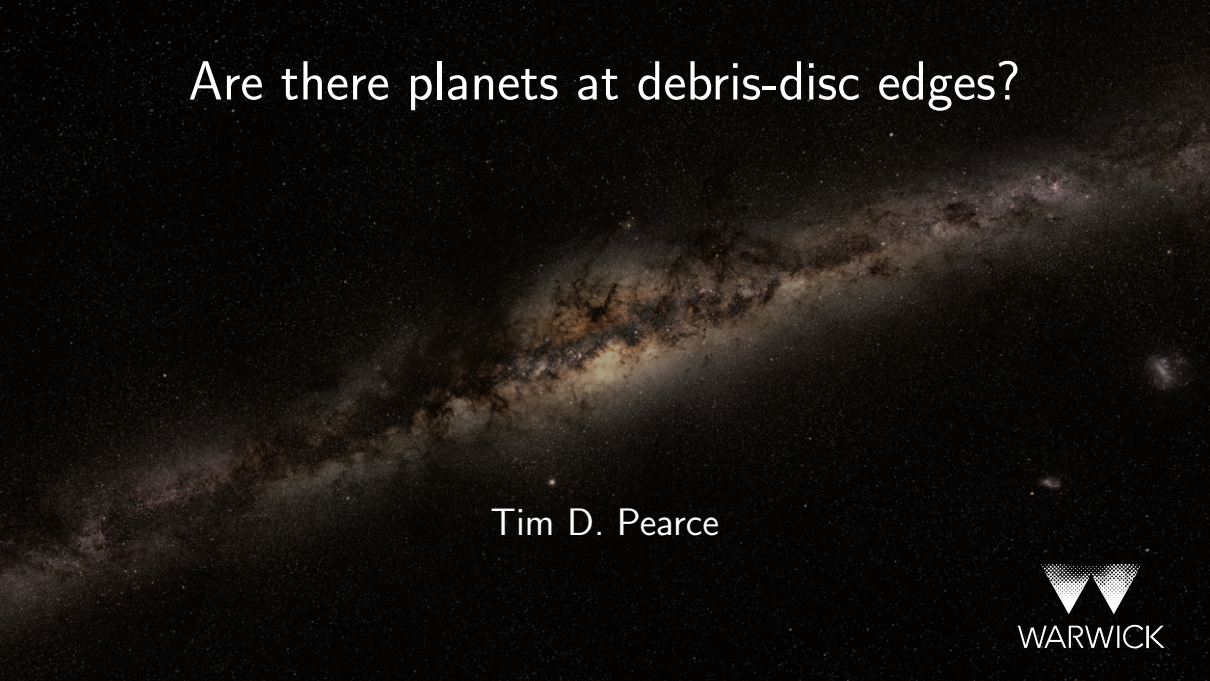
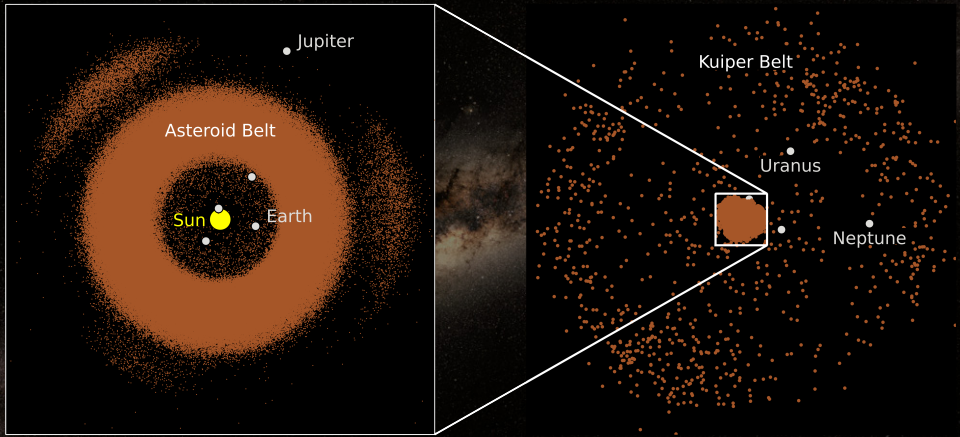
Are there planets at debris-disc edges?



Tim D. Pearce

WARWICK

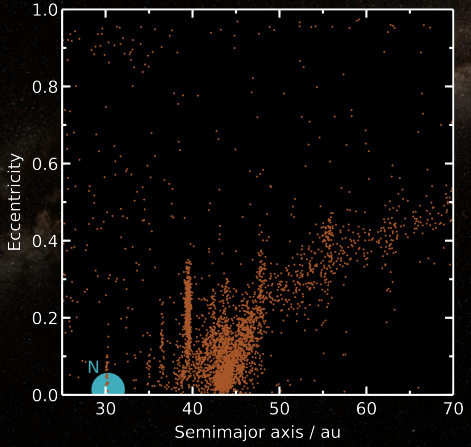
Solar System



Ephemerides: JPL

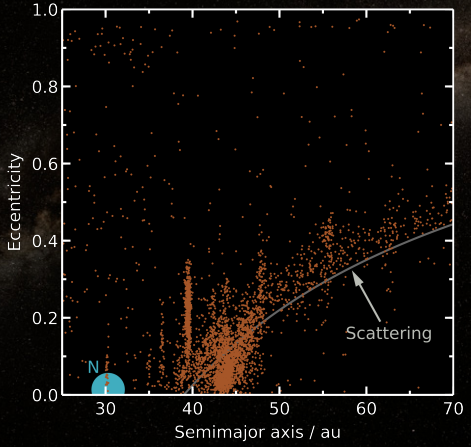
Solar System

Kuiper Belt



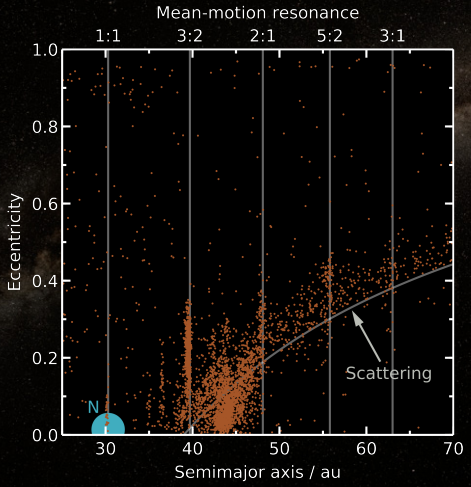
Solar System

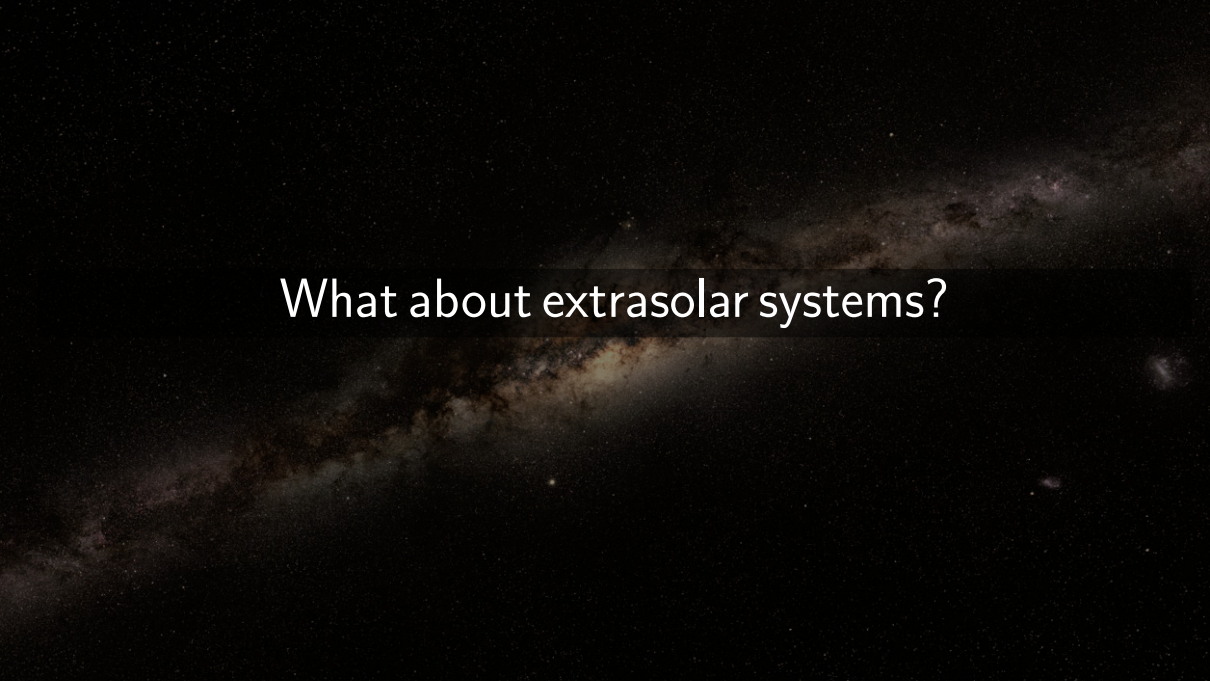
Kuiper Belt



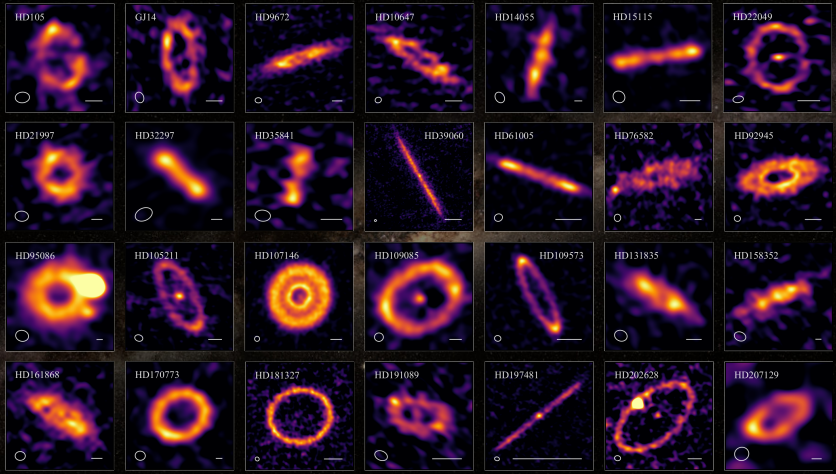
Solar System

Kuiper Belt




What about extrasolar systems?

Extrasolar debris discs



Matrà et al. in prep.

The traditional picture

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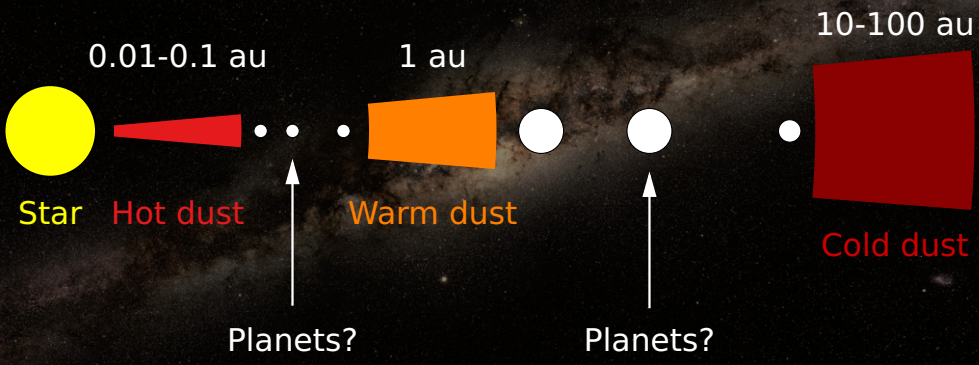

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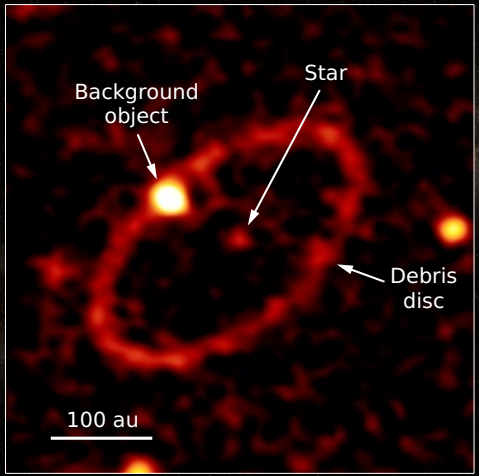
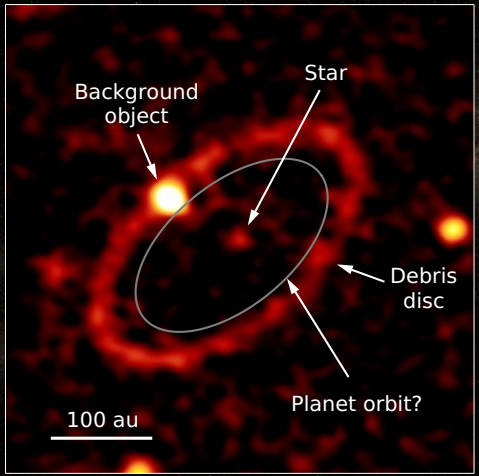


ALMA: Faramaz et al. 2019

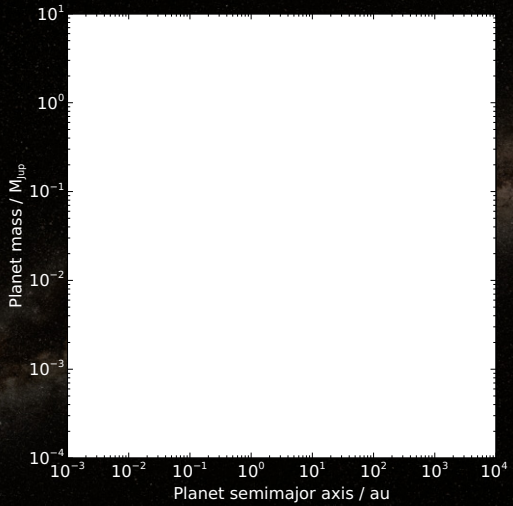
The traditional picture



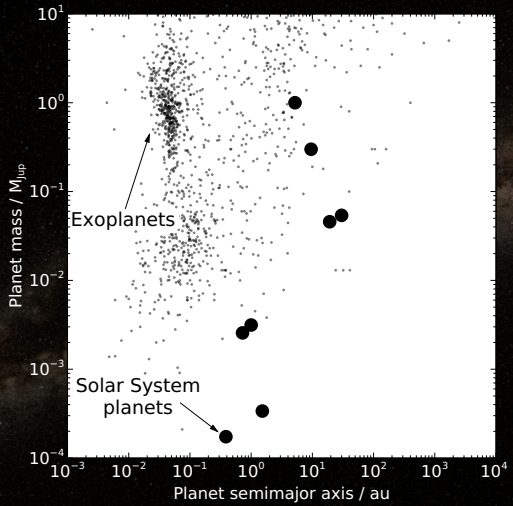
ALMA: Faramaz et al. 2019

Planet parameters: Pearce et al. 2022

Debris-inferred exoplanets

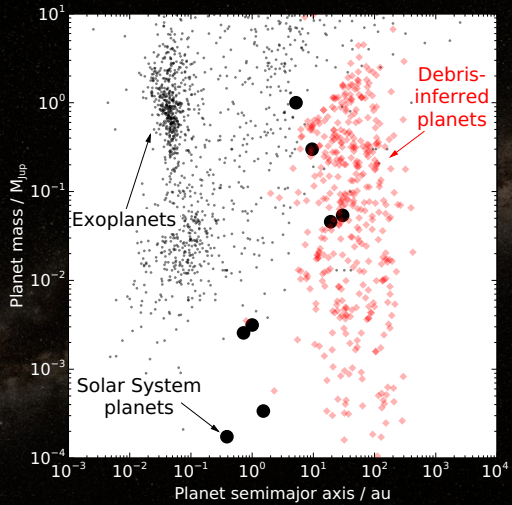


Debris-inferred exoplanets



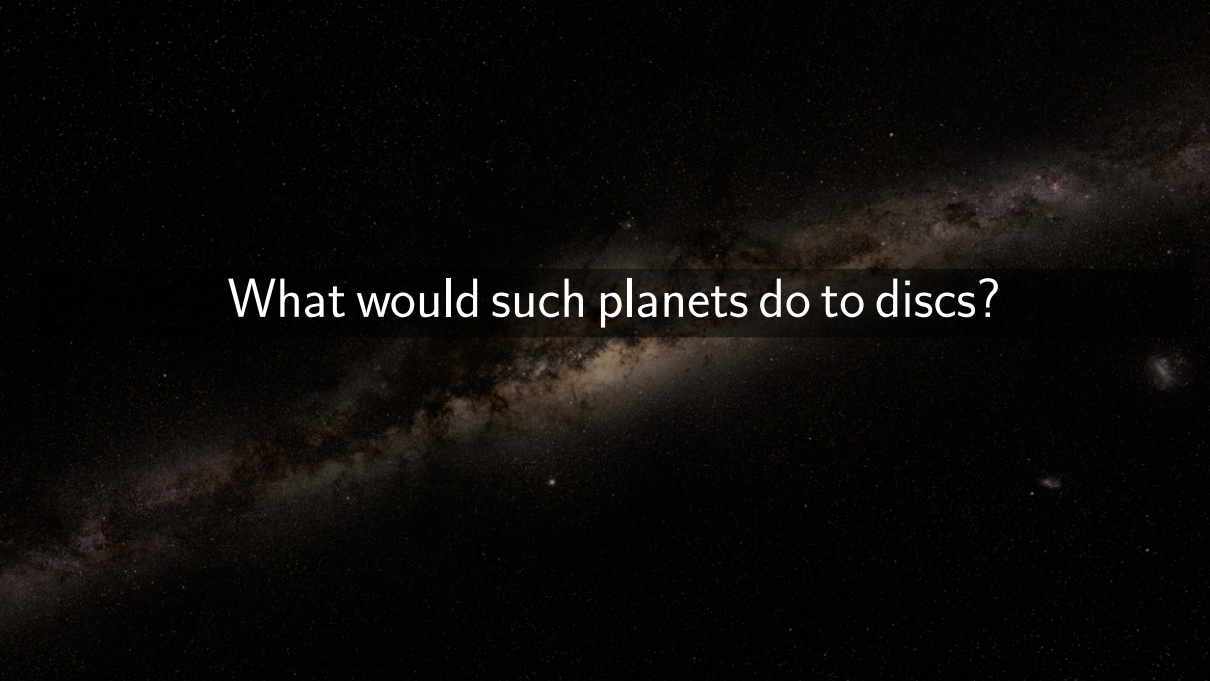
Exoplanet data: Exoplanet.eu

Debris-inferred exoplanets

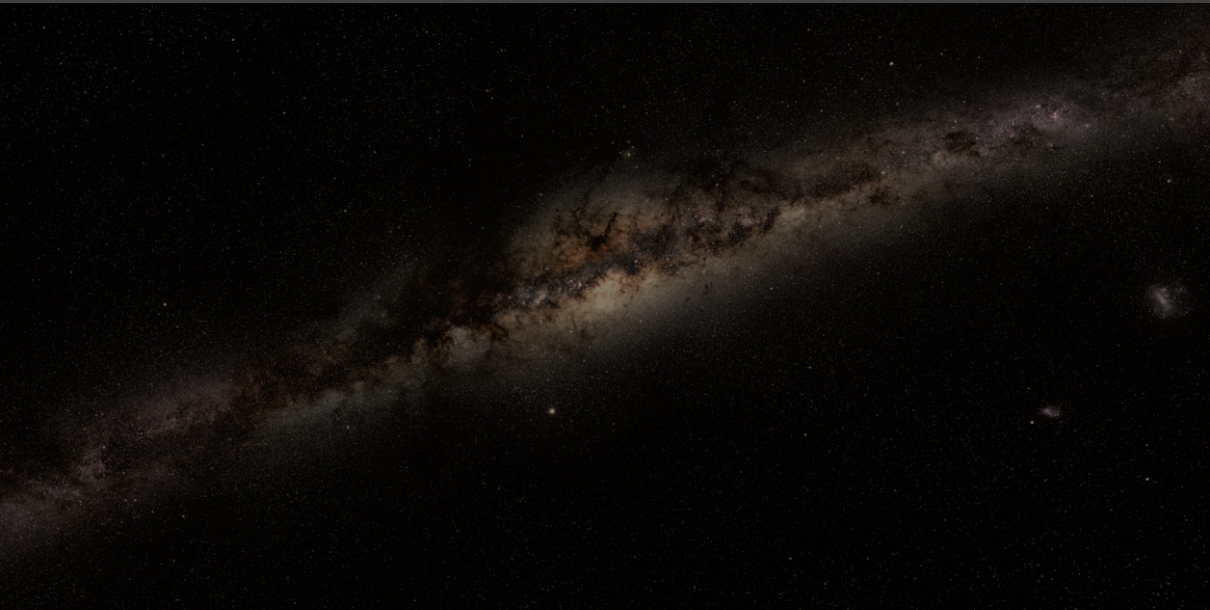


Exoplanet data: Exoplanet.eu

Inferred planets: Pearce et al. 2022


What would such planets do to discs?

1. Planets would truncate discs



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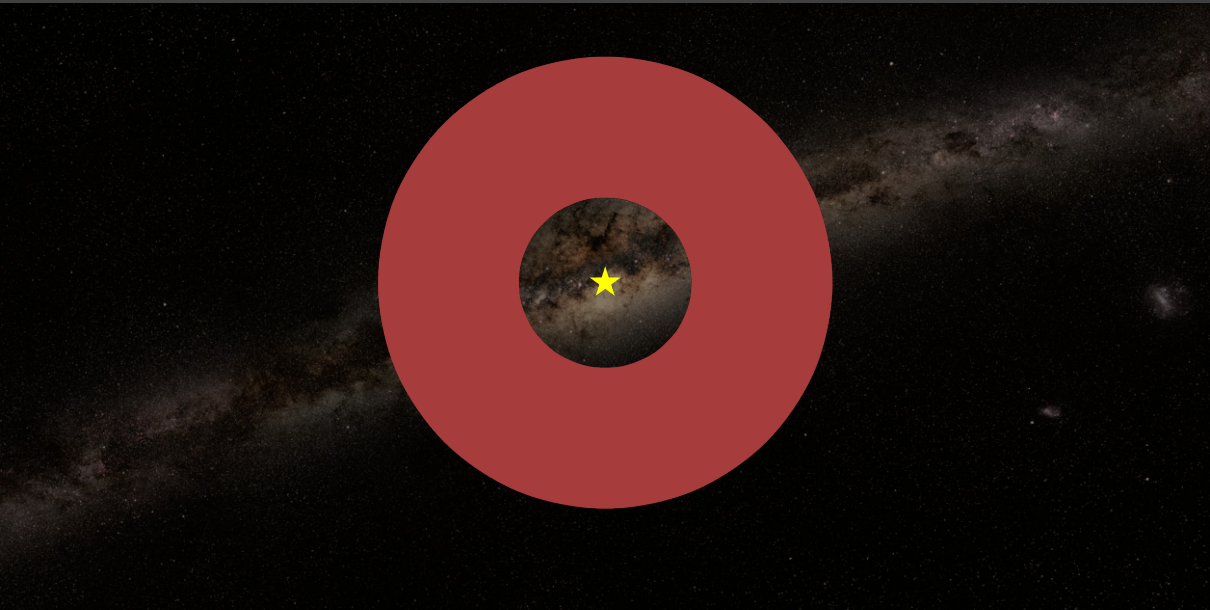

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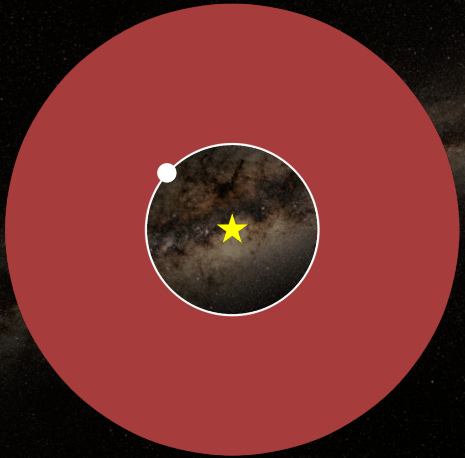
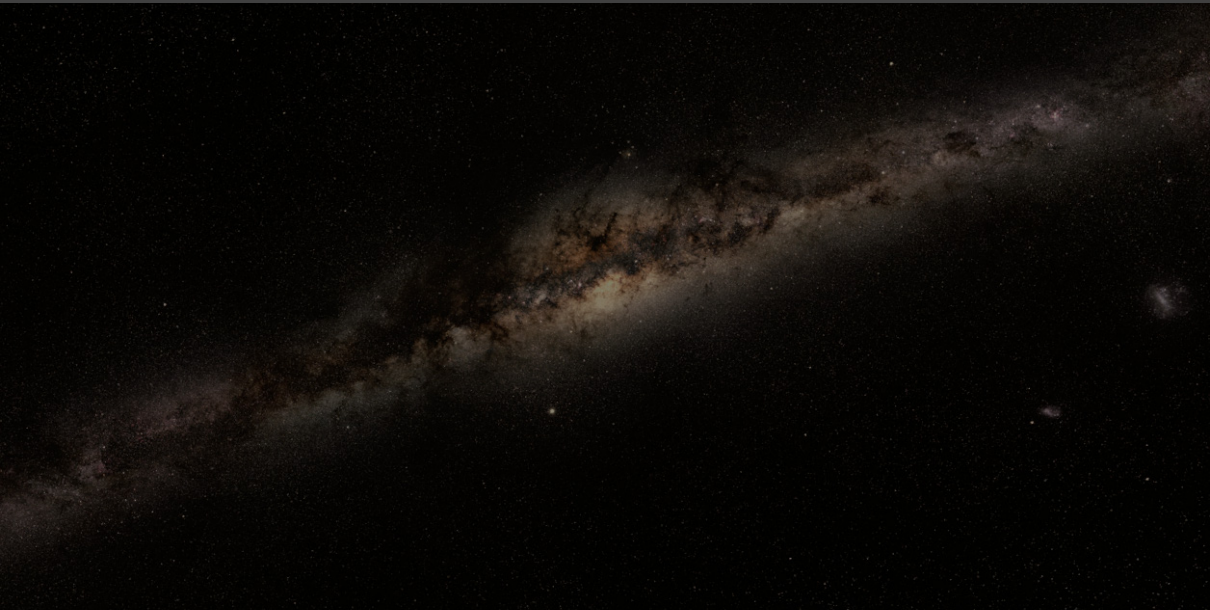


1. Planets would truncate discs

E.g. Wisdom 1980; Quillen 2006; Chiang et al. 2009; Mustill & Wyatt 2012; Faramaz et al. 2014; Pearce & Wyatt 2014; Pearce et al. 2024

2. Planets would sharpen disc edges



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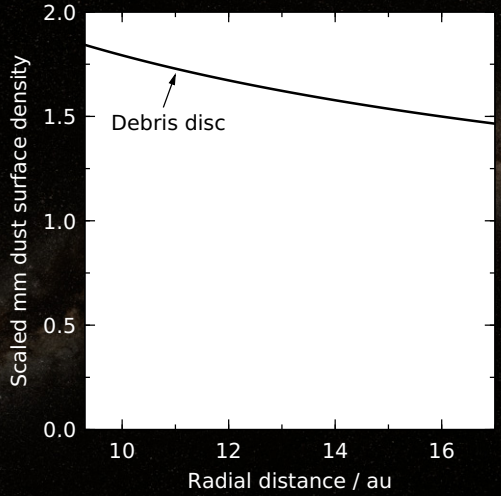

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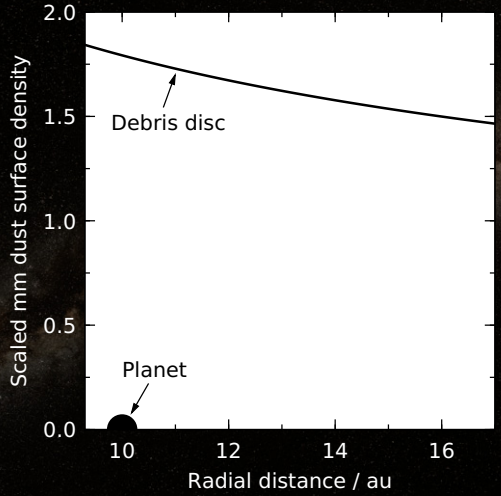

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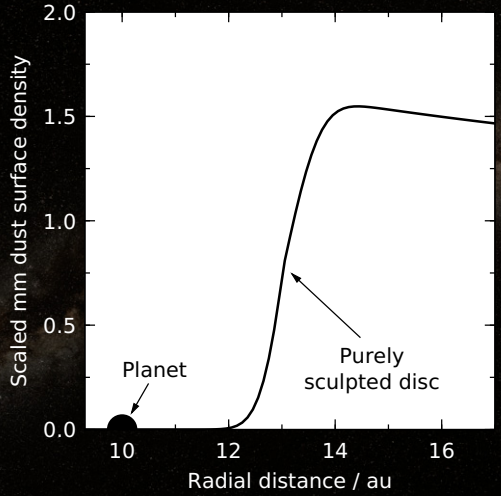

Pearce et al. 2024

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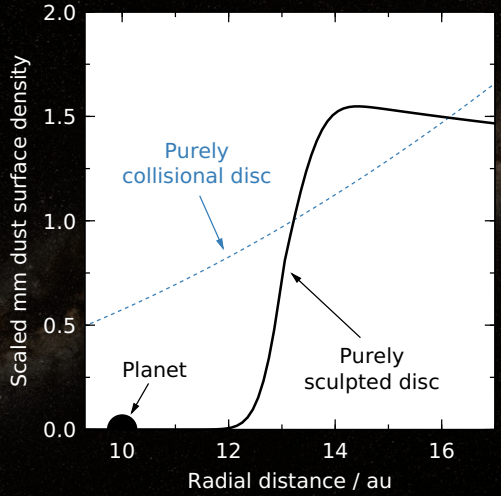

Pearce et al. 2024

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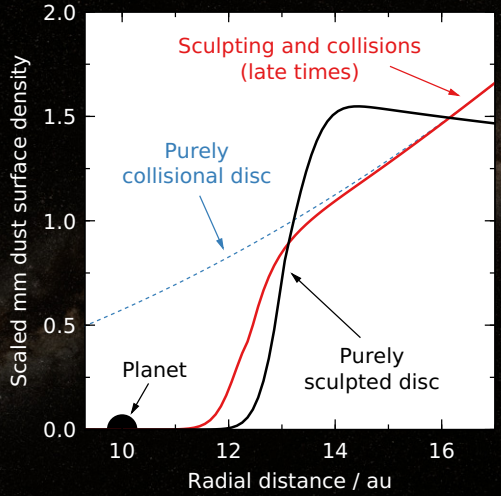

Pearce et al. 2024

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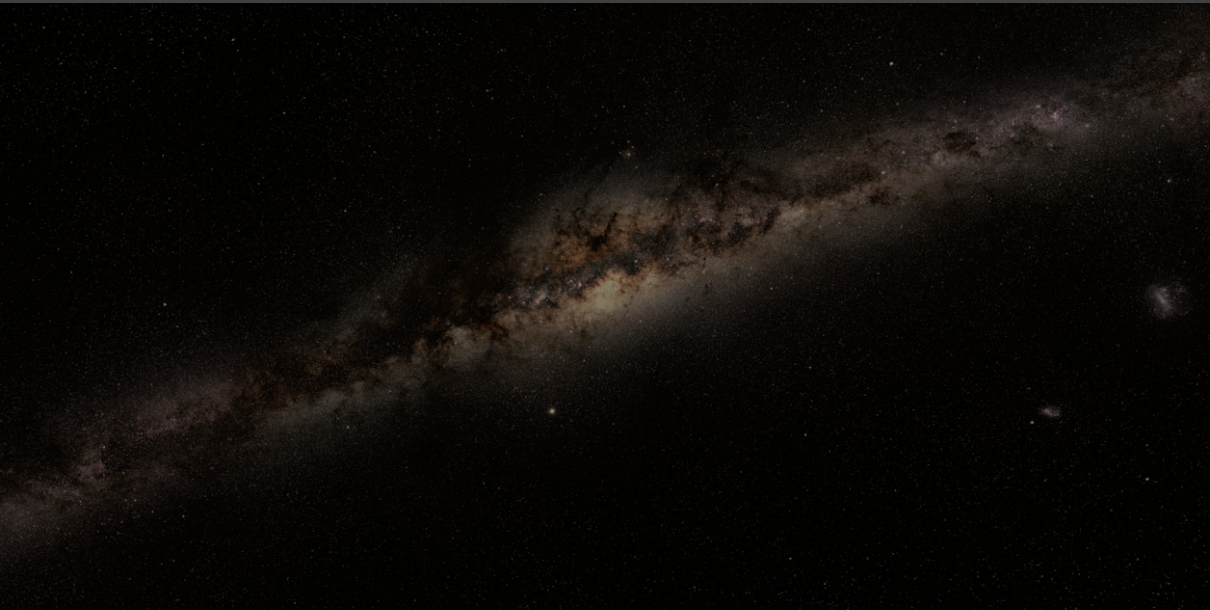

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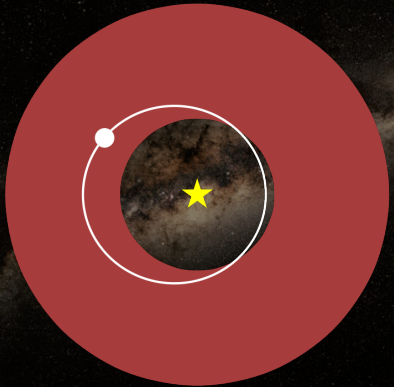

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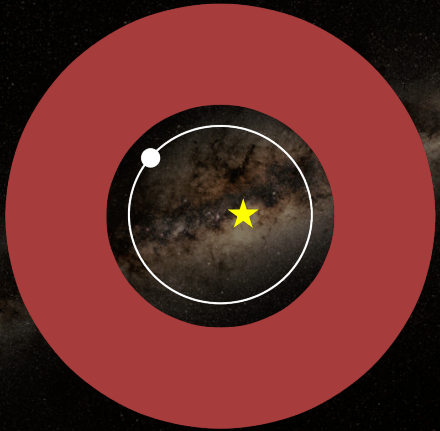
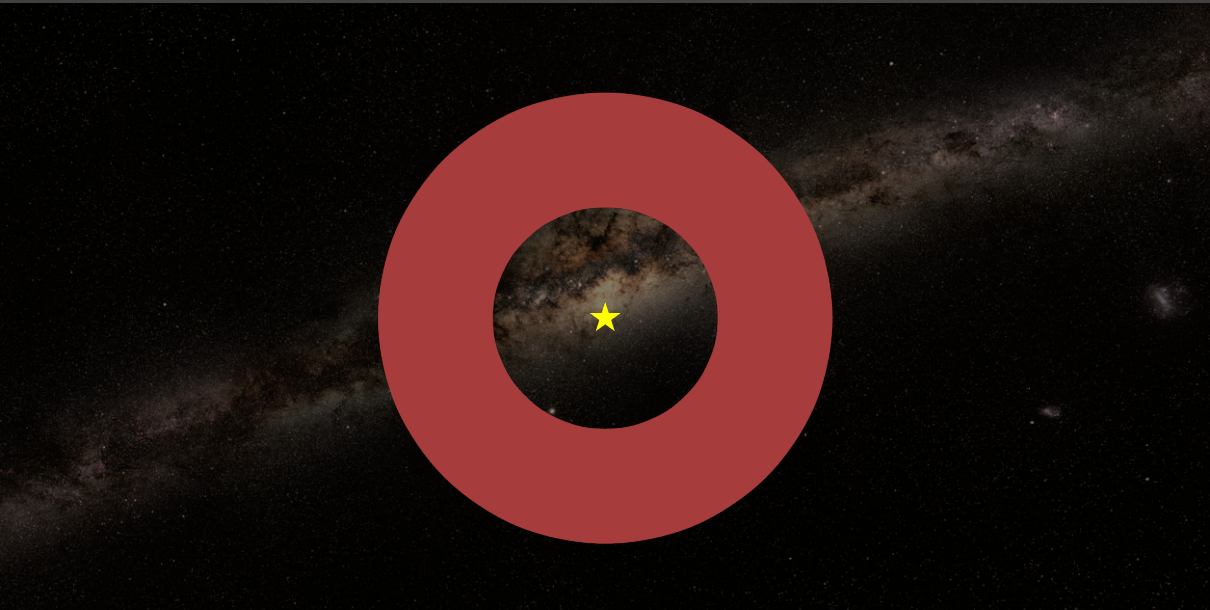


E.g. Faramaz et al. 2014; Pearce & Wyatt 2014

4. Planets would stir discs



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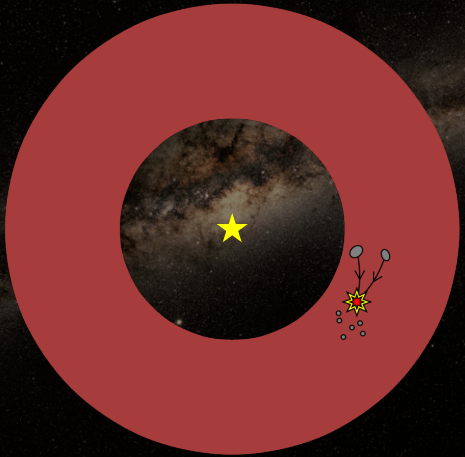
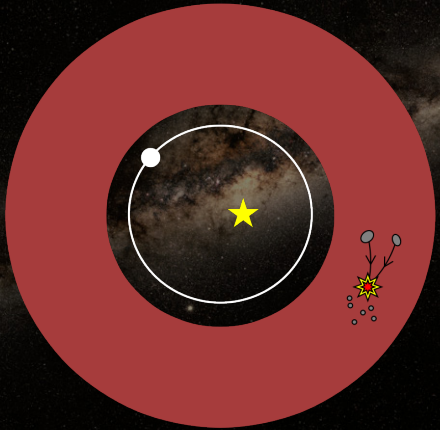


4. Planets would stir discs

"Secular stirring"



Mustill & Wyatt 2009

4. Planets would stir discs

"Projectile stirring"

Costa, Pearce & Krivov 2024

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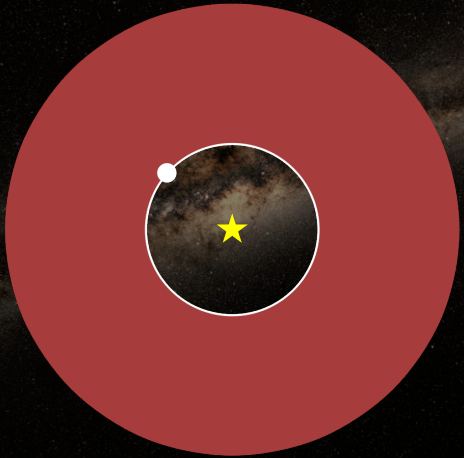

Costa, Pearce & Krivov 2024

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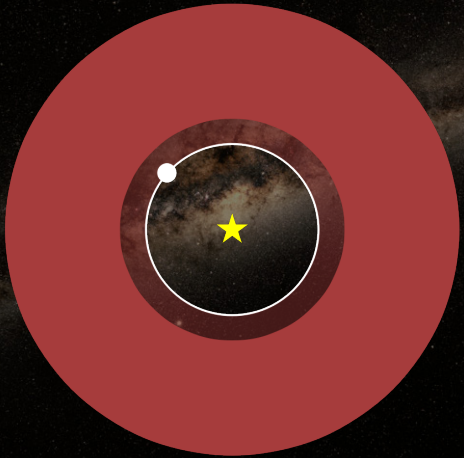

Costa, Pearce & Krivov 2024

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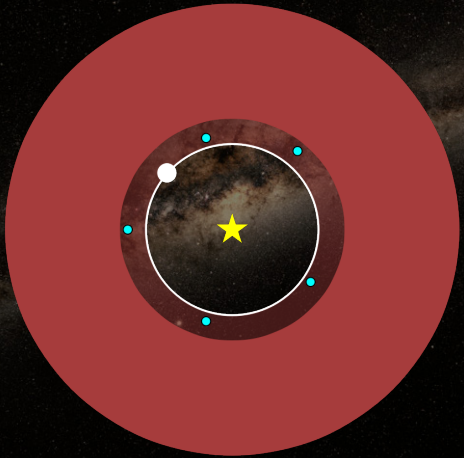

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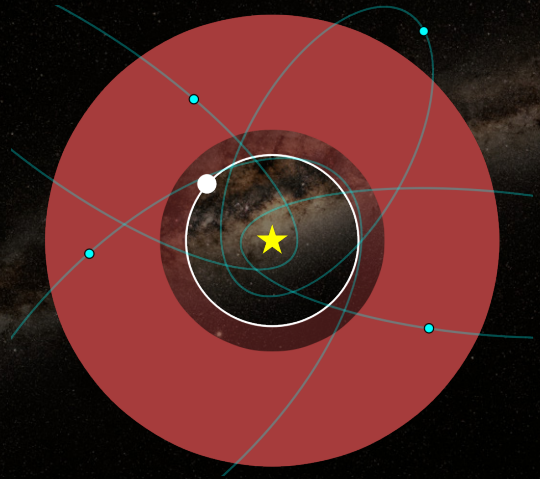

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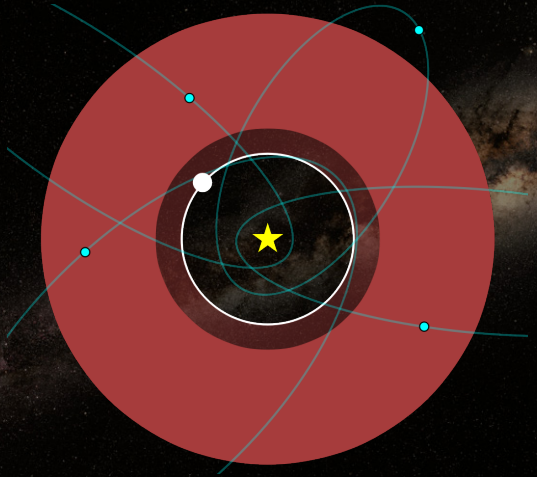

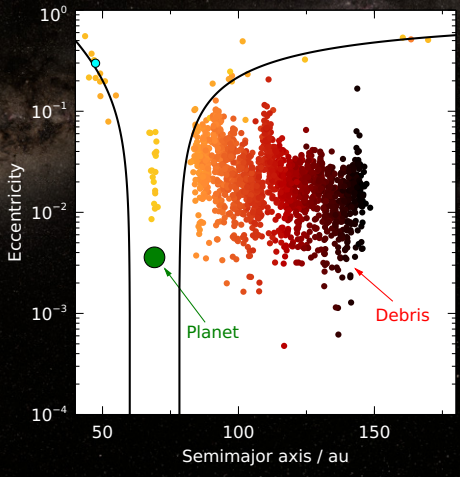

Costa, Pearce & Krivov 2024

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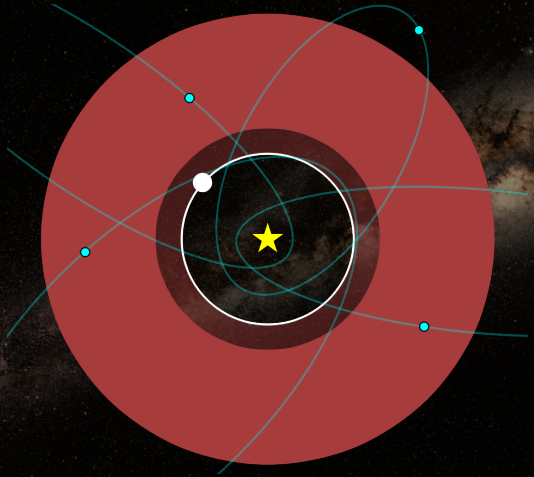
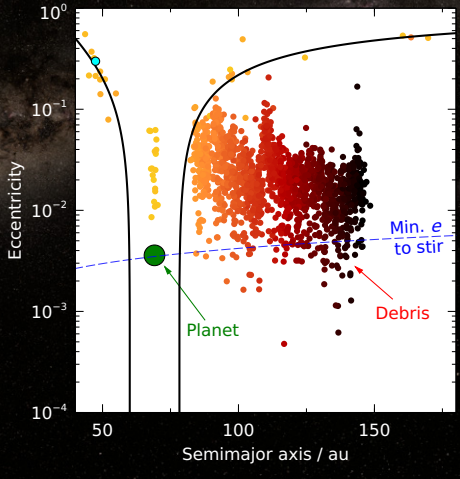
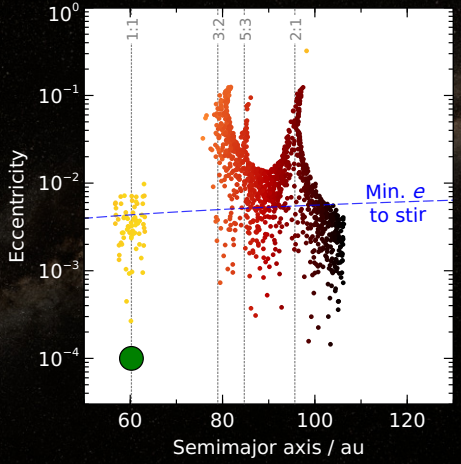




Costa, Pearce & Krivov 2024

4. Planets would stir discs

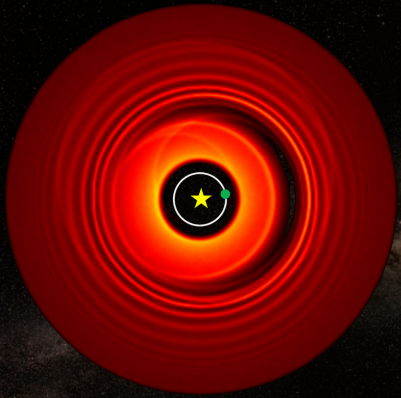
"Resonant stirring"



Costa, Pearce & Krivov 2024

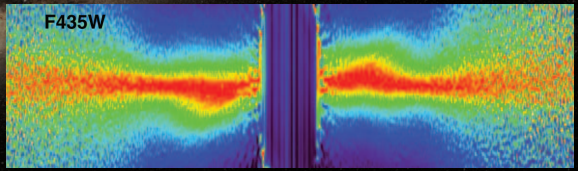
5. Planets may do other stuff too

Gaps and spirals:



Sefilian, Rafikov & Wyatt 2021

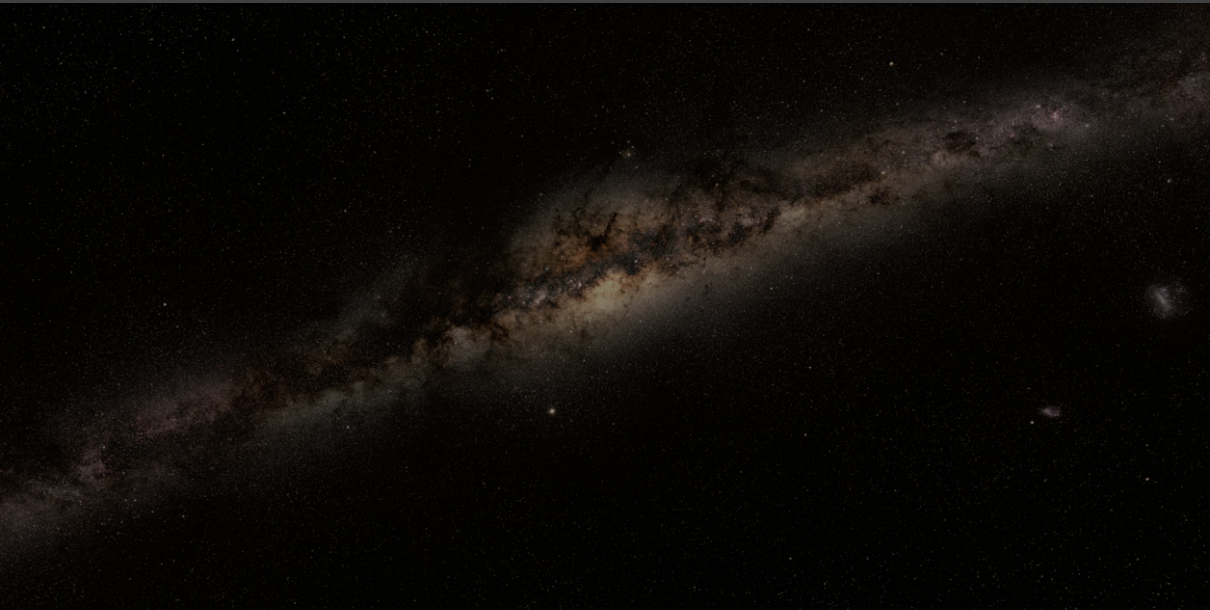
Warps:



Golimowski et al. 2006


But do planets *really* reside at debris-disc edges?

Problems



Problems

1. Disc edges are less steep than expected

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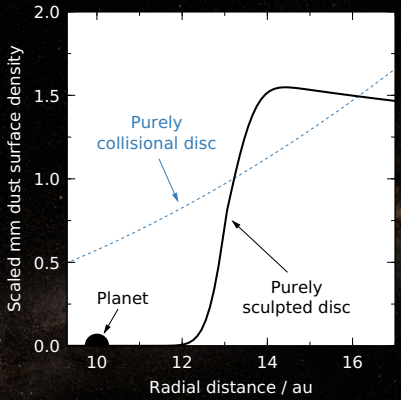

Pearce et al. 2024 (also Imaz Blanco et al. 2023)

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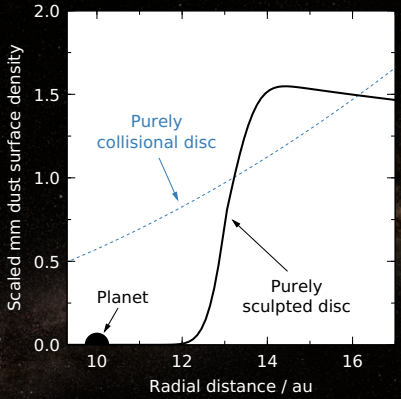

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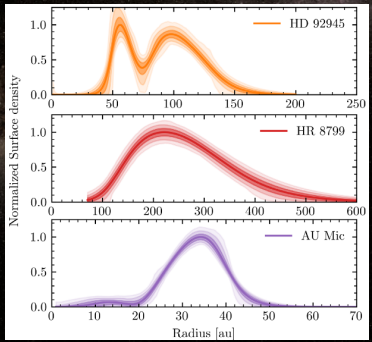

Marino 2021

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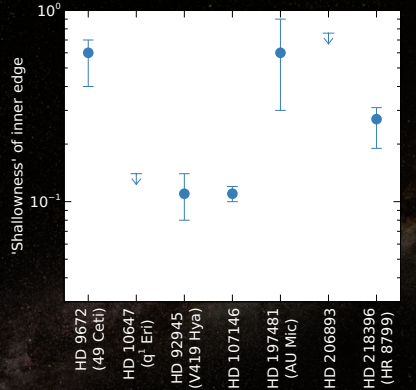

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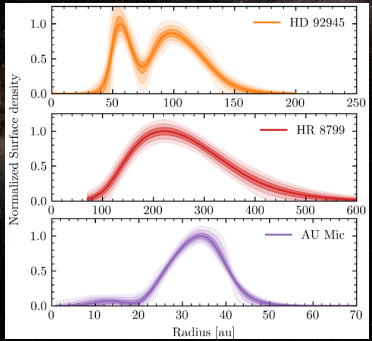

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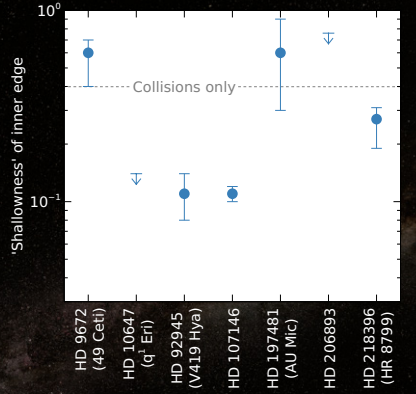

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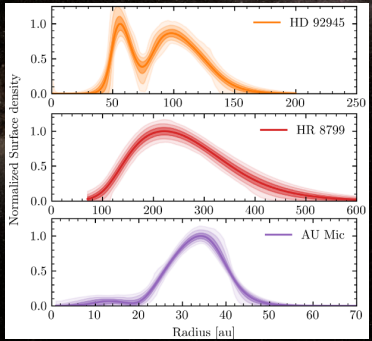

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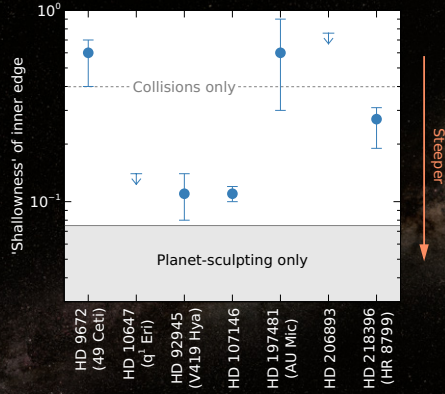

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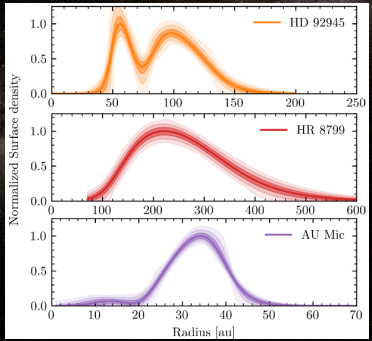

Marino 2021

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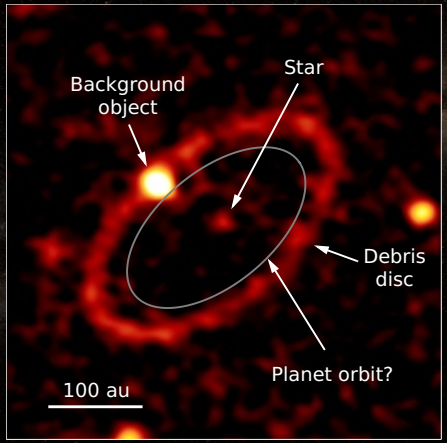

ALMA: Faramaz et al. 2019

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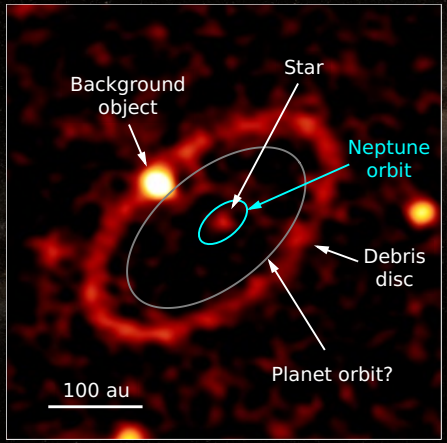

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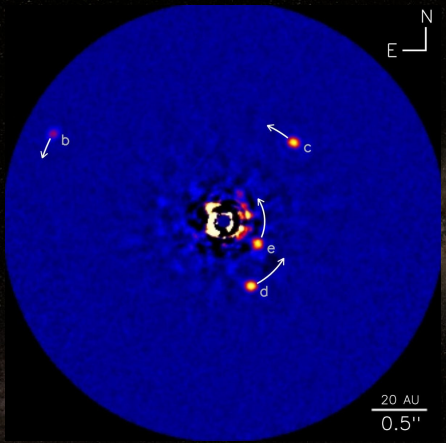

Marois et al. 2010

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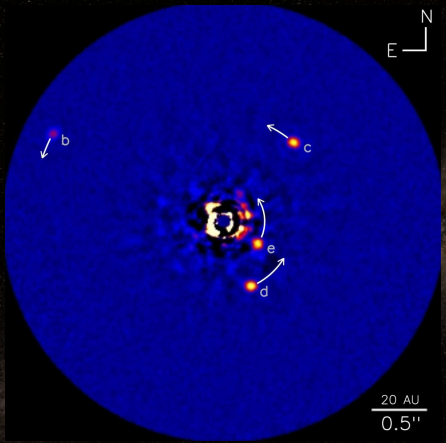
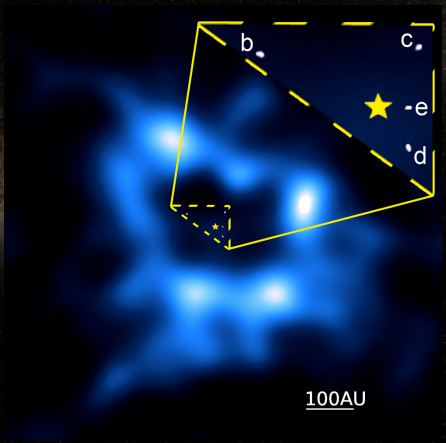


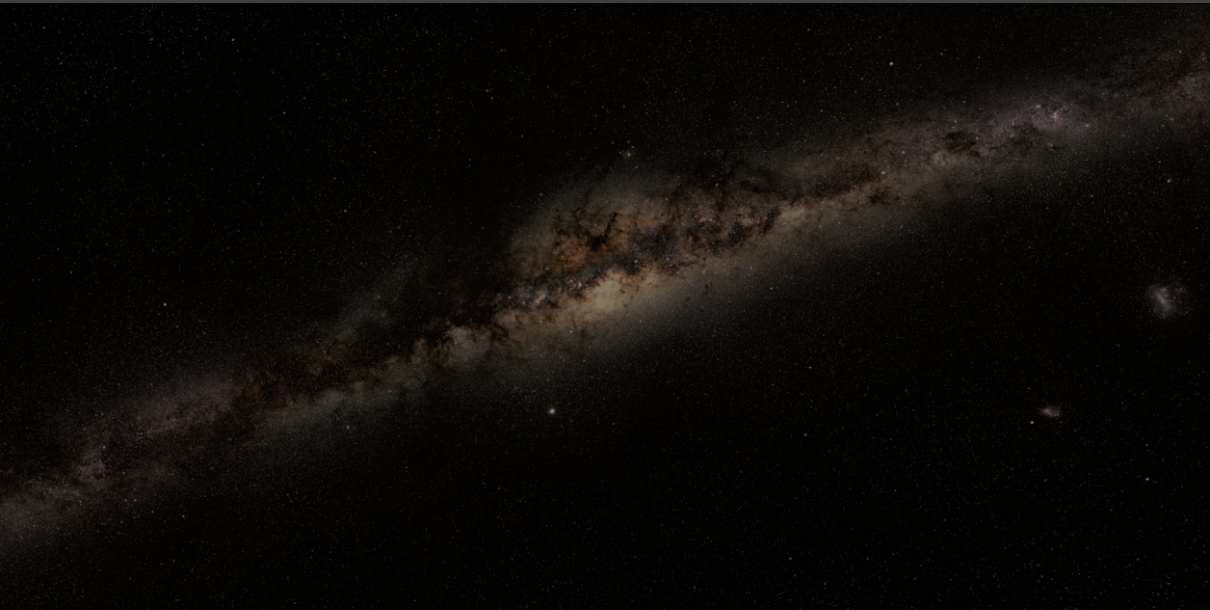
Marois et al. 2010



Booth et al. 2016


What if planets are *not* at debris-disc inner edges?

1. Maybe planets significantly migrate



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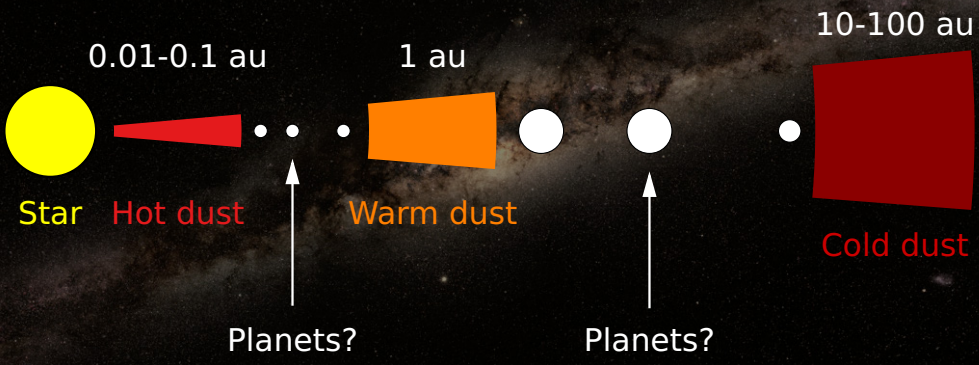

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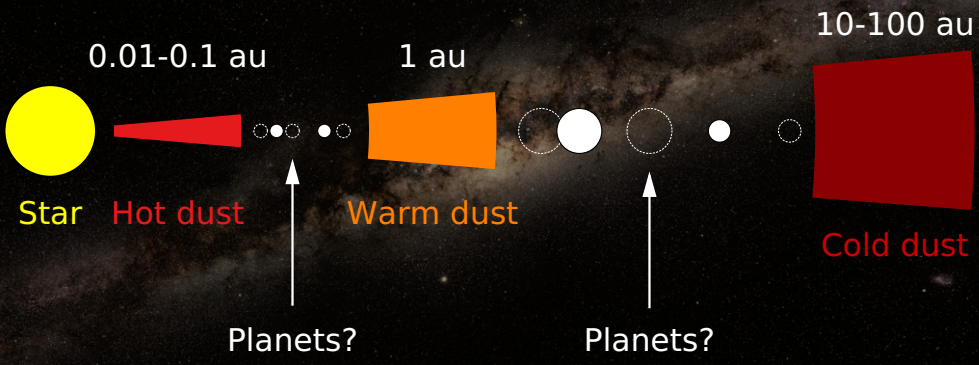

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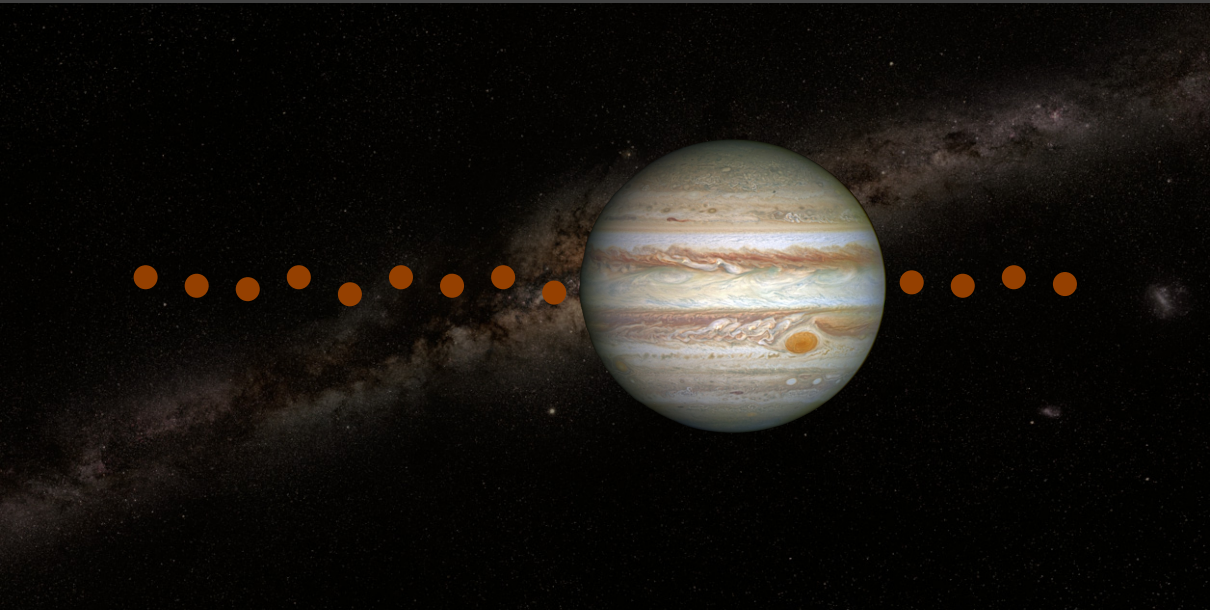

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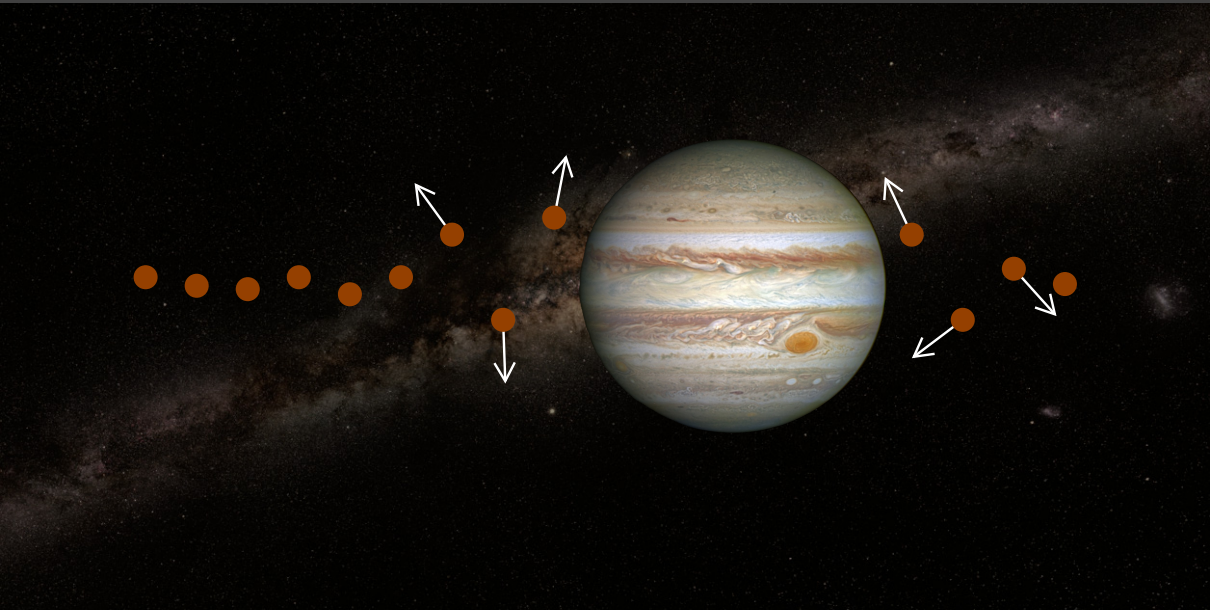

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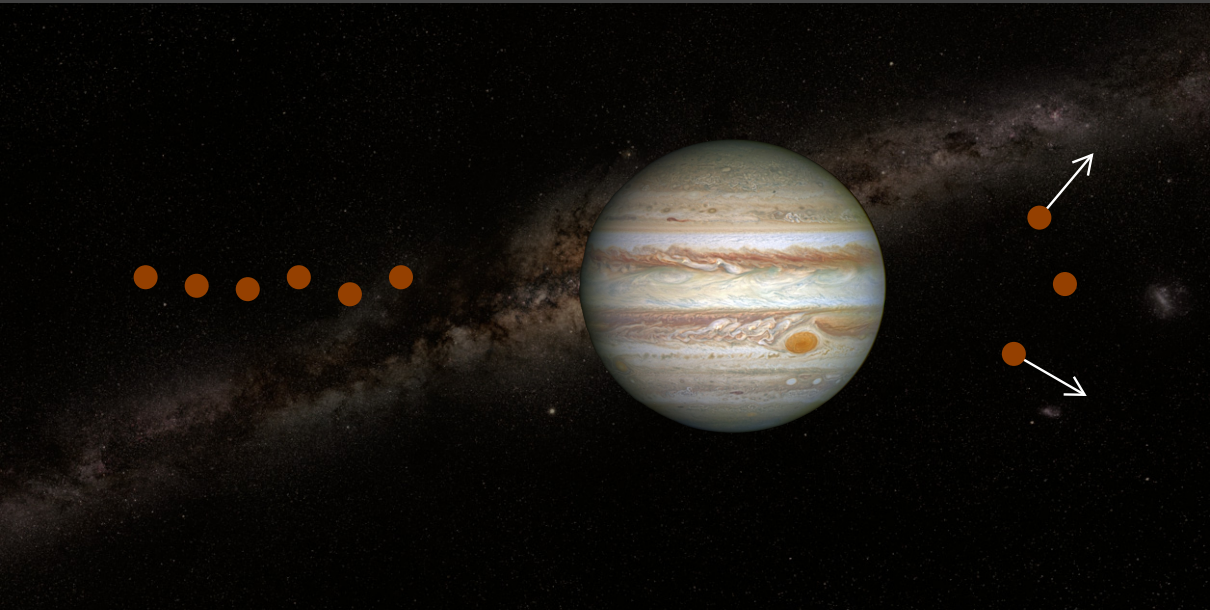

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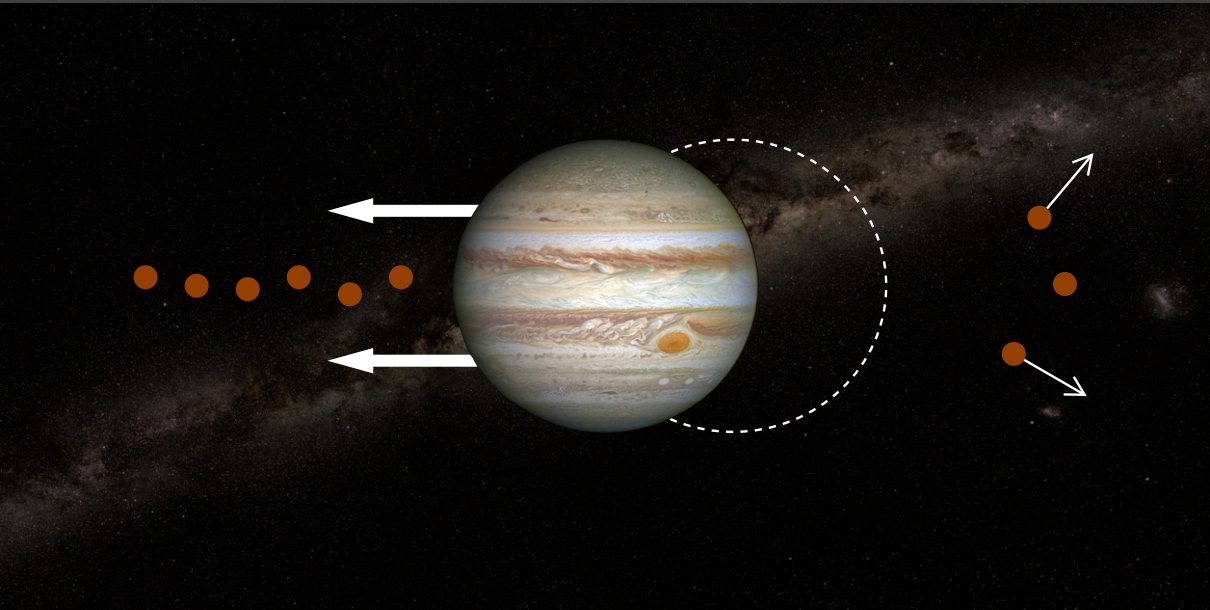

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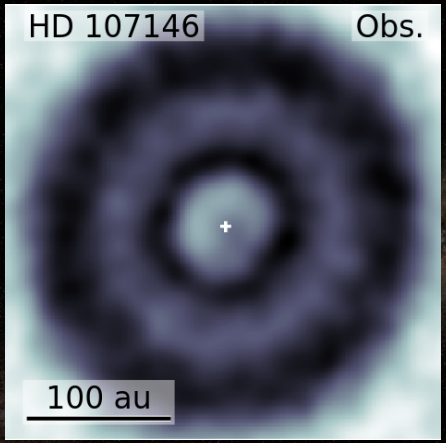
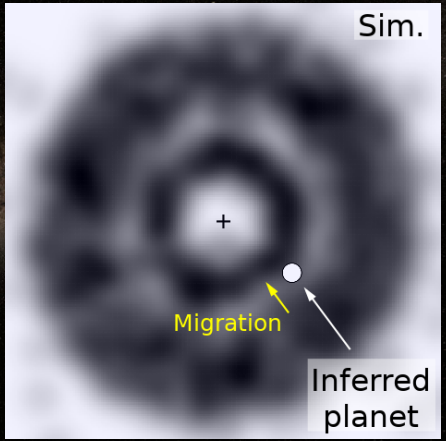


Marino et al. 2018



Friebe, Pearce & Löhne 2022

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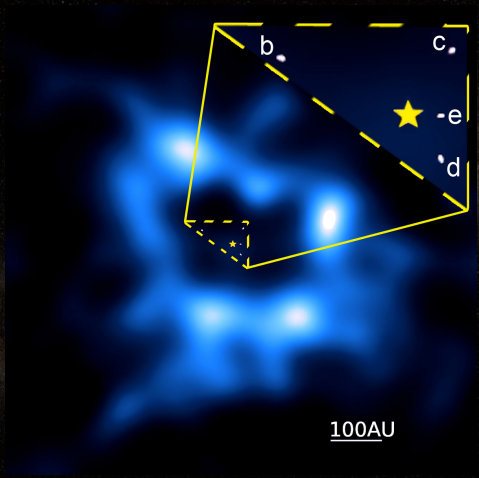

Booth et al. 2016

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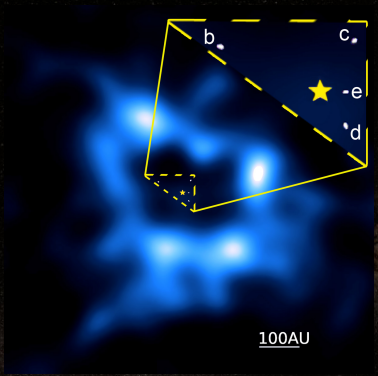
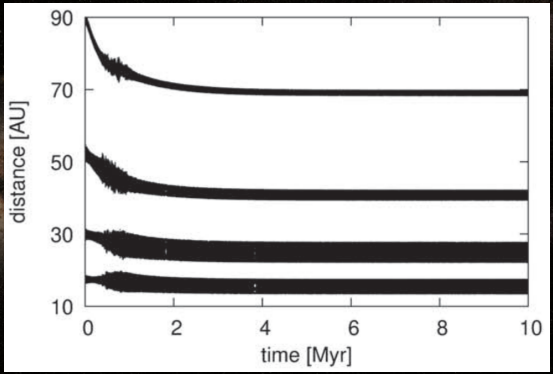


Booth et al. 2016



Goździewski & Migaszewski 2018

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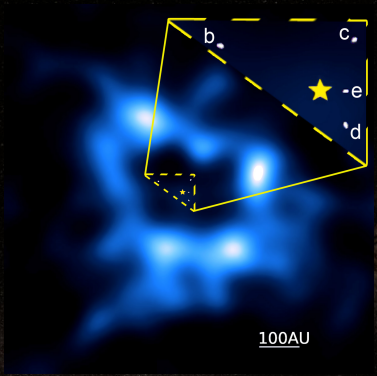

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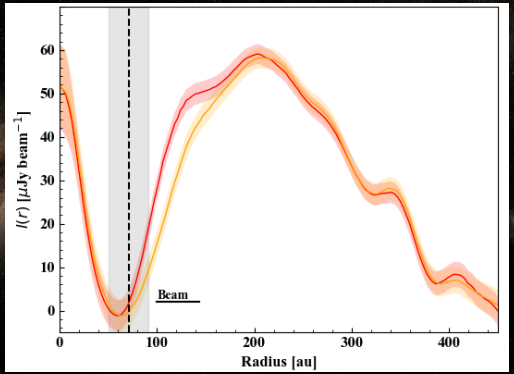

Faramaz et al. 2021

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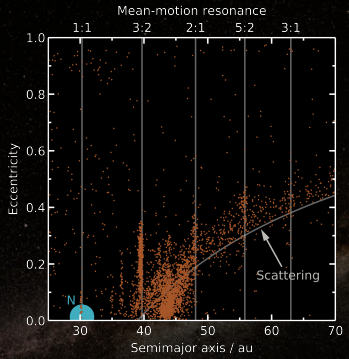

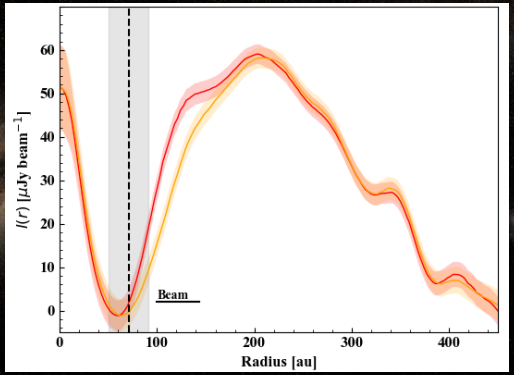

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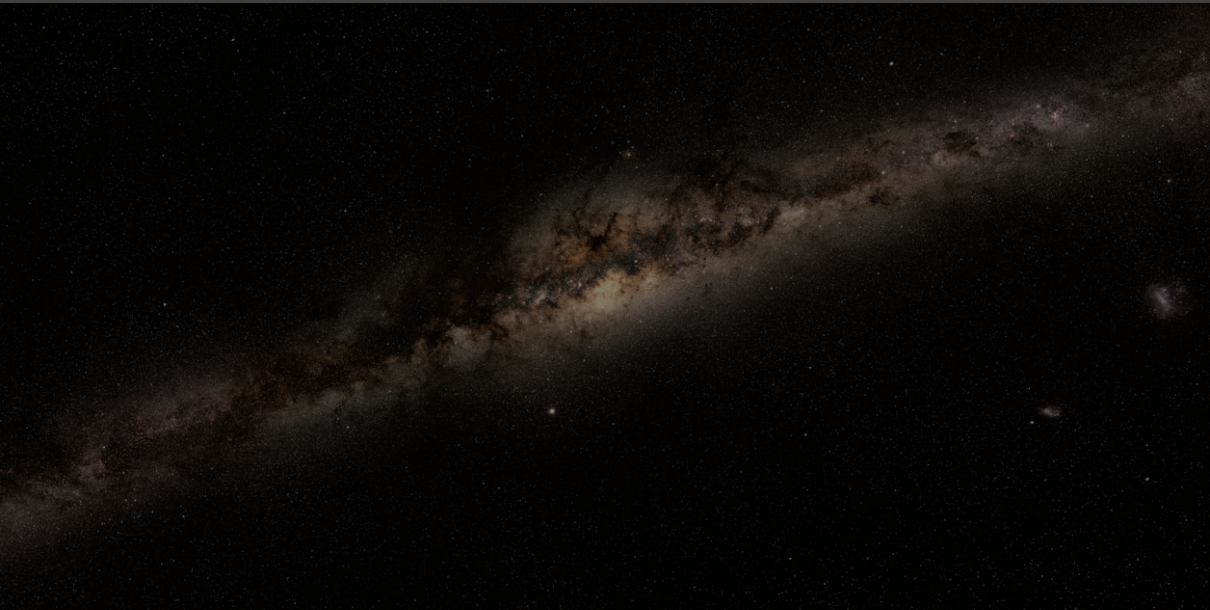
2. Something else stirs debris discs



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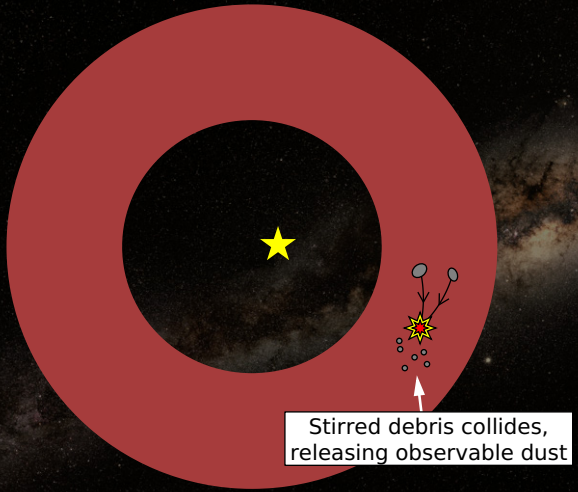

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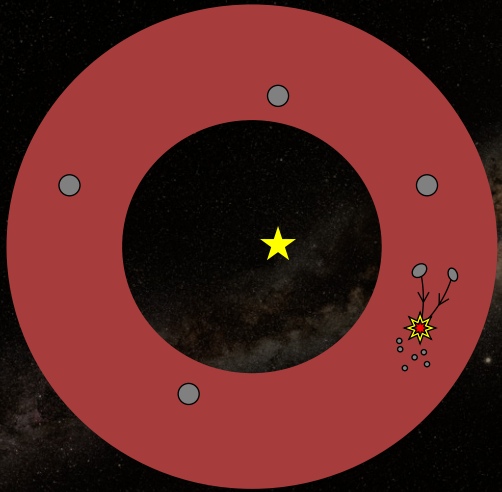

Other stirring mechanisms:

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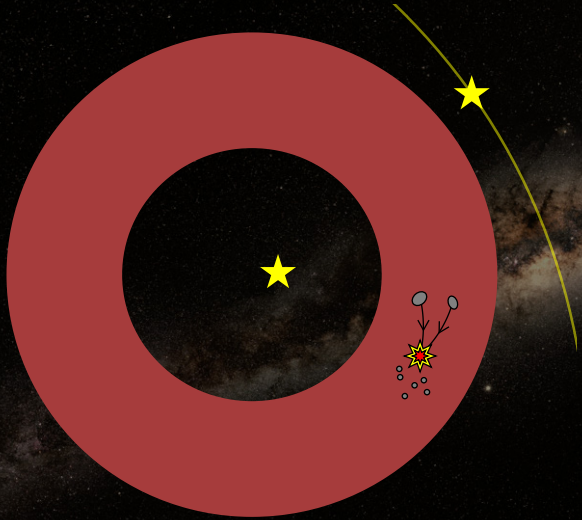

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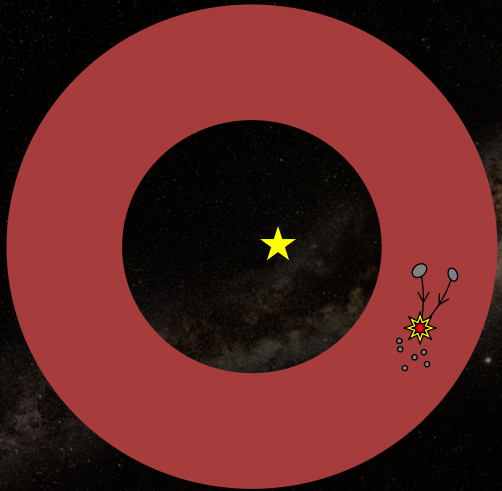

Other stirring mechanisms:

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- Pre stirring

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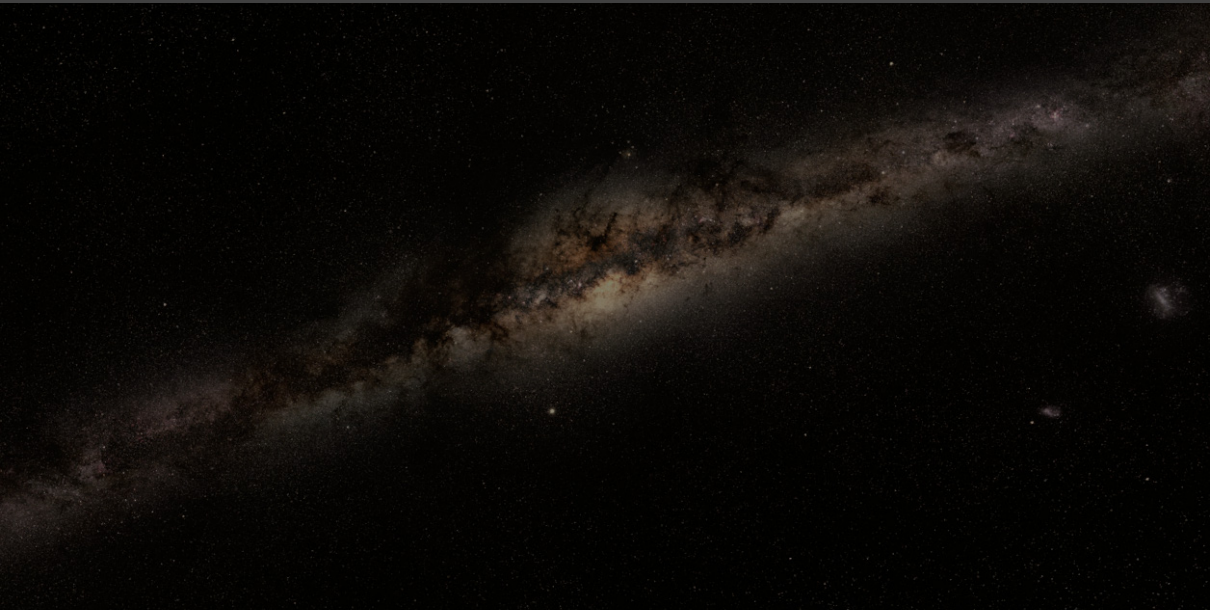

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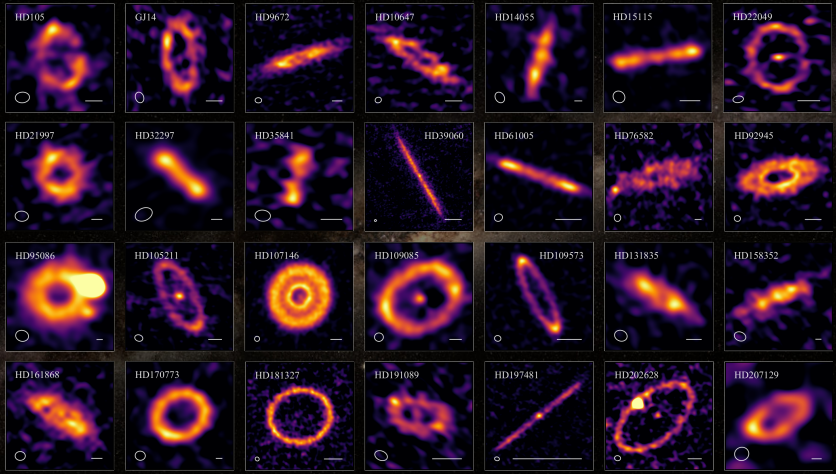

Matrà et al. in prep.

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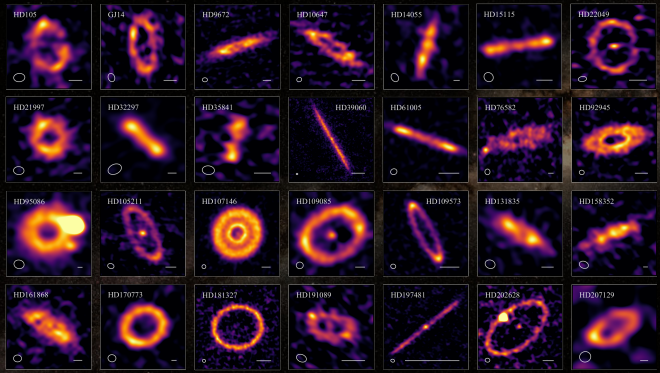

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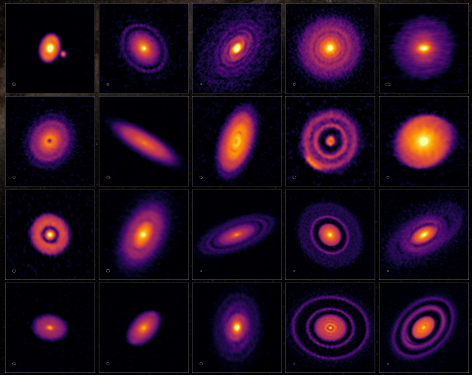
Protoplanetary discs:



Andrews et al. 2018

JWST will help

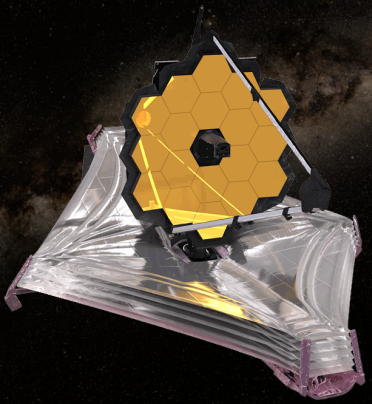


Image: NASA

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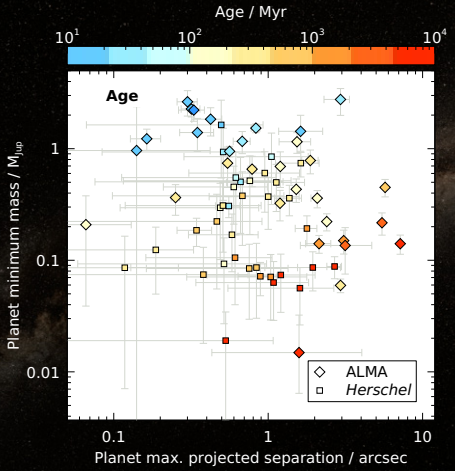

Inferred planets: Pearce et al. 2022

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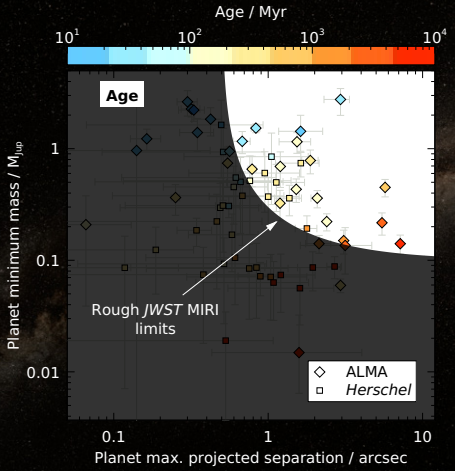

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Rough *JWST* curves based on Carter et al. 2021

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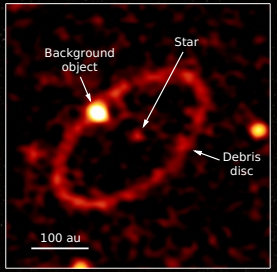

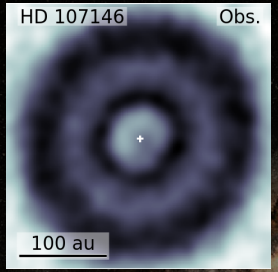

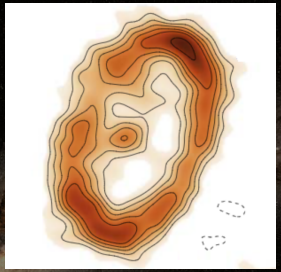

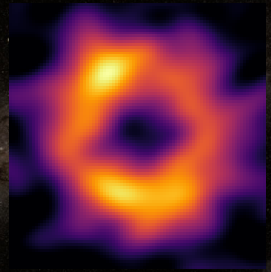

JWST GO programmes: 1668 (Marino), 2538 (Hinkley), 3973 (Pearce & Matthews)

ALMA images: Faramaz et al. 2019, Marino et al. 2018, MacGregor et al. 2022, Matrà et al. in prep.

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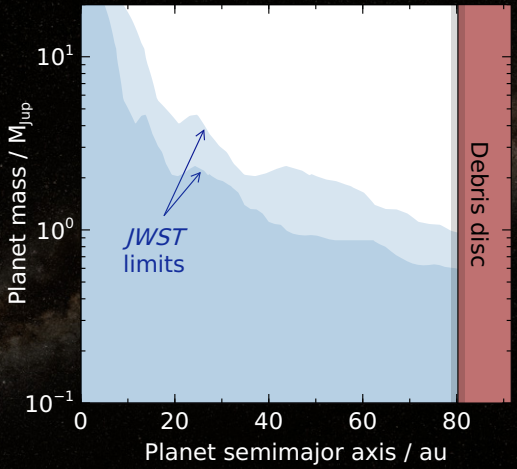
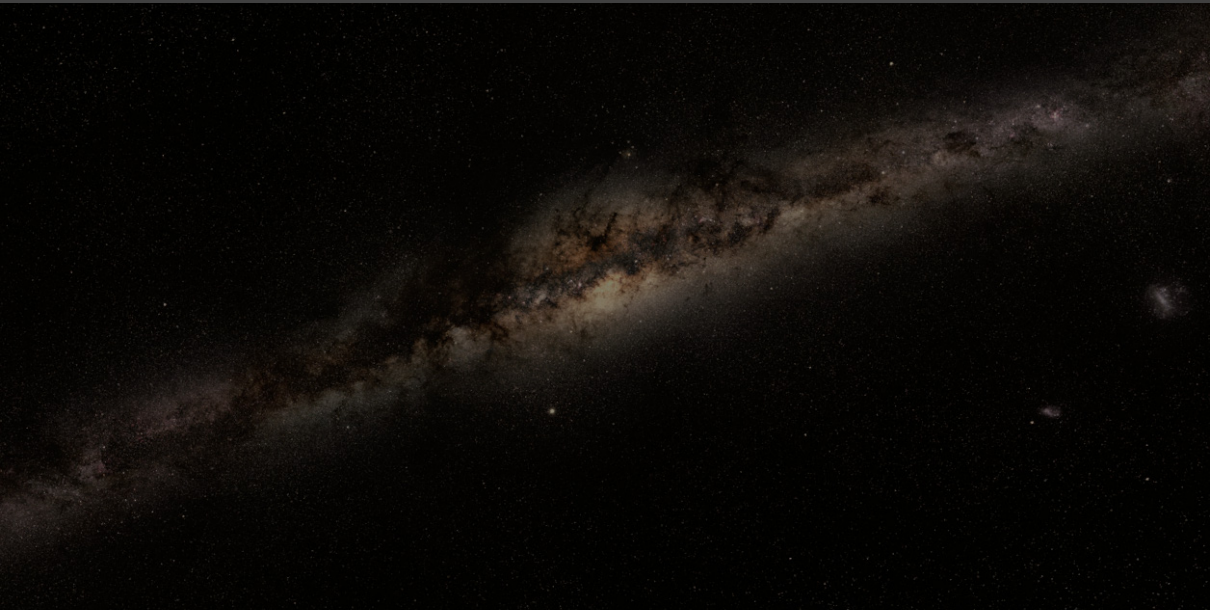


JWST GO 3973 (Pearce & Matthews)

Conclusions



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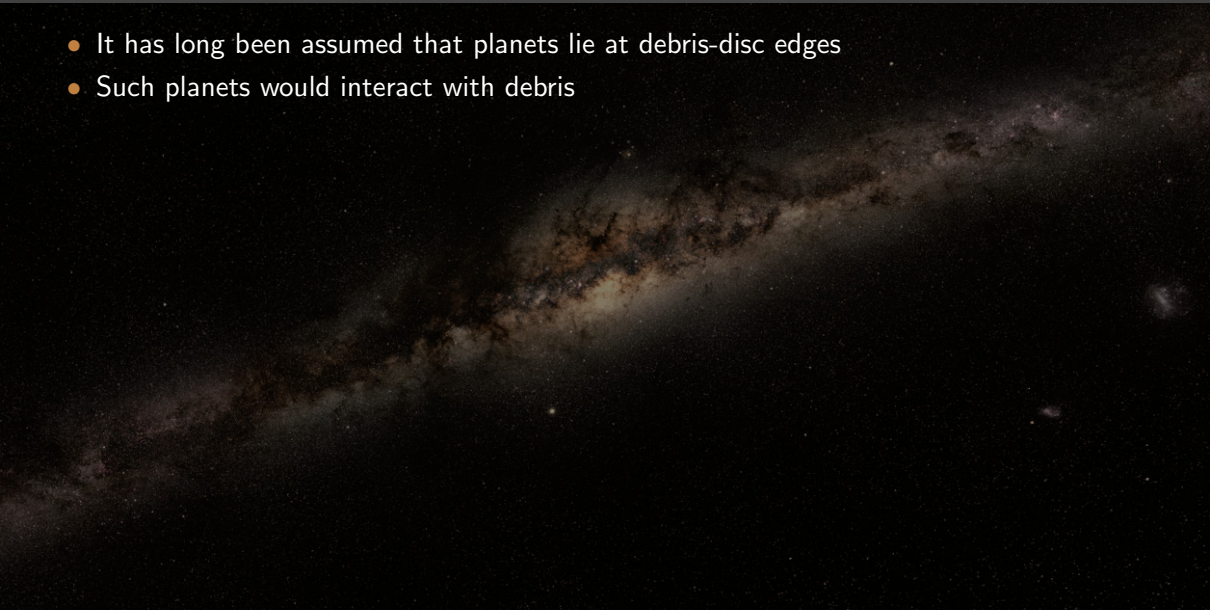

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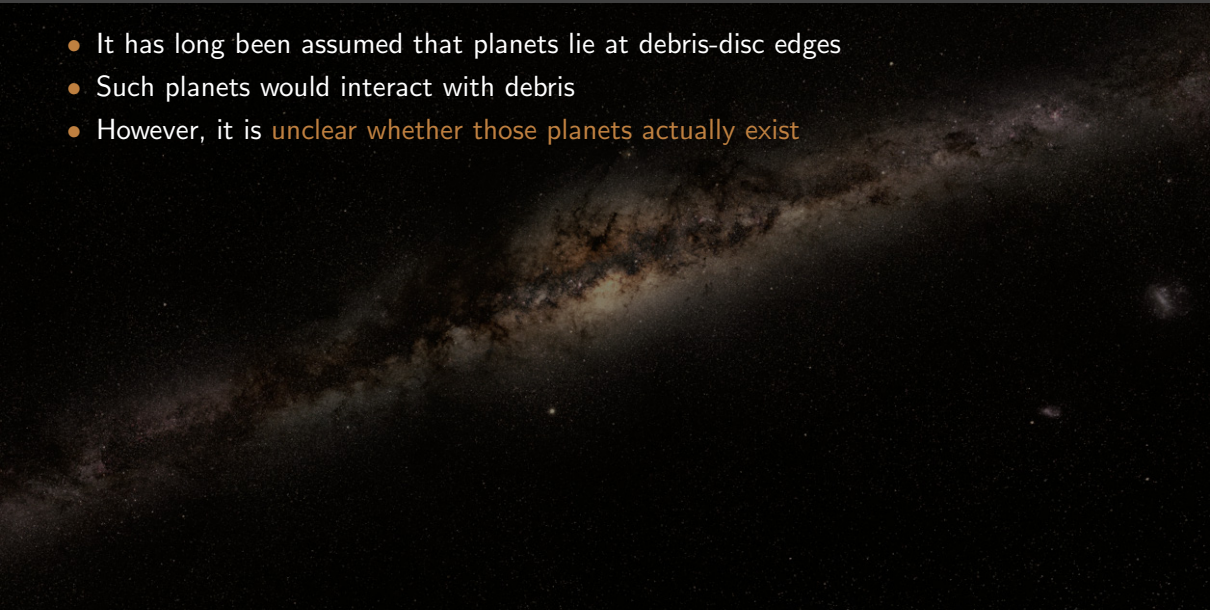

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Questions?

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