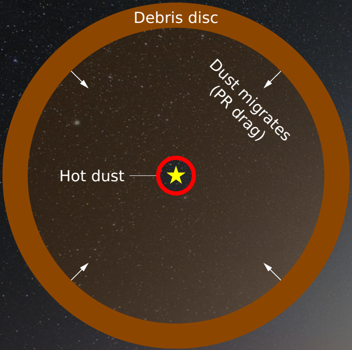

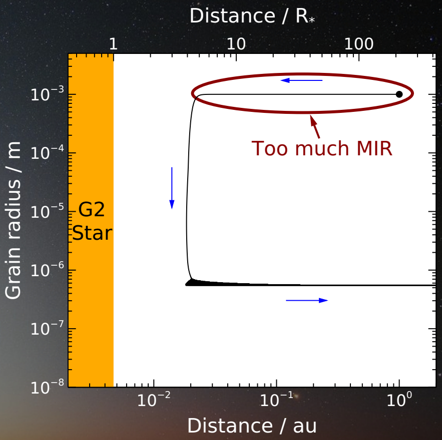

⇒ PR-drag models produce too much MIR

E.g. Krivov, Kimura & Mann 1998, Kobayashi et al. 2008, 2009, van Lieshout et al. 2014, Sezestre, Augereau & Thébault 2019, Pearce, Krivov & Booth 2020

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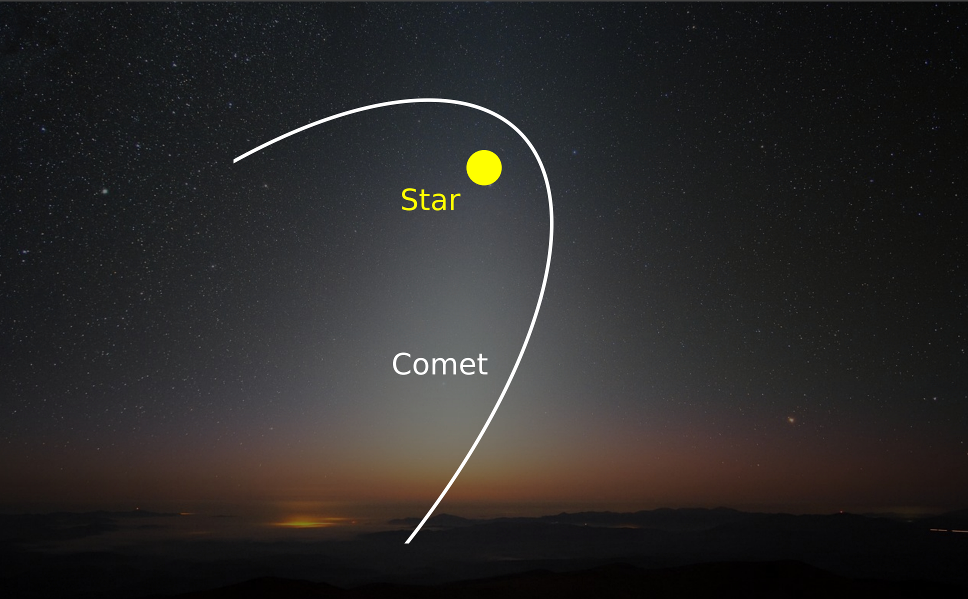

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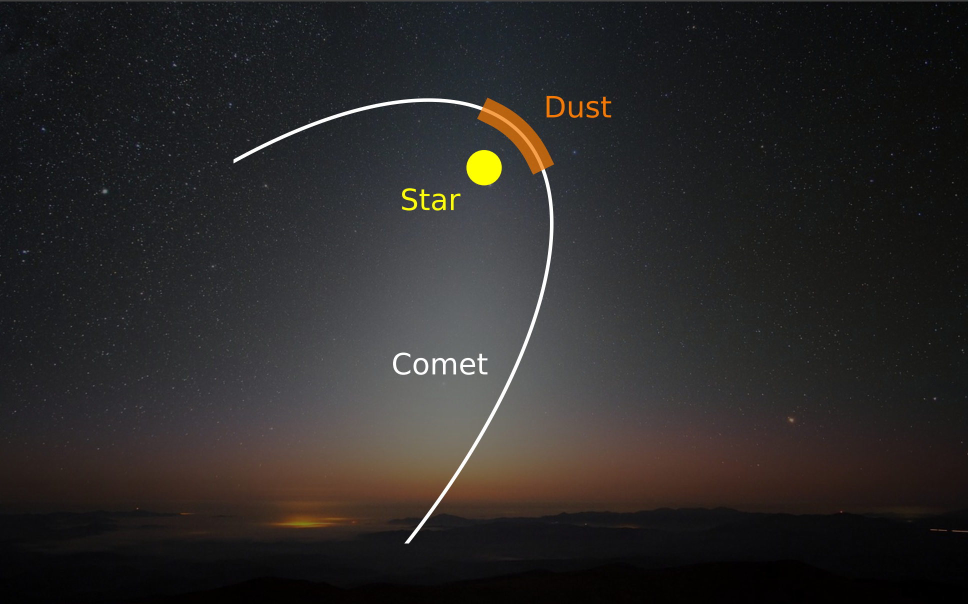

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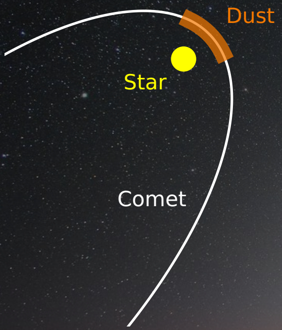

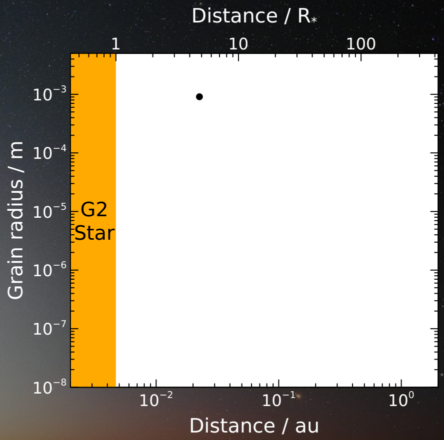

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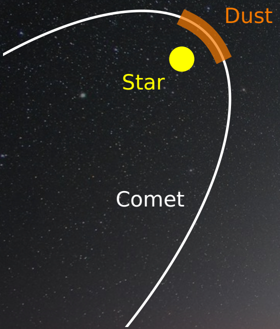

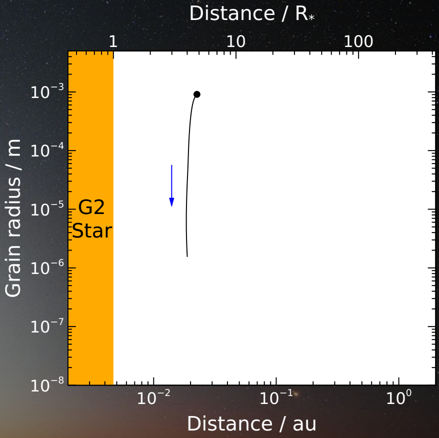

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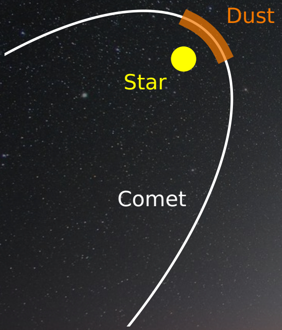

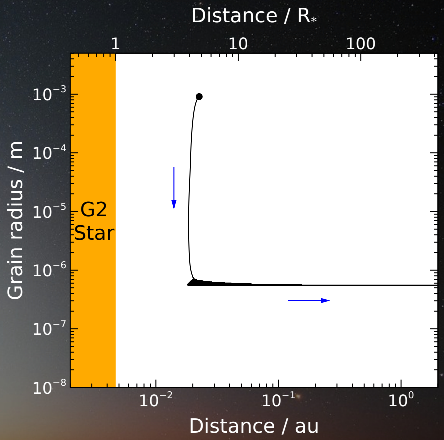

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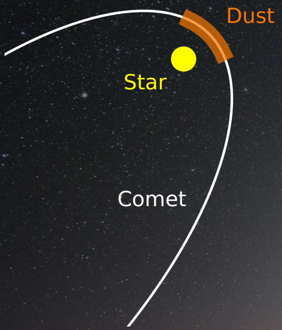
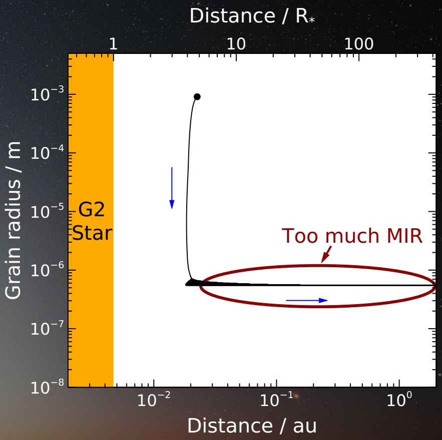




⇒ Star-grazing comets also produce too much MIR,
or need unphysically huge inflow rates

E.g. Bonsor et al. 2014, Raymond & Bonsor 2014, Marboeuf, Bonsor & Augereau 2016, Faramaz et al. 2017, Sezestre, Augereau & Thébault 2019, Pearce et al. 2022

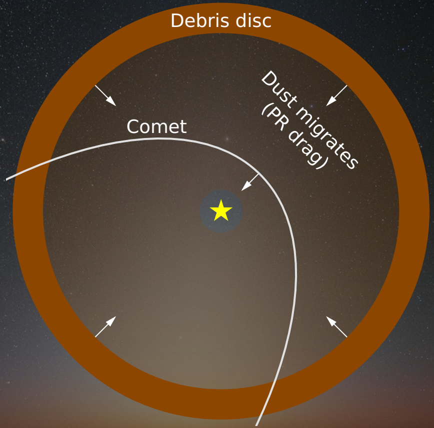
Simply getting dust close to stars

is not enough to explain hot exozodi

Magnetic trapping

E.g. Czechowski & Mann 2010, Su et al. 2013, Rieke, Gáspár & Ballering 2016, Stamm et al. 2019, Kimura et al. 2020

Magnetic trapping



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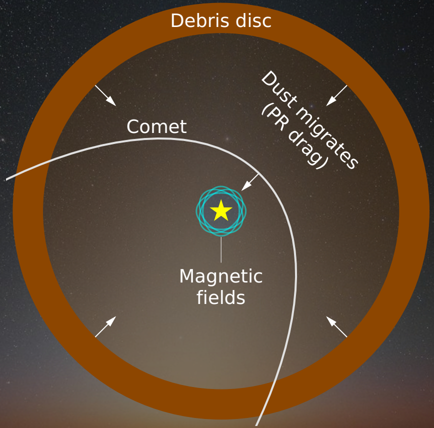

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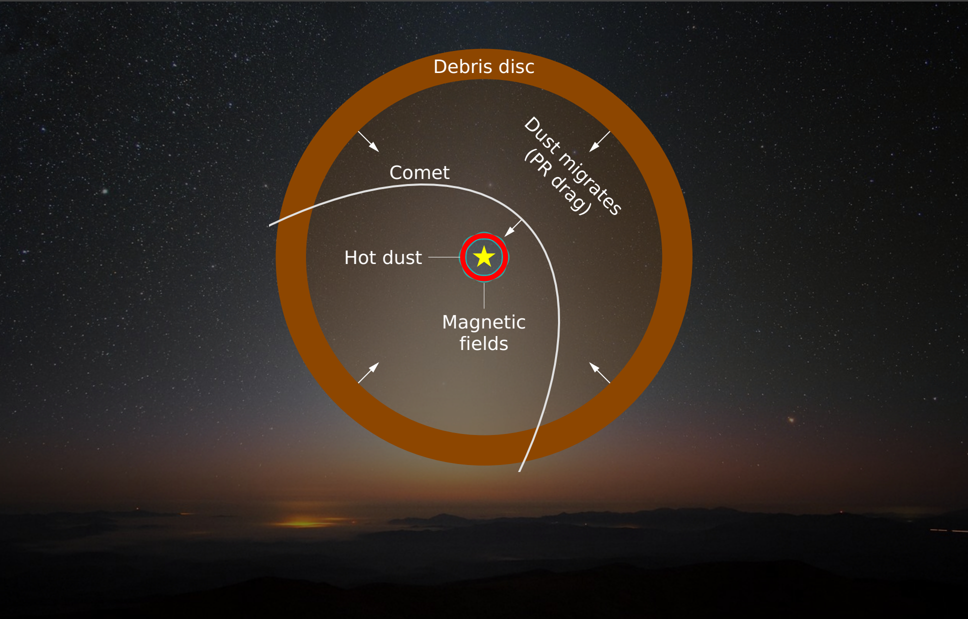

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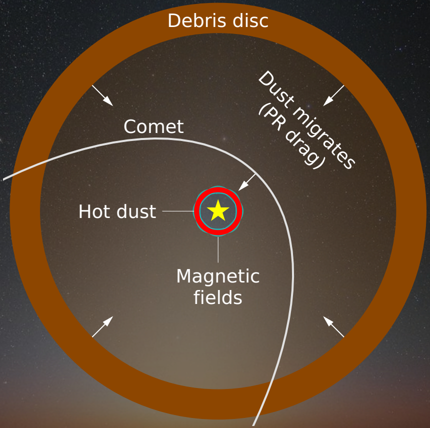

⇒ Magnetic models struggle with sublimation, and NIR-excess ubiquity across star types

E.g. Czechowski & Mann 2010, Su et al. 2013, Rieke, Gáspár & Ballering 2016, Stamm et al. 2019, Kimura et al. 2020

Gas trapping

E.g. Lebreton et al. 2013, Pearce, Krivov & Booth 2020

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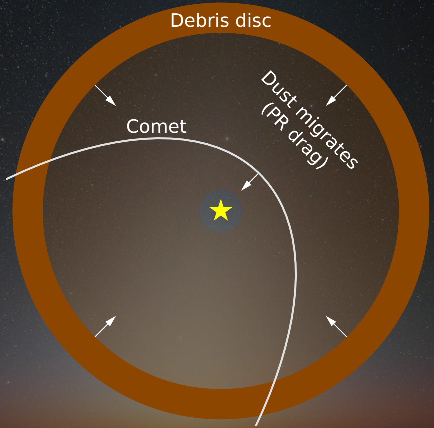

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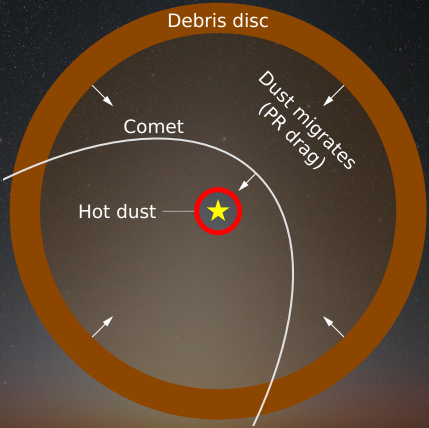

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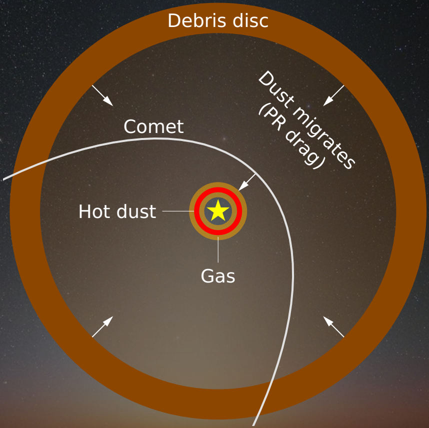

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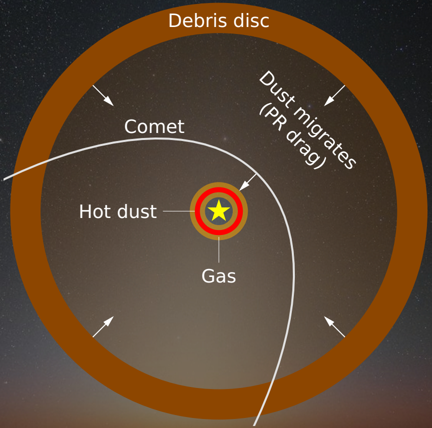
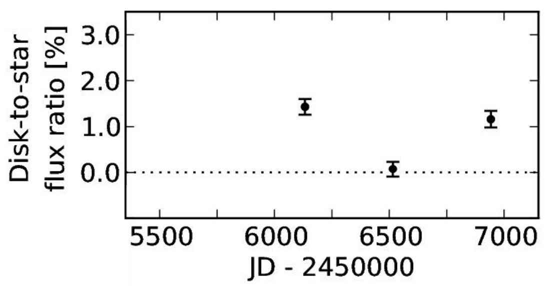


⇒ Gas models struggle with trapped-grain size around A-type stars

E.g. Lebreton et al. 2013, Pearce, Krivov & Booth 2020

Variability



Adapted from Ertel et al. 2016

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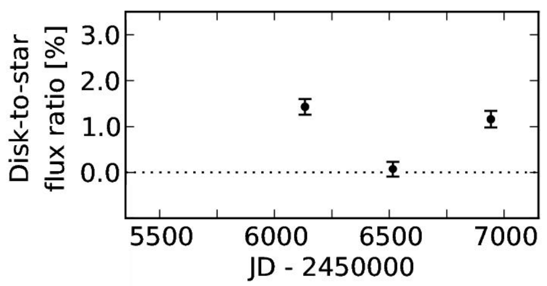
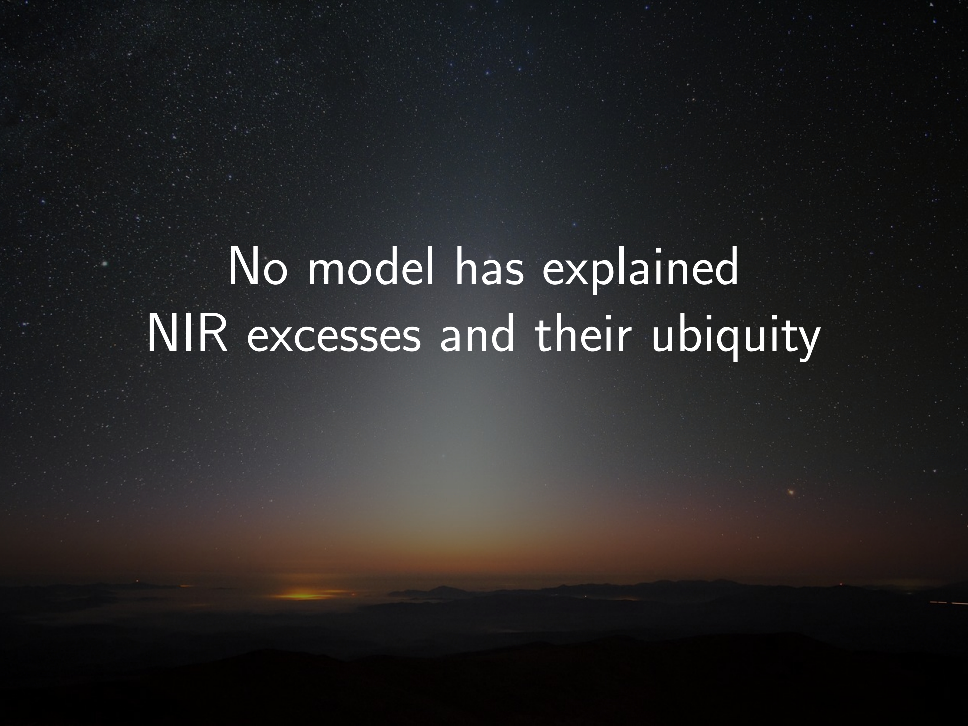


⇒ Hard to reconcile trapping models with variability

Adapted from Ertel et al. 2016


No model has explained
NIR excesses and their ubiquity

Where next for theory?

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6. Are we *sure* that NIR excesses are hot dust?

What would help?

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- More wavelengths at higher resolution!

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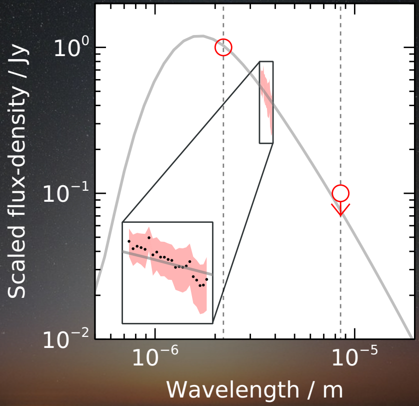
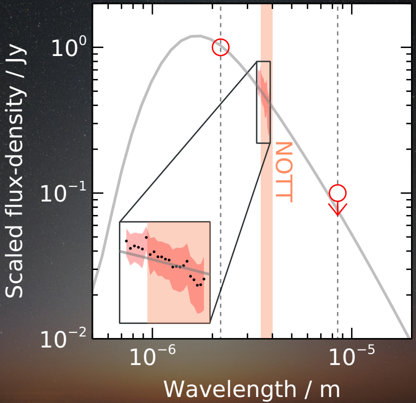


MATISSE data: Kirchschlager et al. 2020. Model: Pearce et al. 2022

What would help?

- More wavelengths at higher resolution!



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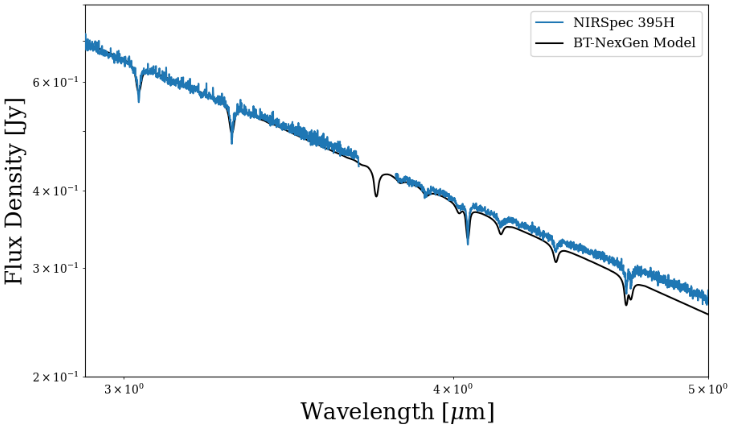
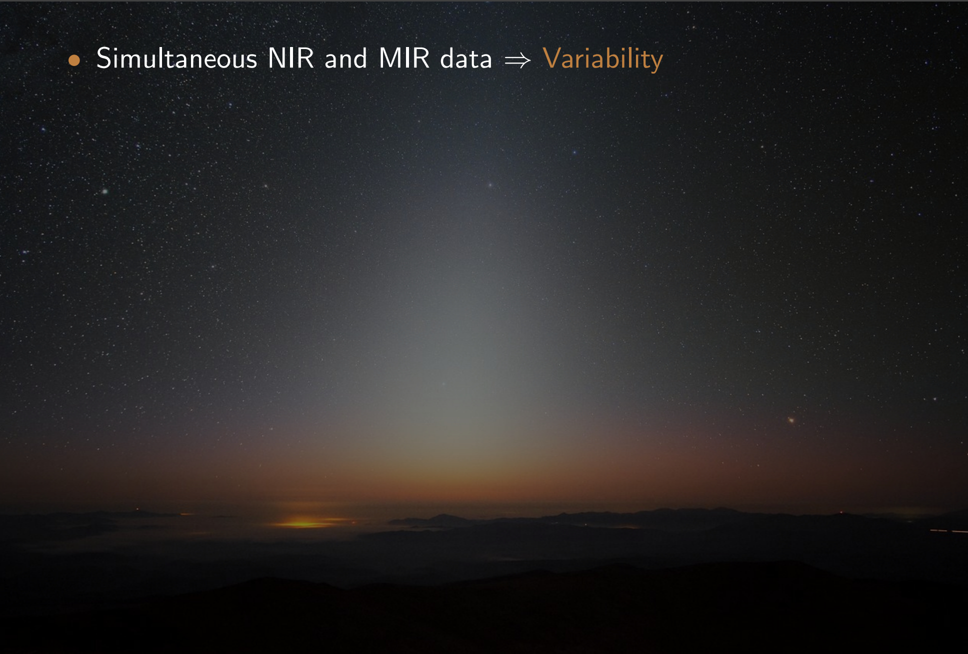


JWST GO 2053 (Rebollido et al. in prep.)

What would help?

- Simultaneous NIR and MIR data $\Rightarrow$ Variability



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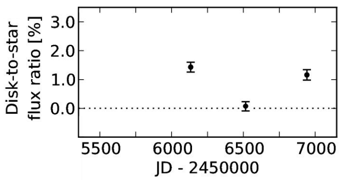

Ertel et al. 2016

What would help?

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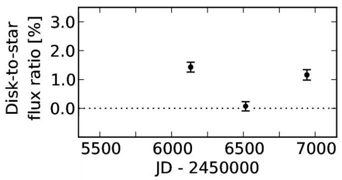
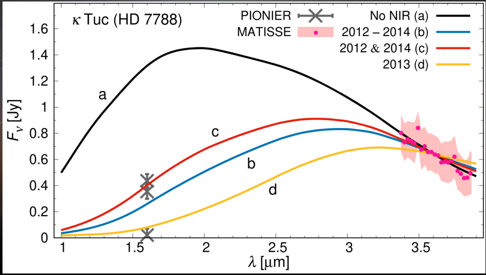


Ertel et al. 2016



Kirchschlager et al. 2020

What would help?

- Anything that hints at dust distribution

Conclusions

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- Near-IR excesses are interpreted as very hot dust very close to stars
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- Upcoming theory will assess our assumptions and explore new ideas
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Questions?

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Images

Zodiacal light: ESO/Y. Beletsky