

Kuiper Belts around other stars

Tim Pearce



**UNIVERSITY
OF WARWICK**

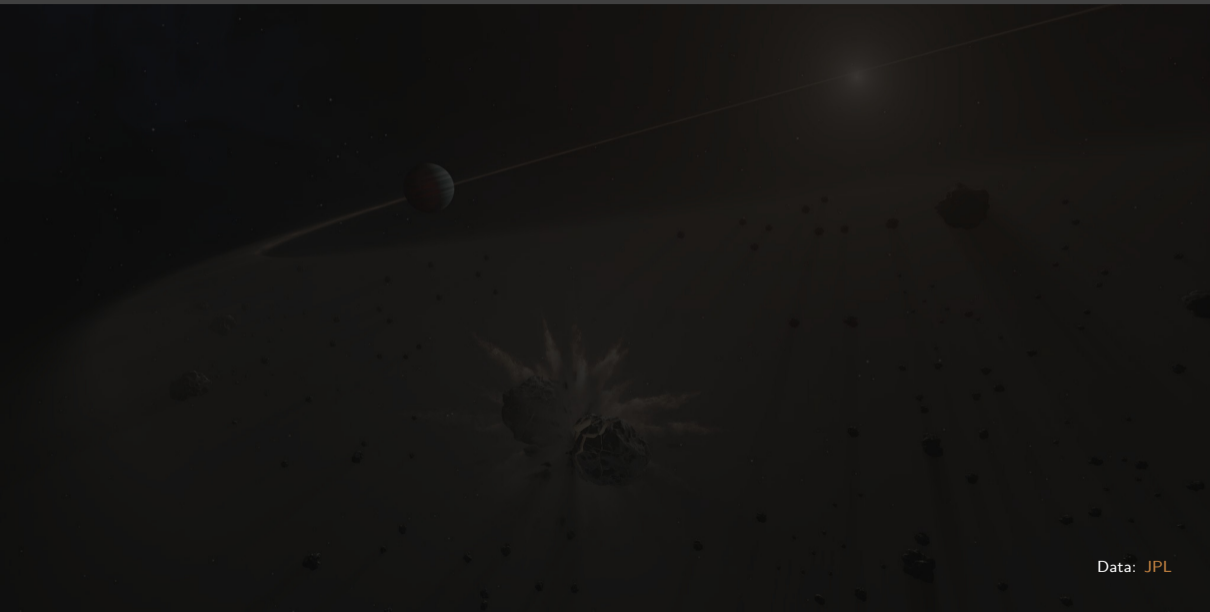
Stephen Hawking Fellow



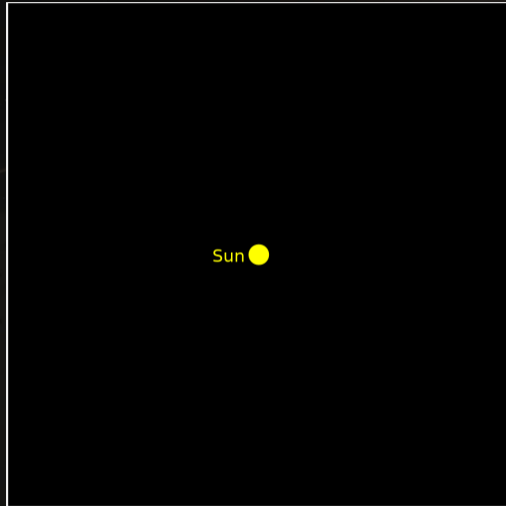
Science and
Technology
Facilities Council

Image: NASA/JPL-Caltech

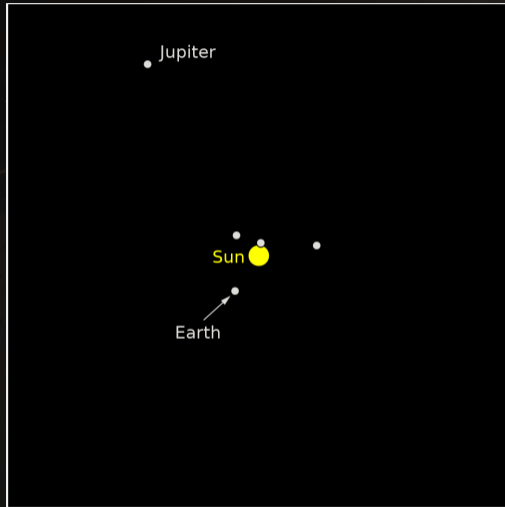
Solar System



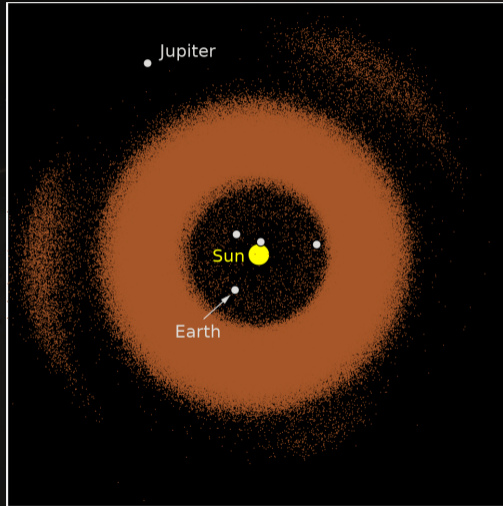
Solar System



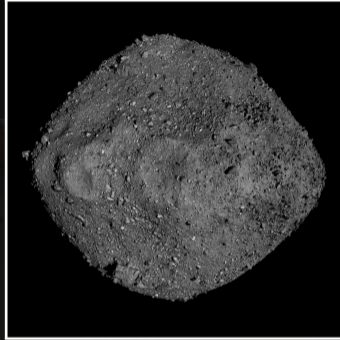
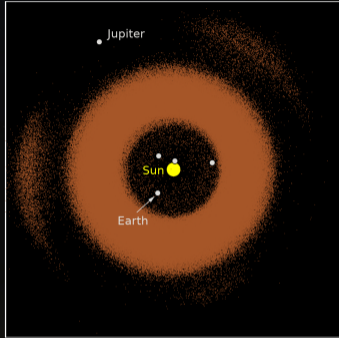
Solar System



Solar System

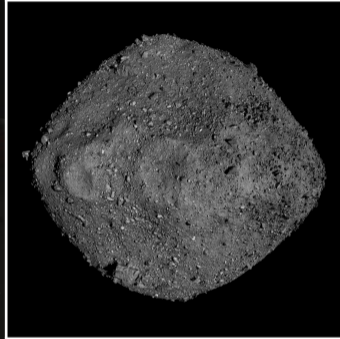
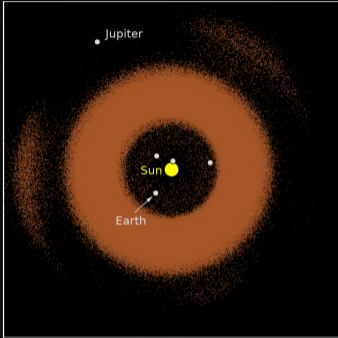


Solar System



Bennu

Solar System

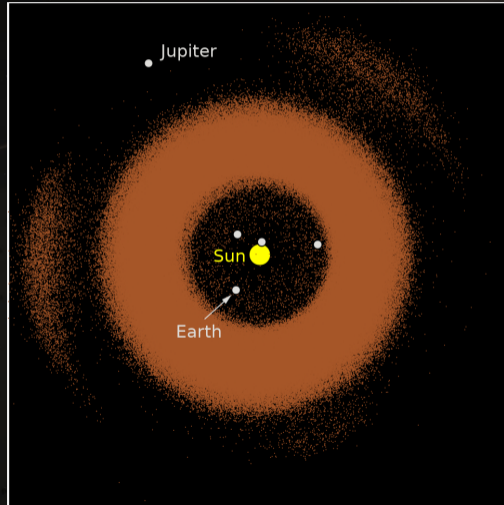


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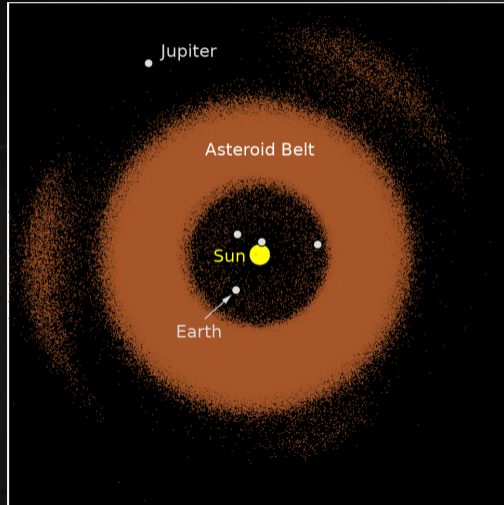


Ceres

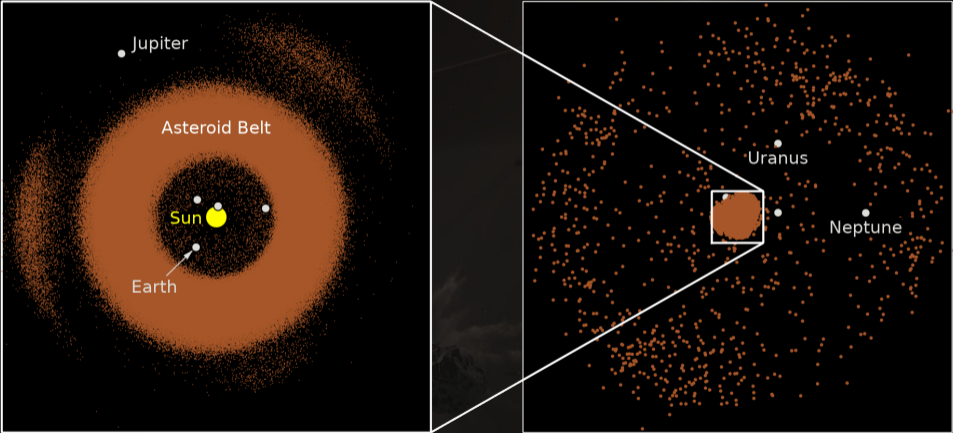
Solar System



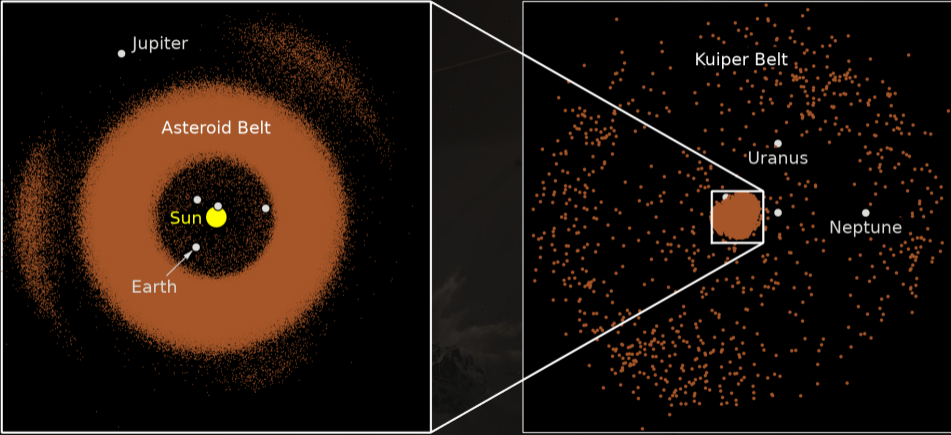
Solar System



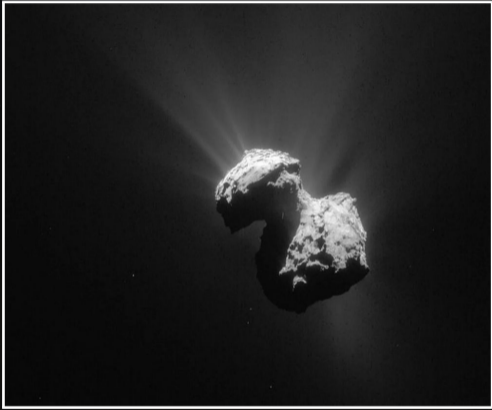
Solar System



Solar System

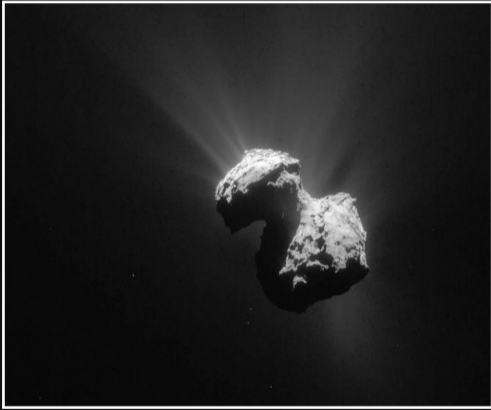


Solar System



Comet 67P / Churyumov-Gerasimenko

Solar System

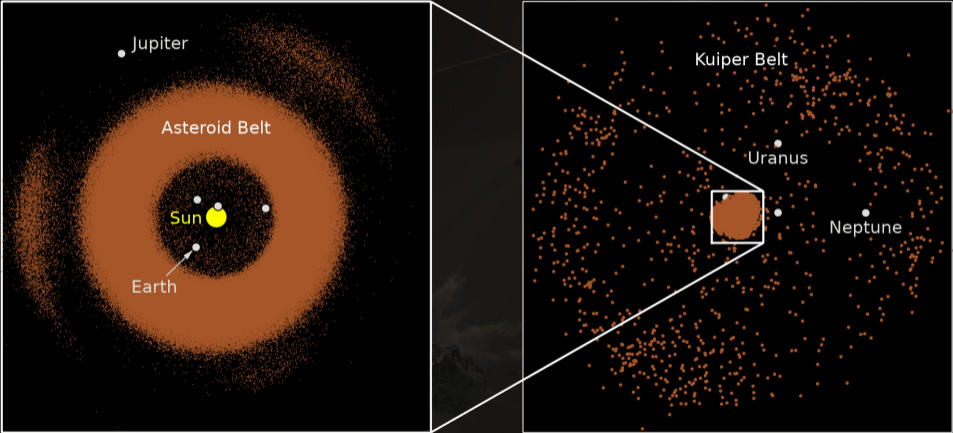


Comet 67P / Churyumov-Gerasimenko

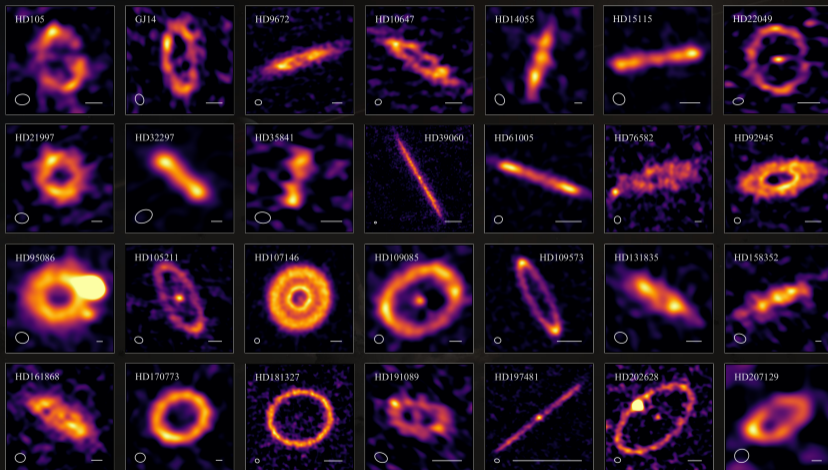


Pluto

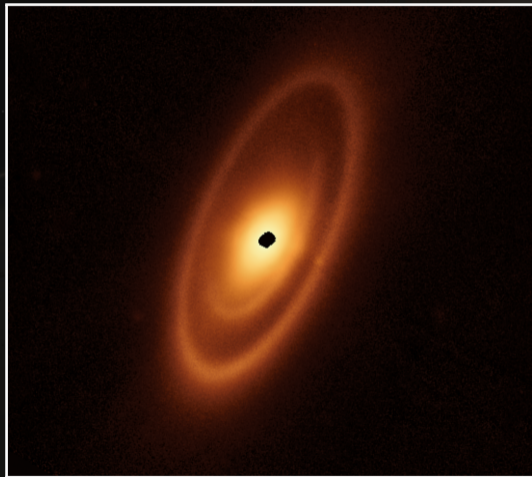
Solar System

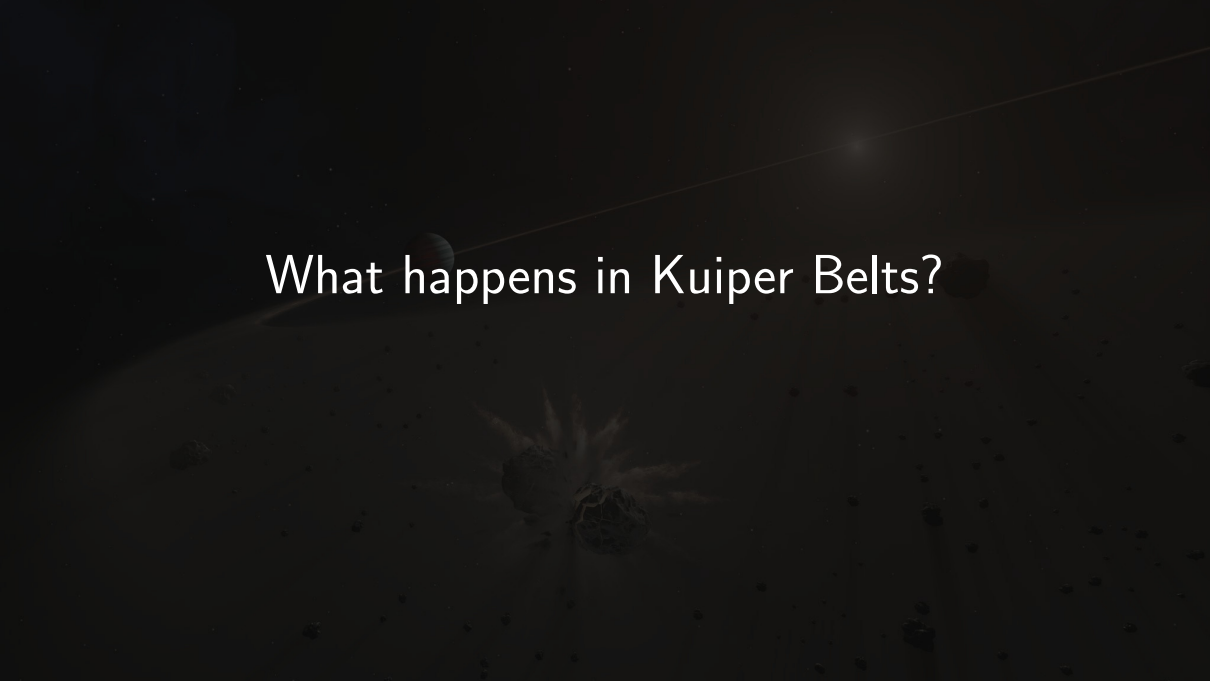


Extrasolar Kuiper Belts



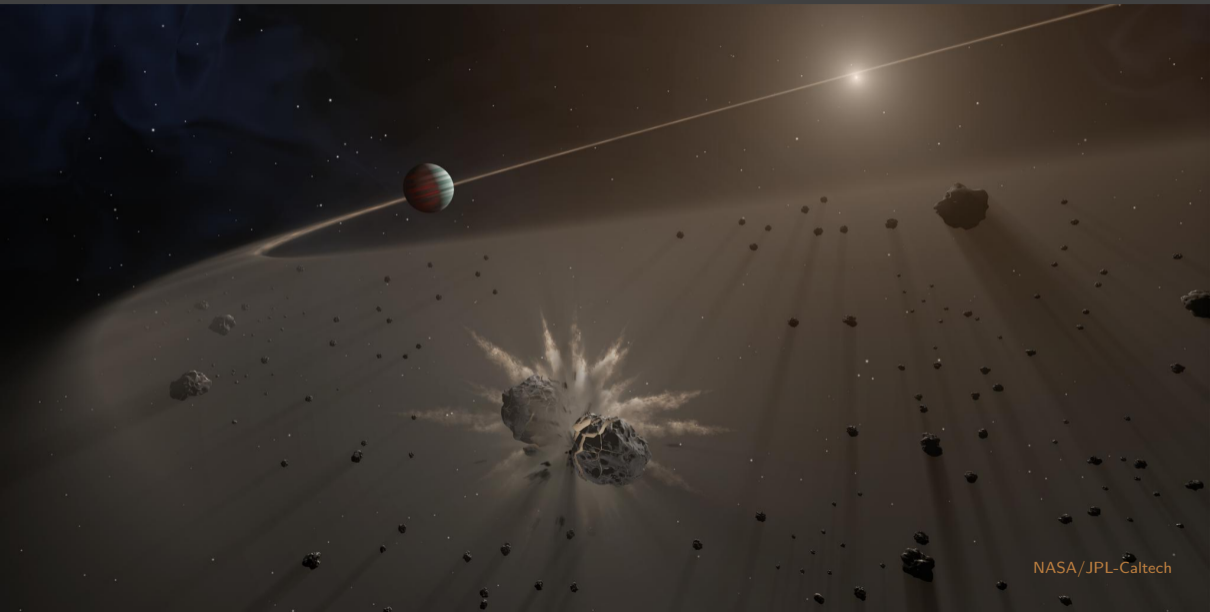
Extrasolar Kuiper Belts



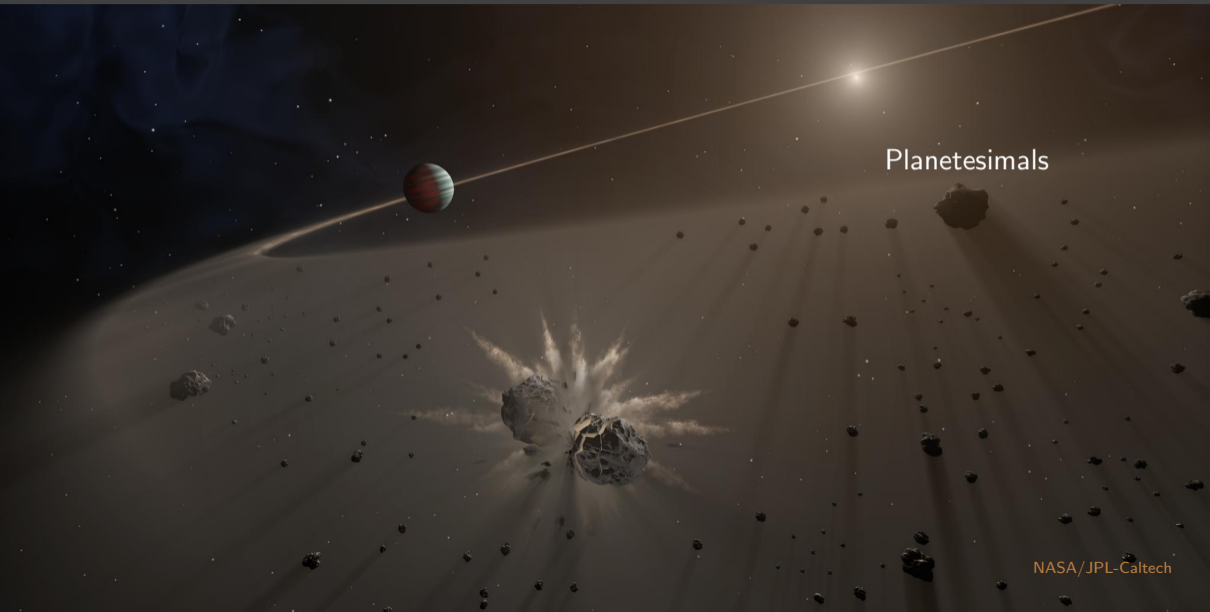
A dark space scene with a bright star in the upper right, a planet in the upper left, and a Kuiper Belt object in the lower center. The text "What happens in Kuiper Belts?" is centered in white.

What happens in Kuiper Belts?

What happens in Kuiper Belts?

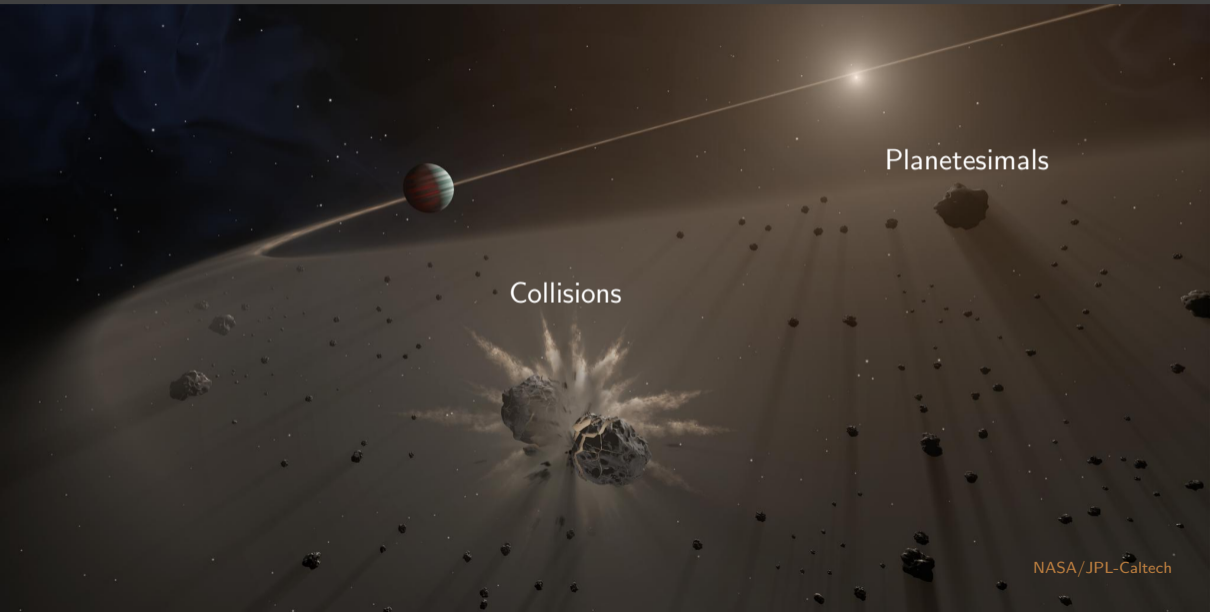


What happens in Kuiper Belts?



Planetesimals

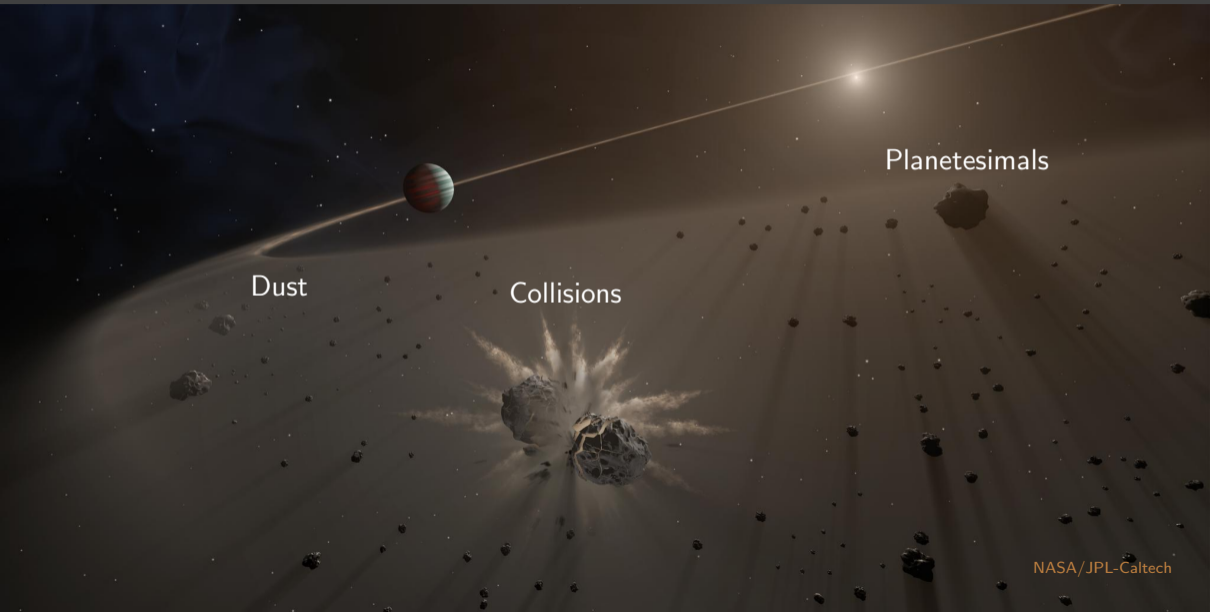
What happens in Kuiper Belts?



Planetesimals

Collisions

What happens in Kuiper Belts?

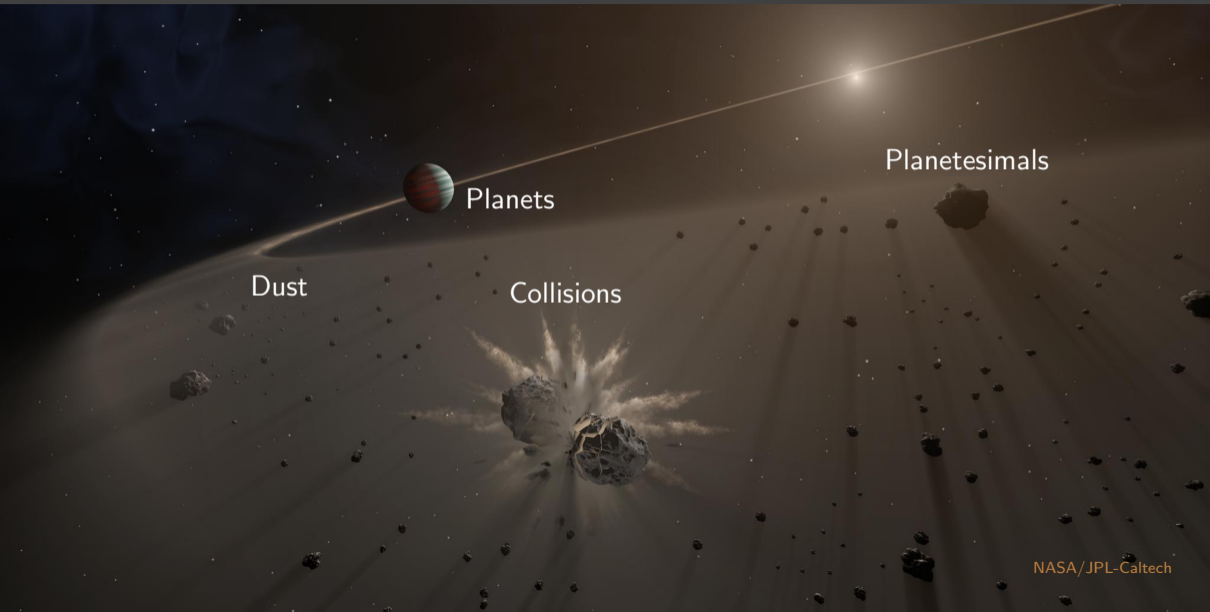


Dust

Collisions

Planetesimals

What happens in Kuiper Belts?



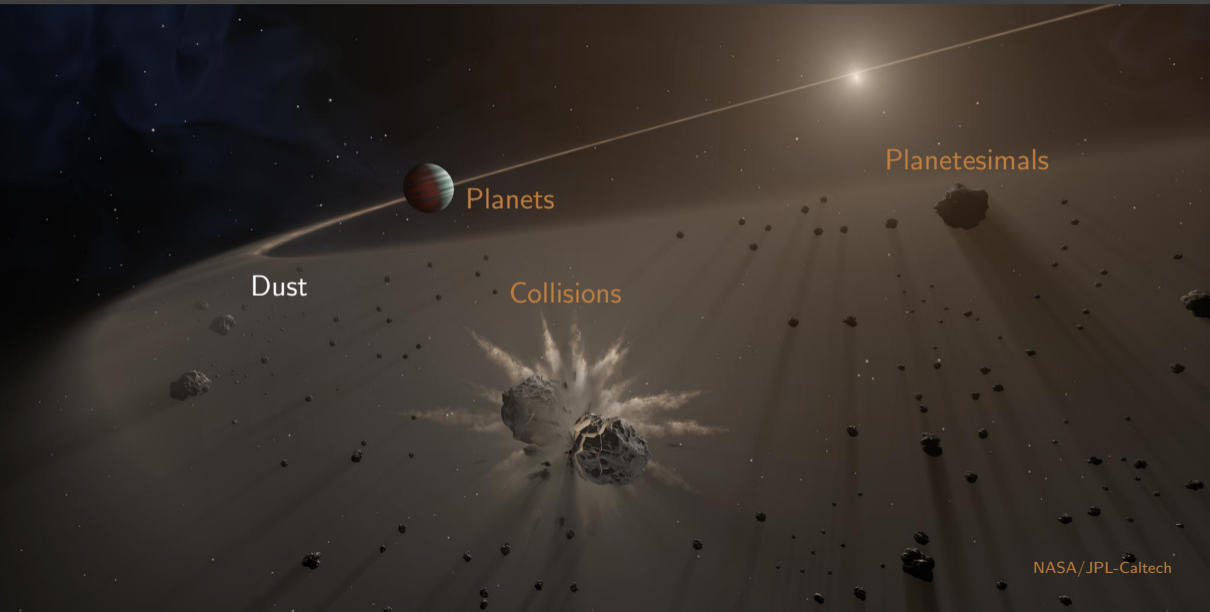
Dust

Planets

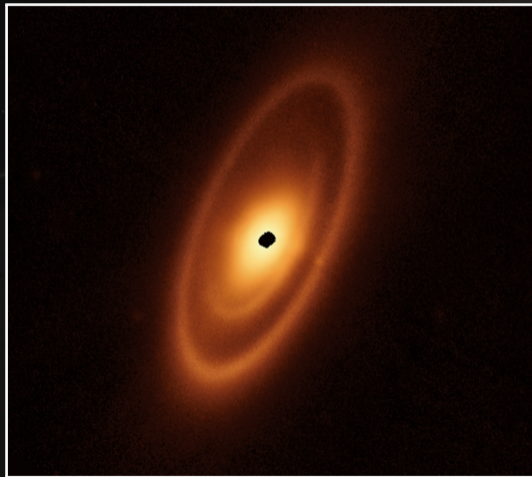
Collisions

Planetesimals

What happens in Kuiper Belts?



Extrasolar Kuiper Belts



We see dust, not planetesimals

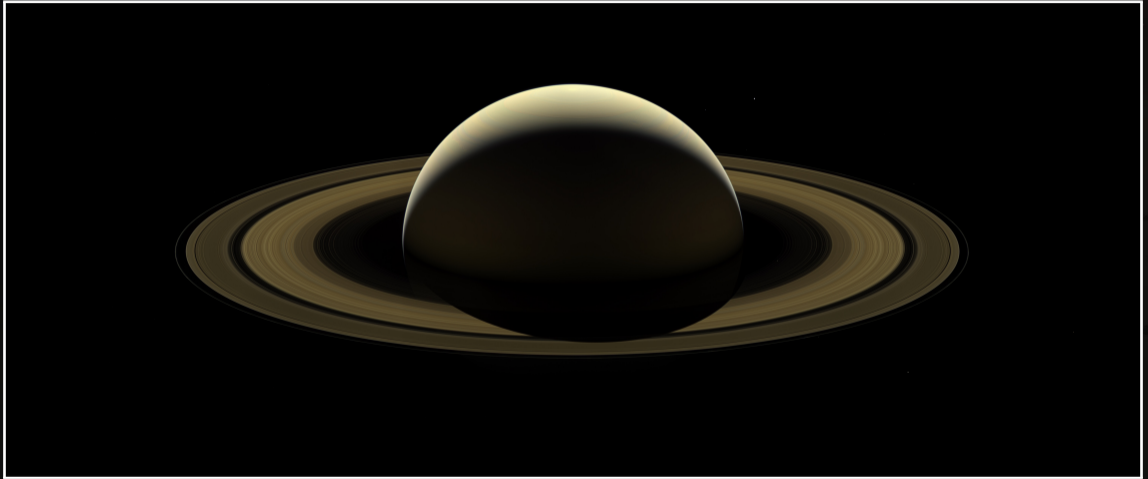
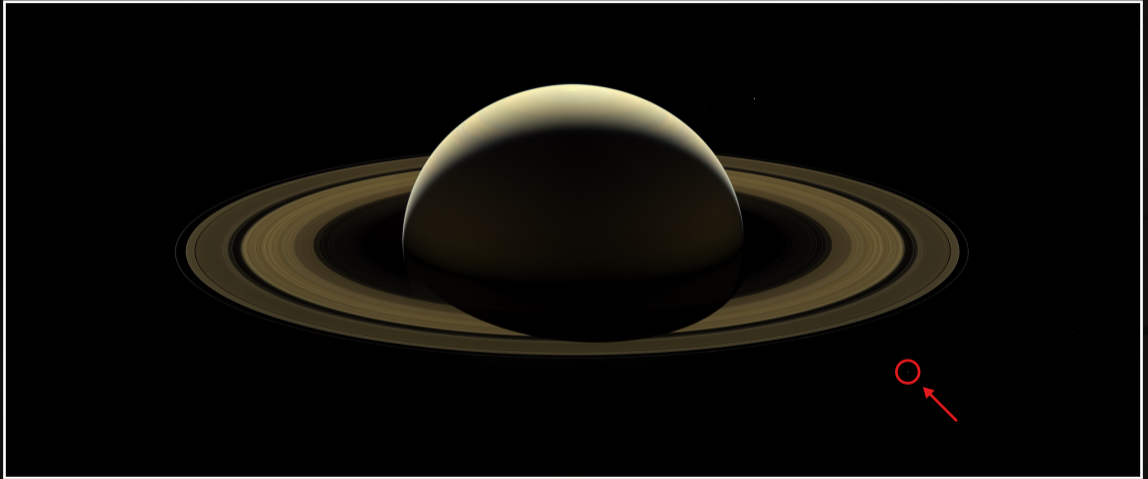
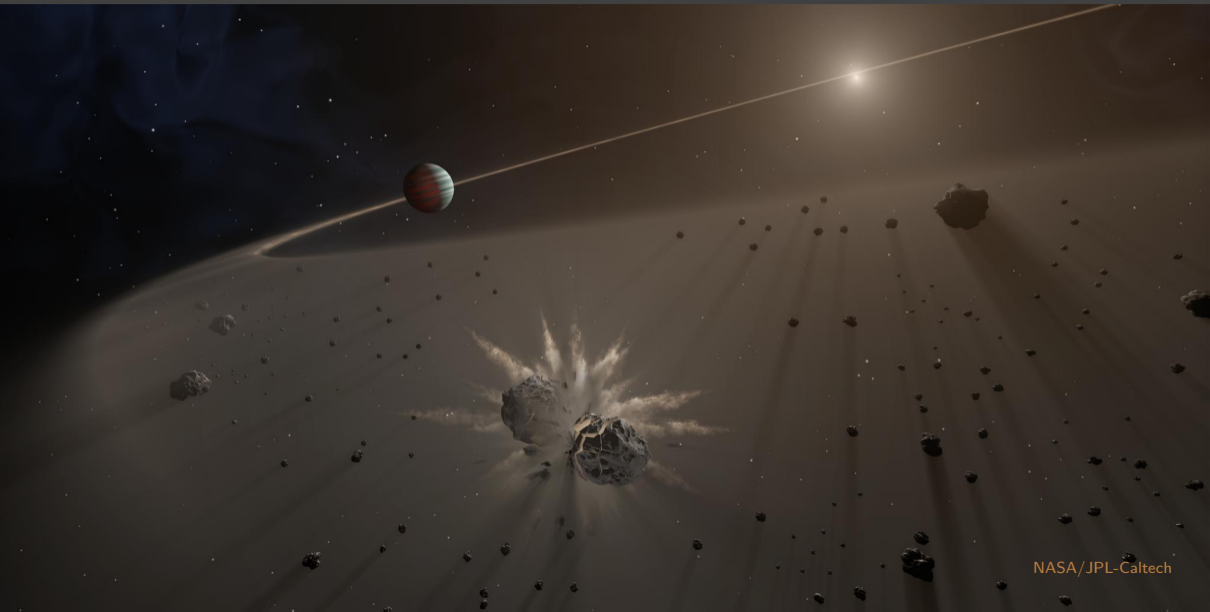


Image: NASA/JPL-Caltech/Space Science Institute

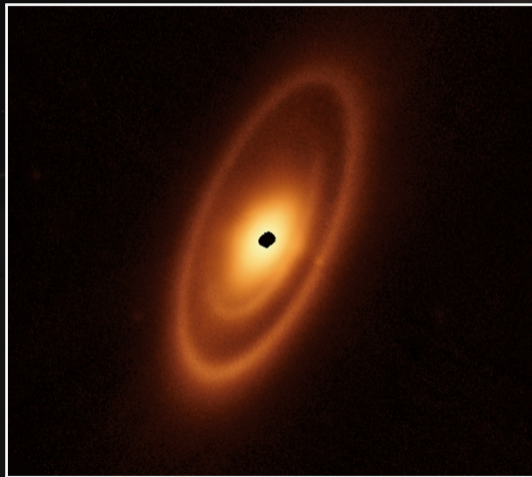
We see dust, not planetesimals



We see dust, not planetesimals

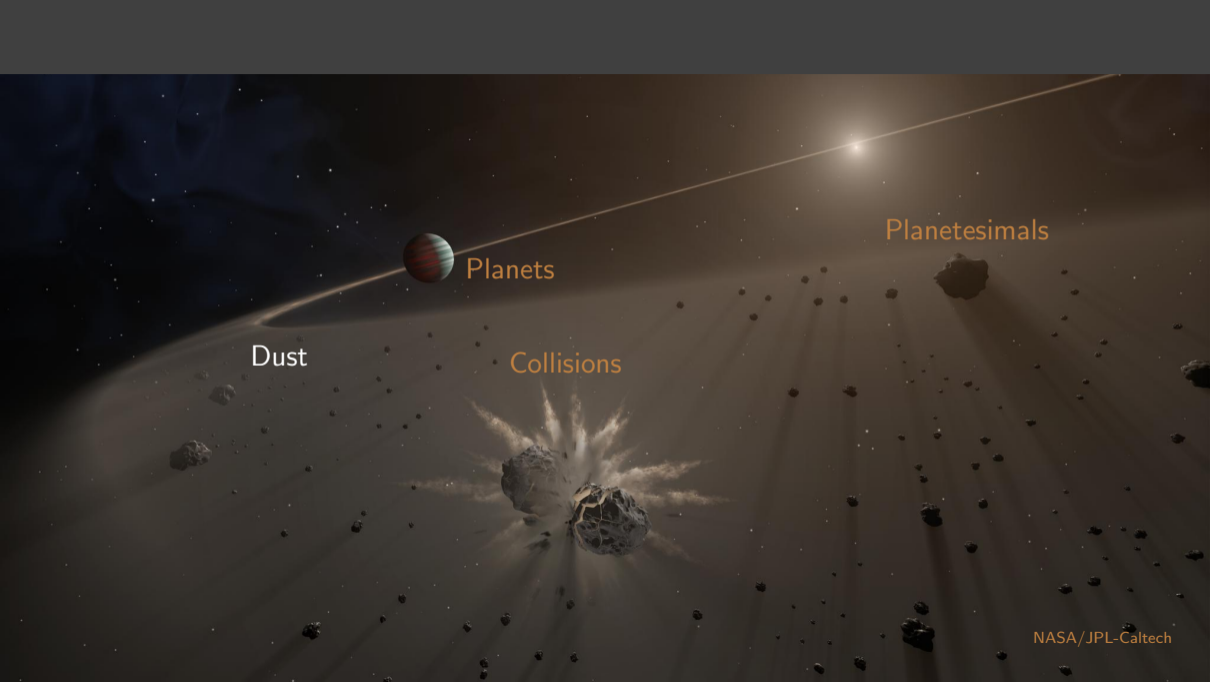


We see dust, not planetesimals



A dark space scene with a bright star in the upper right, a planet in the upper left, and a comet with a long tail in the lower center. The text "Where does the dust come from?" is centered in white.

Where does the dust come from?

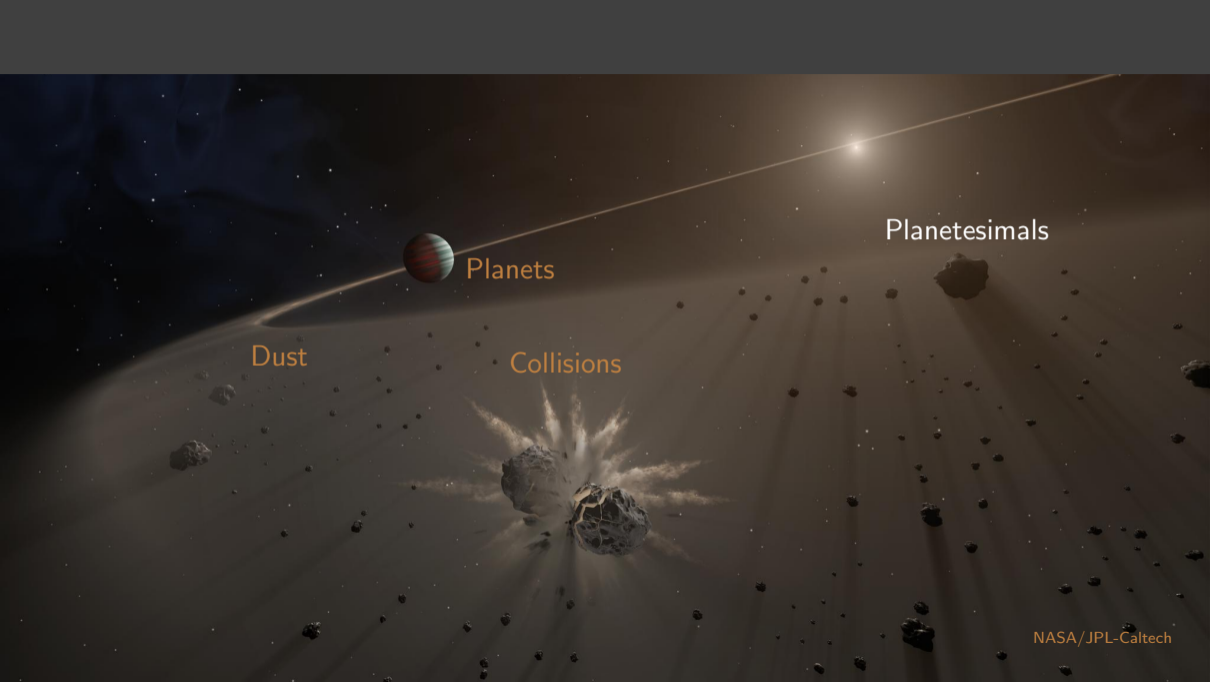


Dust

Collisions

Planets

Planetesimals



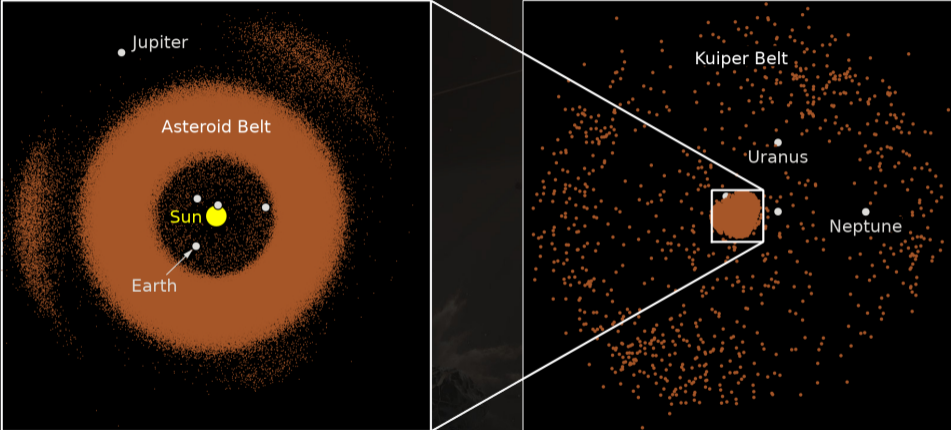
Planets

Planetesimals

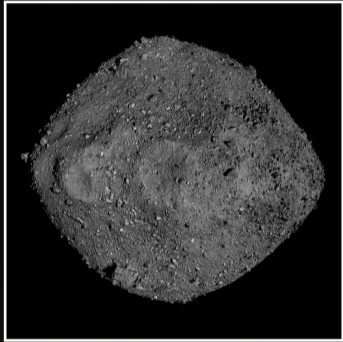
Dust

Collisions

Planetesimals in the Solar System

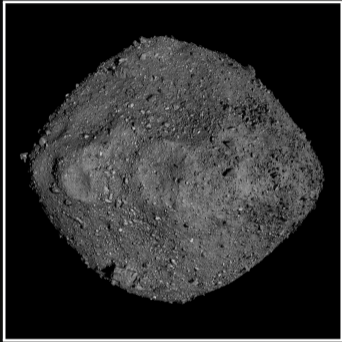


Planetesimals in the Solar System

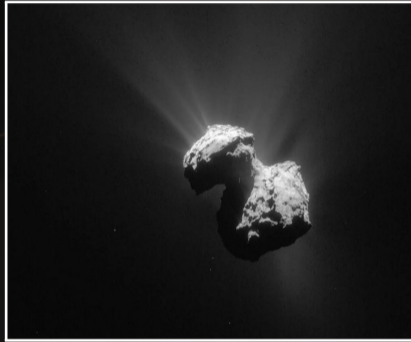


Bennu
(asteroid)

Planetesimals in the Solar System

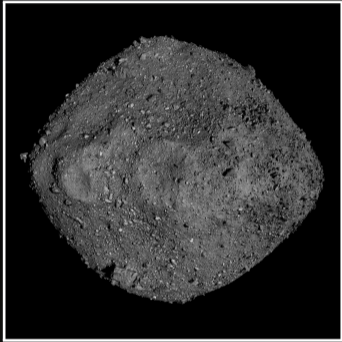


Bennu
(asteroid)

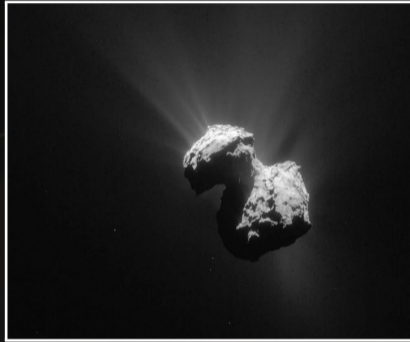


67P / Churyumov-Gerasimenko
(comet)

Planetesimals in the Solar System



Bennu
(asteroid)

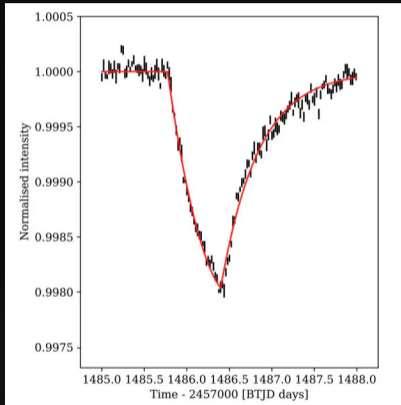


67P / Churyumov-Gerasimenko
(comet)



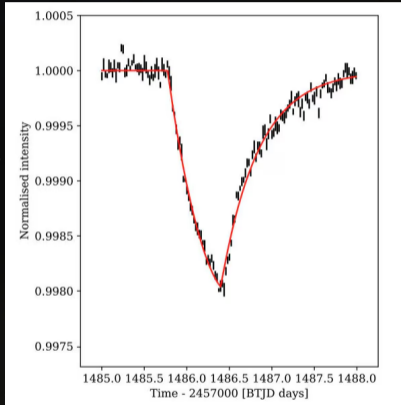
Pluto
(Kuiper Belt object)

Extrasolar planetesimals



Zieba et al. 2019

Extrasolar planetesimals

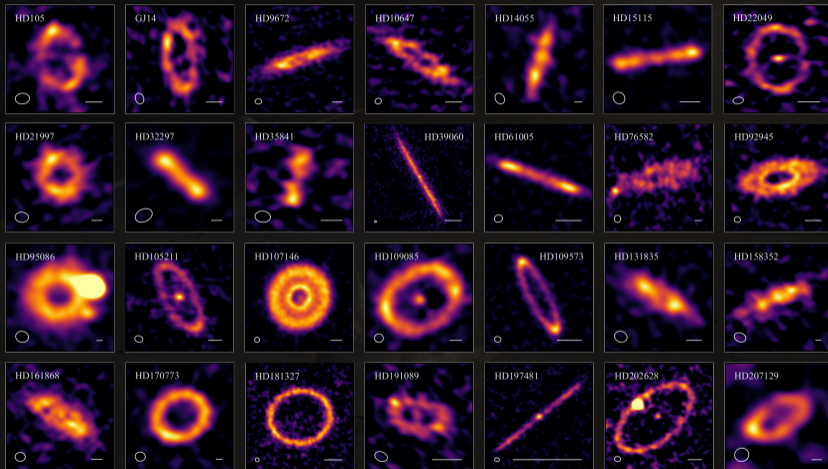


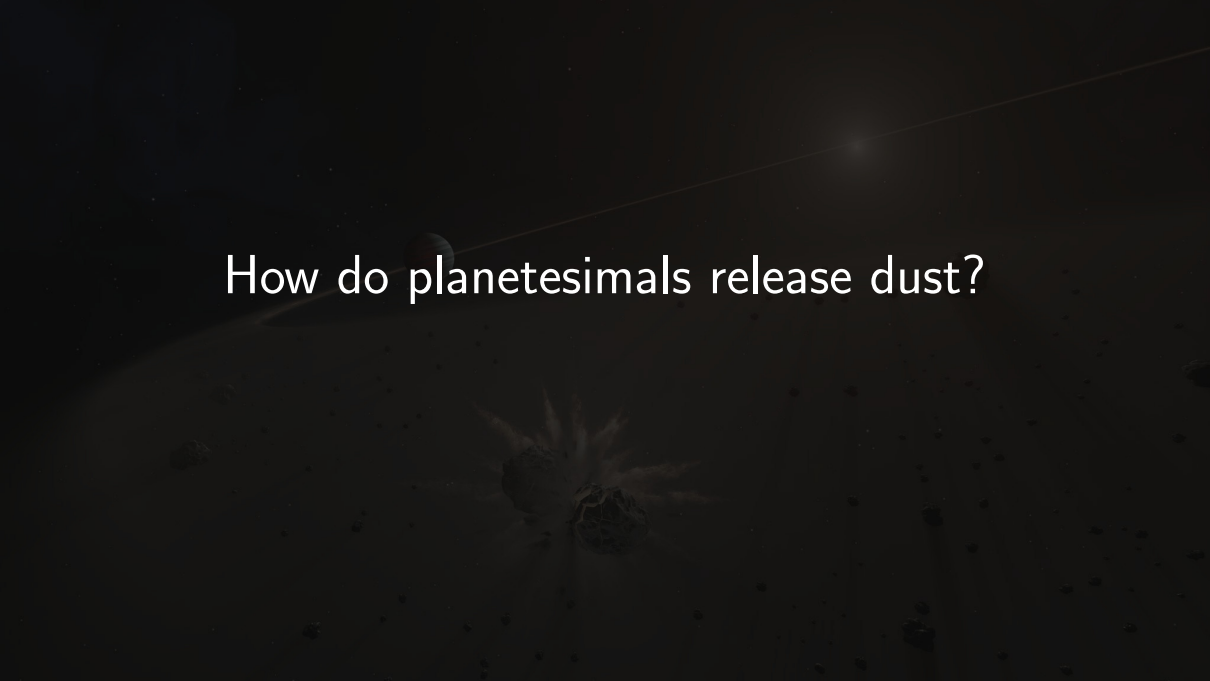
Zieba et al. 2019



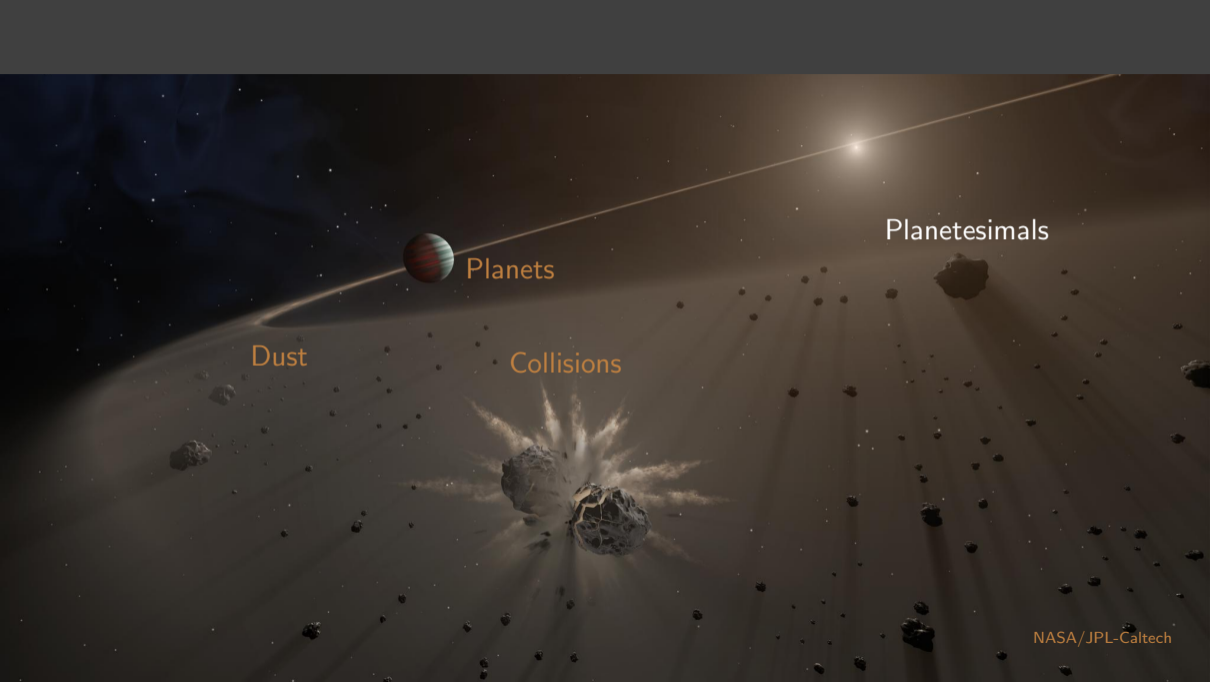
ESO, Calçada

Extrasolar planetesimals



A dark space scene with a bright star in the upper right, a planet in the upper left, and a comet with a long tail in the center. The text "How do planetesimals release dust?" is overlaid in white.

How do planetesimals release dust?

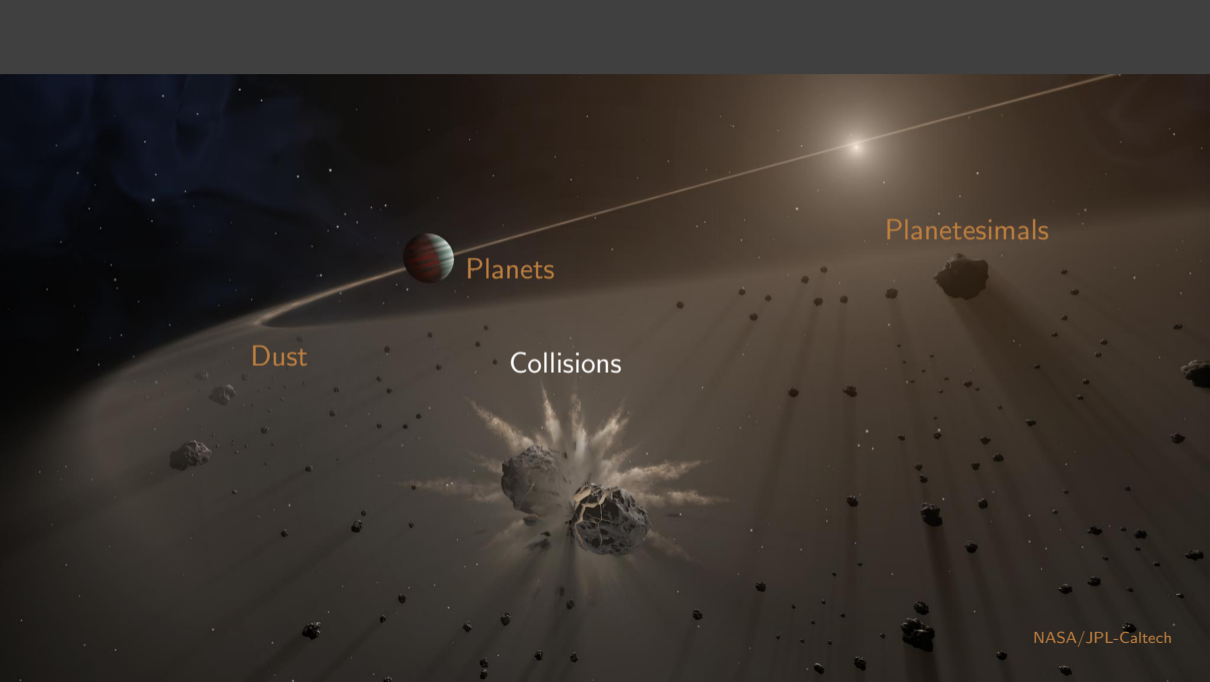


Planets

Planetesimals

Dust

Collisions



Planets

Planetesimals

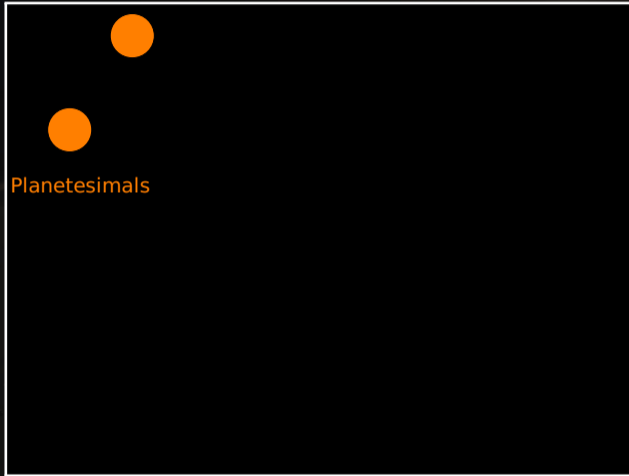
Dust

Collisions

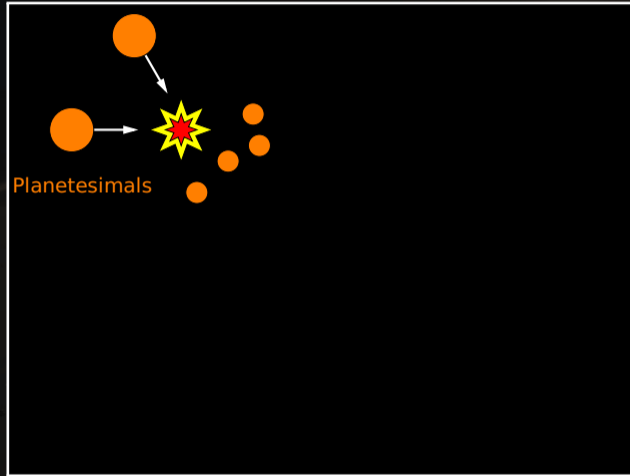
Collisional cascade



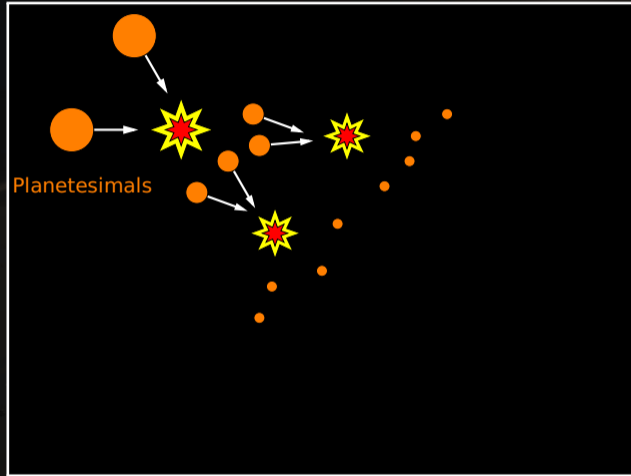
Collisional cascade



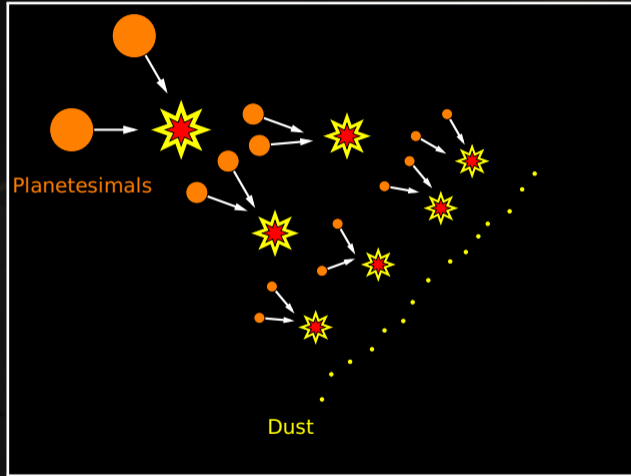
Collisional cascade



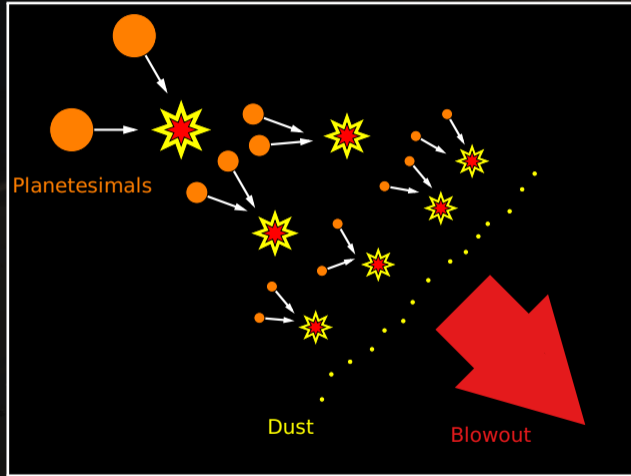
Collisional cascade



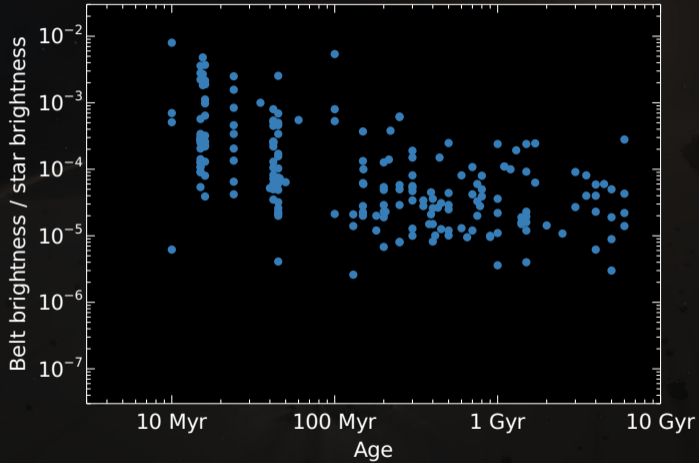
Collisional cascade



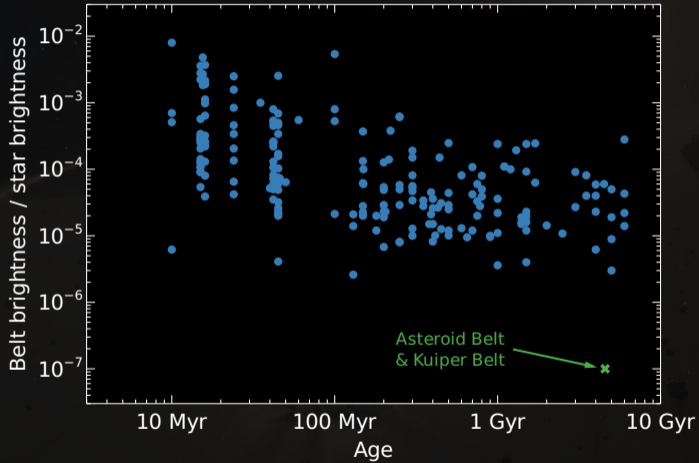
Collisional cascade



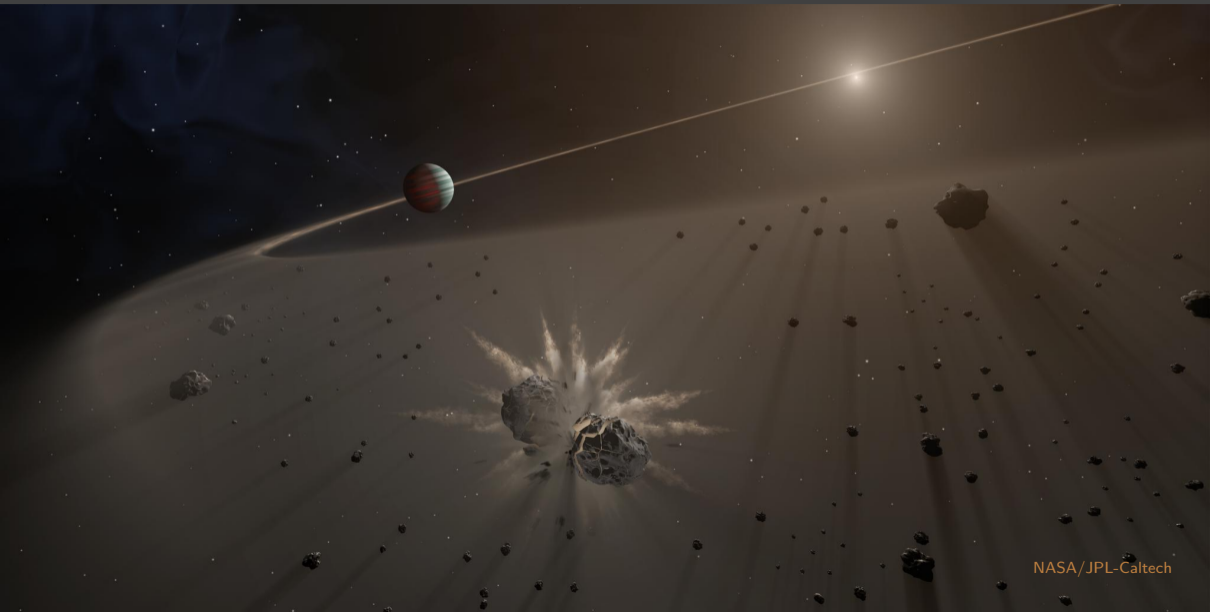
Belts lose mass over time



Belts lose mass over time



Stirring



Stirring



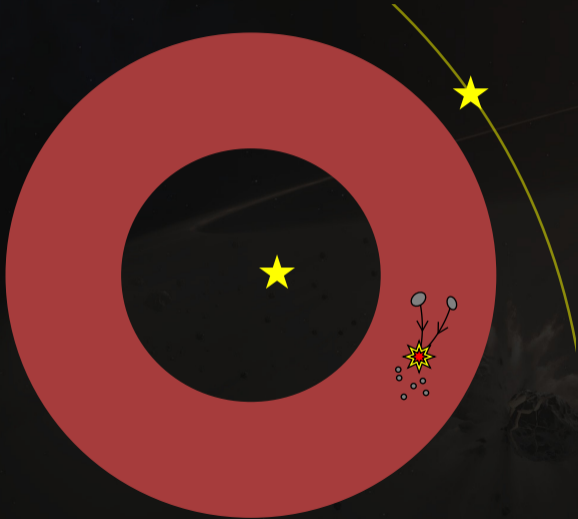
Stirring



Stirring mechanisms:

- Self stirring

Stirring



Stirring mechanisms:

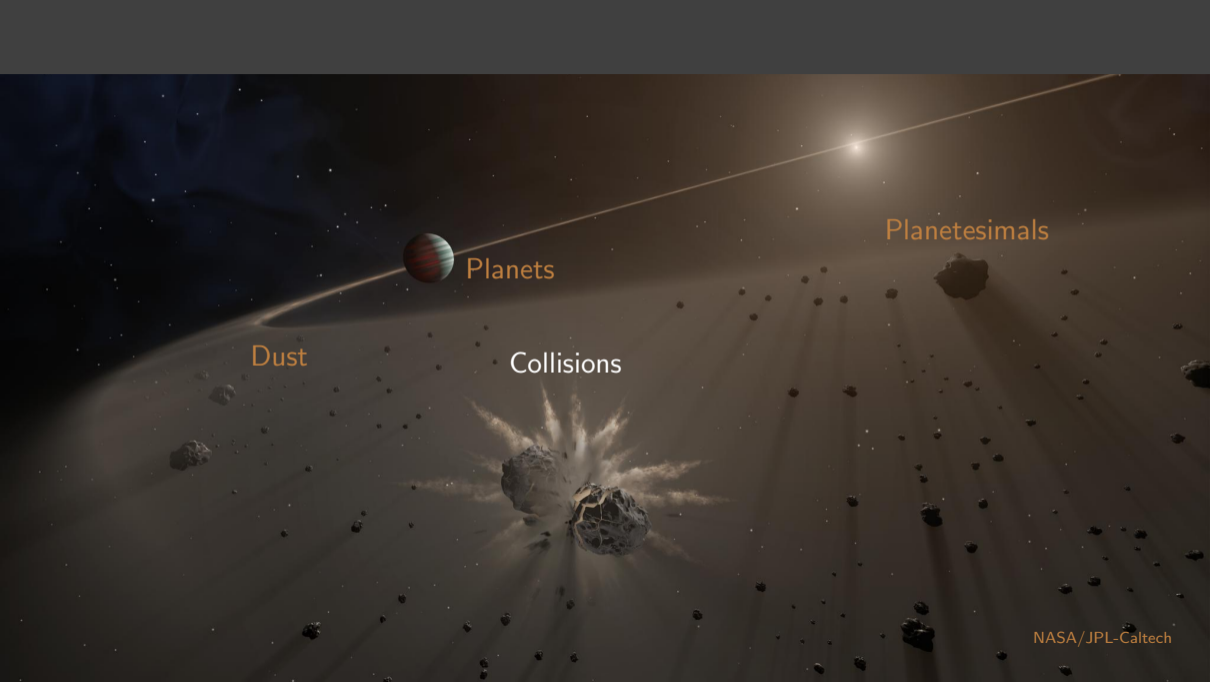
- Self stirring
- Flyby stirring

Stirring



Stirring mechanisms:

- Self stirring
- Flyby stirring
- Planet stirring

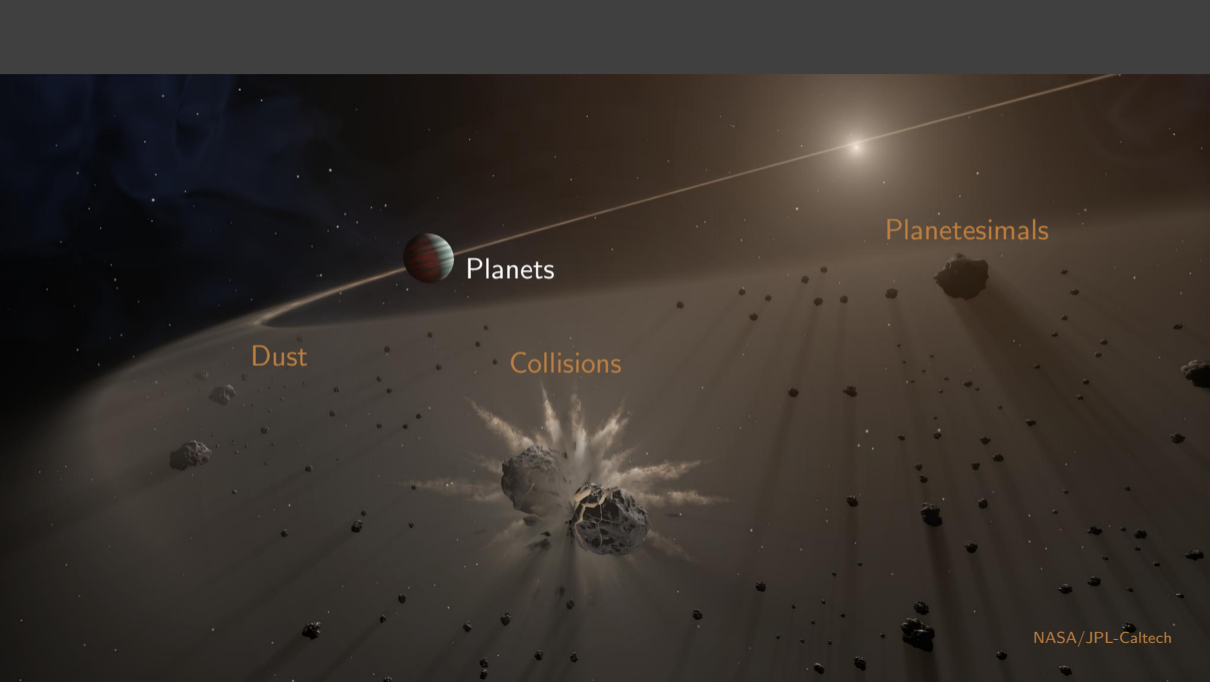


Planets

Planetesimals

Dust

Collisions



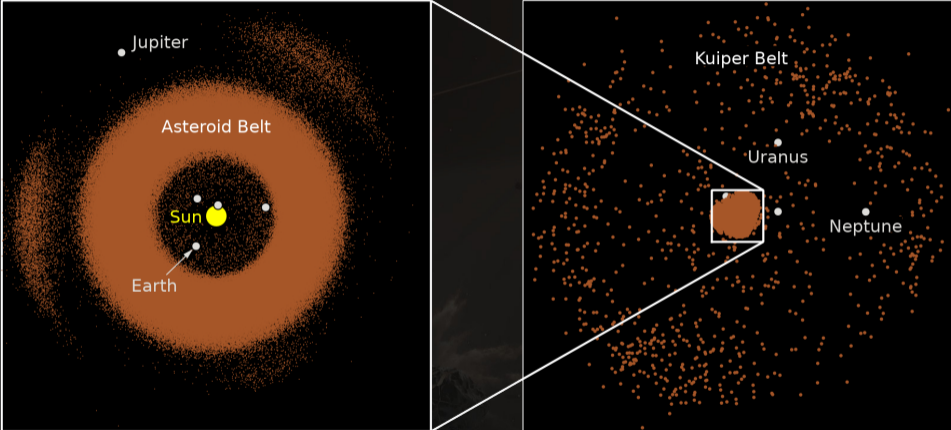
Dust

Collisions

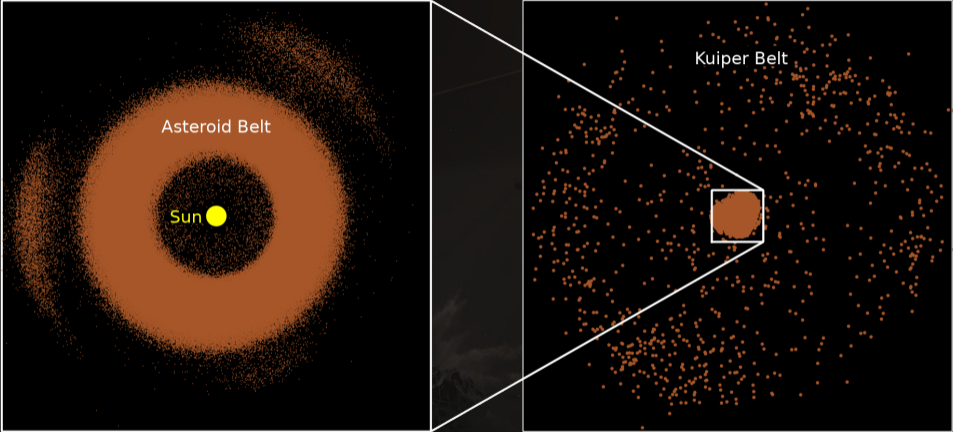
Planets

Planetesimals

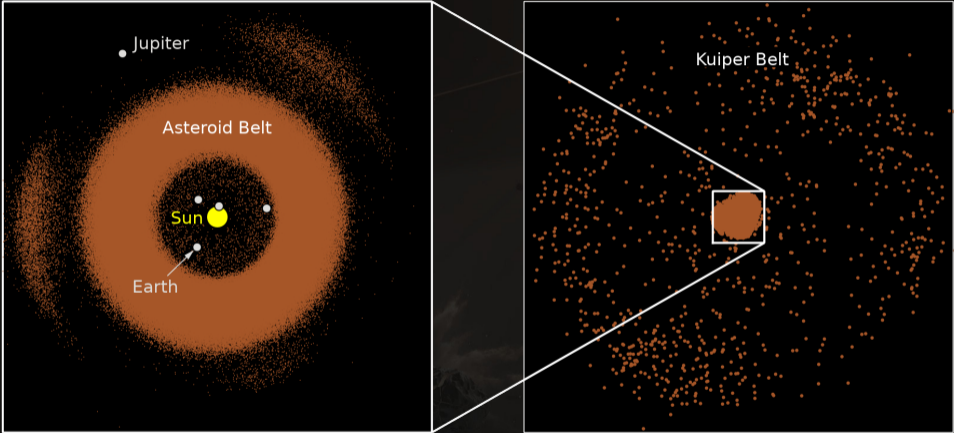
Planets and belts interact in the Solar System



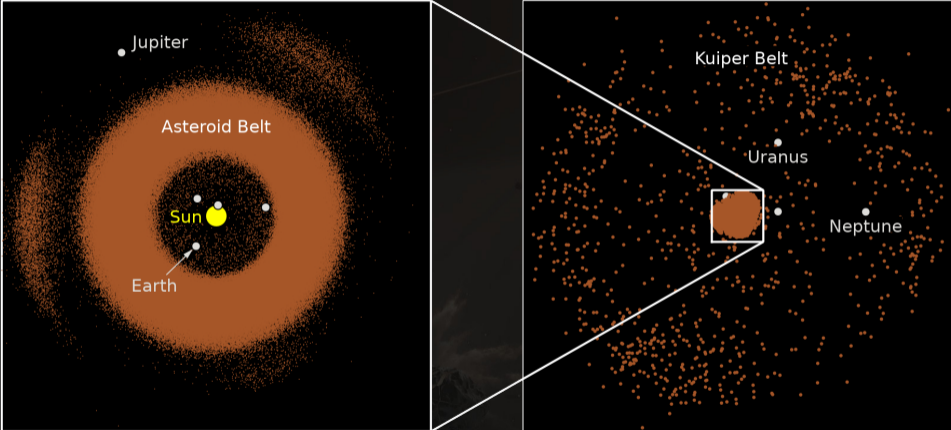
Planets and belts interact in the Solar System



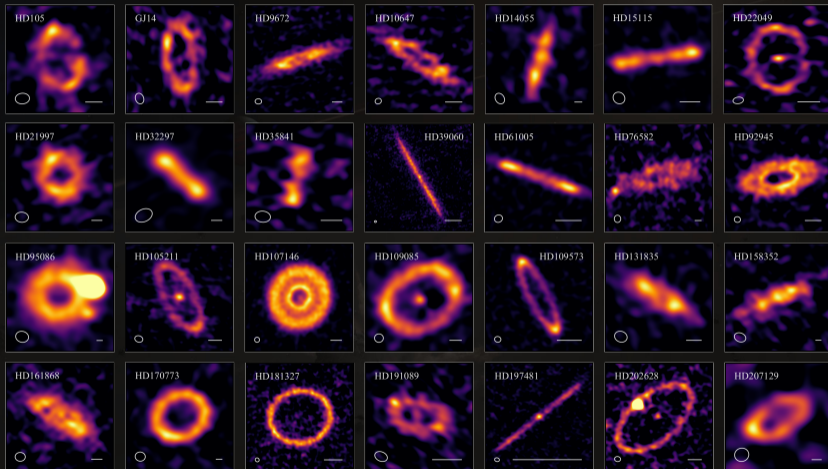
Planets and belts interact in the Solar System

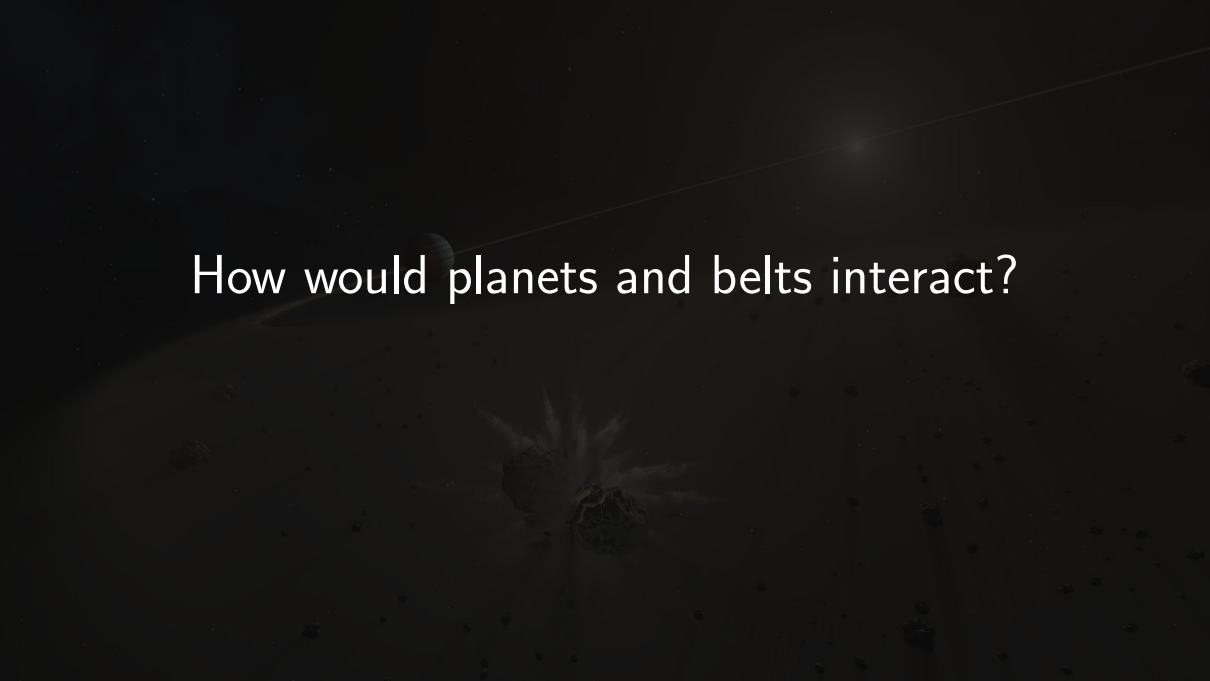


Planets and belts interact in the Solar System



Do planets interact with extrasolar belts too?



A dark space scene featuring a bright star in the upper right, a planet in the upper left, and a protoplanetary disk in the center. The text "How would planets and belts interact?" is overlaid in white.

How would planets and belts interact?

Planets interact with belts

Carve gaps



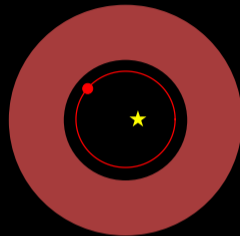
Warp belts



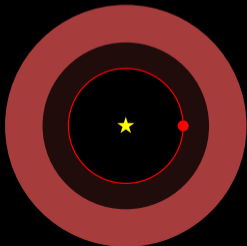
Pass bodies inward



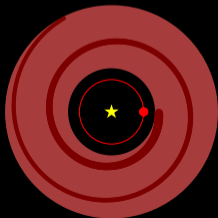
Make belts eccentric



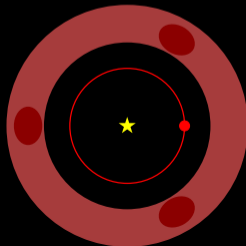
Sculpt disc edges



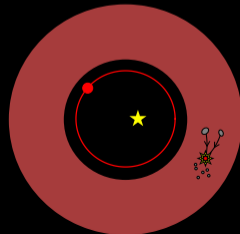
Drive spirals



Make clumps

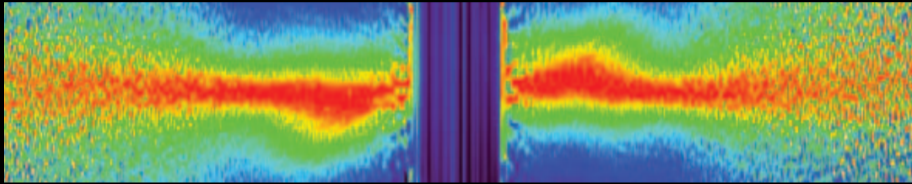


Stir debris

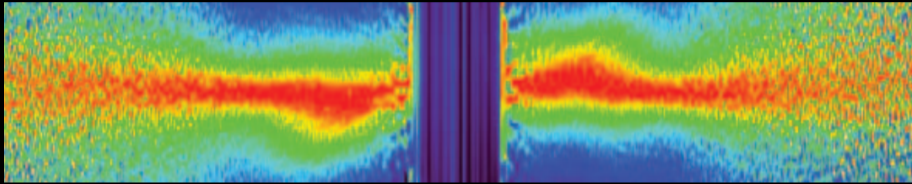


Planets interact with belts

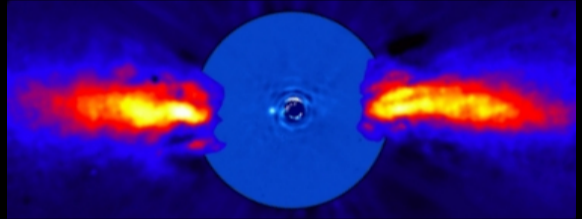
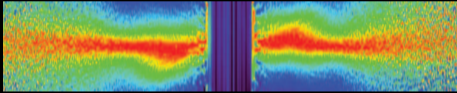
Planets interact with belts



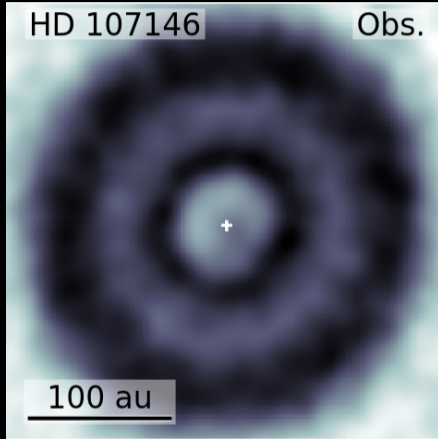
Planets interact with belts



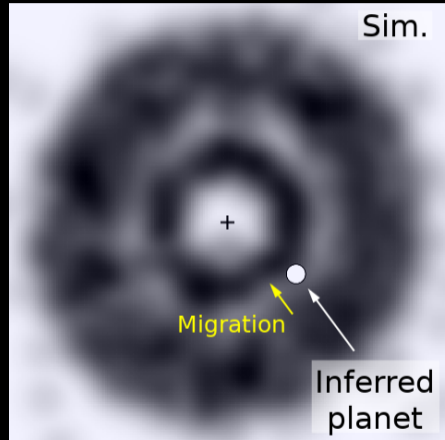
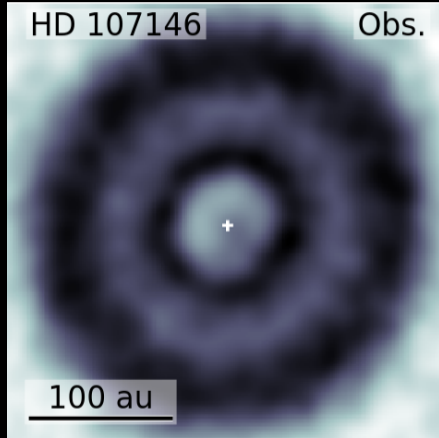
Planets interact with belts



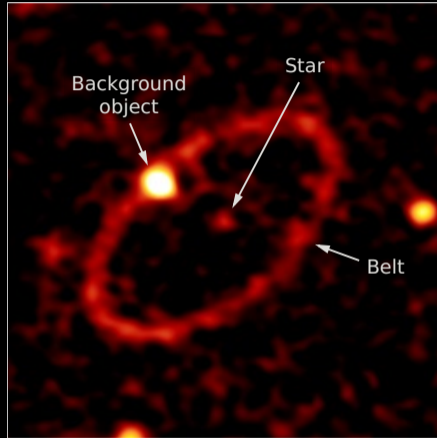
Planets interact with belts



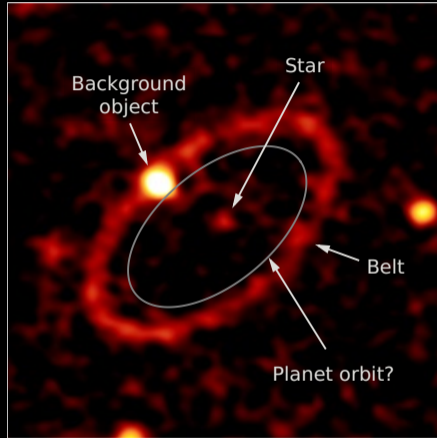
Planets interact with belts



Planets interact with belts

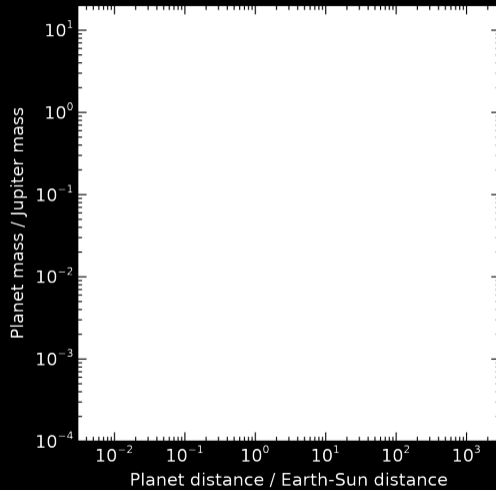


Planets interact with belts

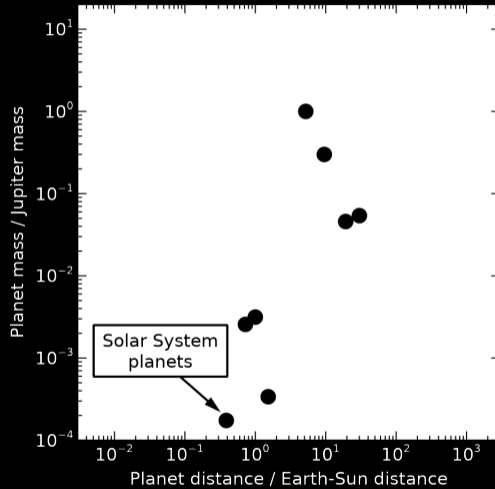


Belts help us find exoplanets

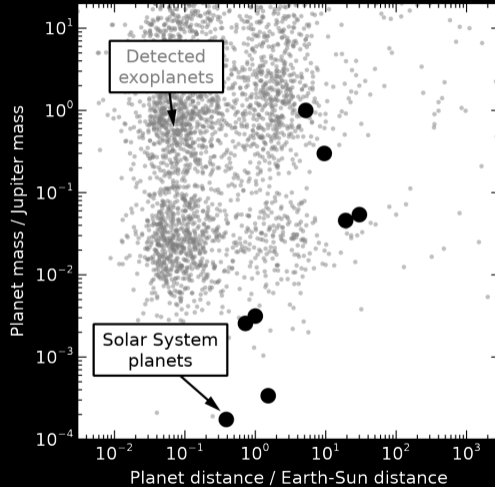
Belts help us find exoplanets



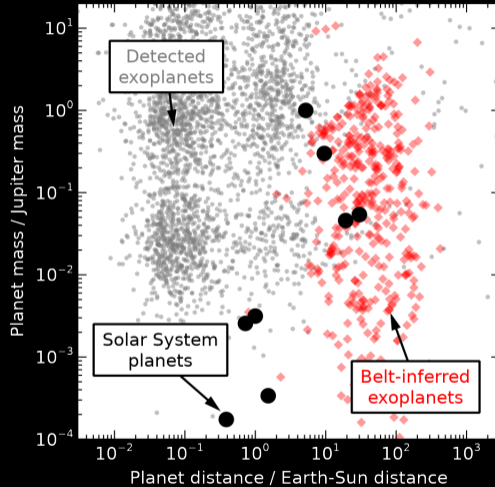
Belts help us find exoplanets



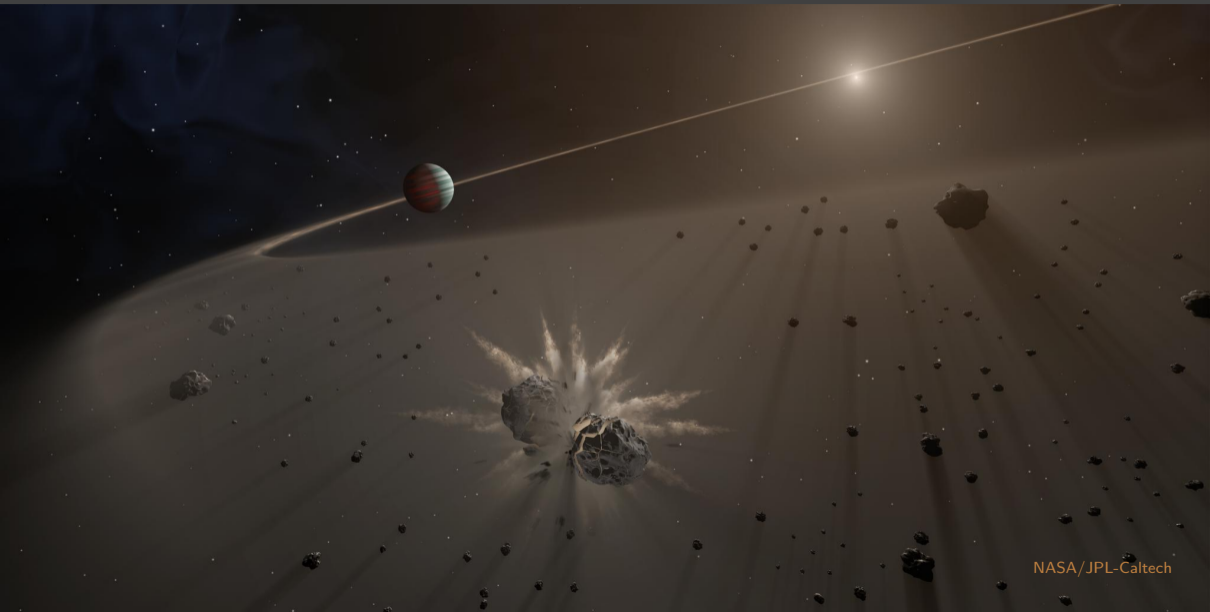
Belts help us find exoplanets



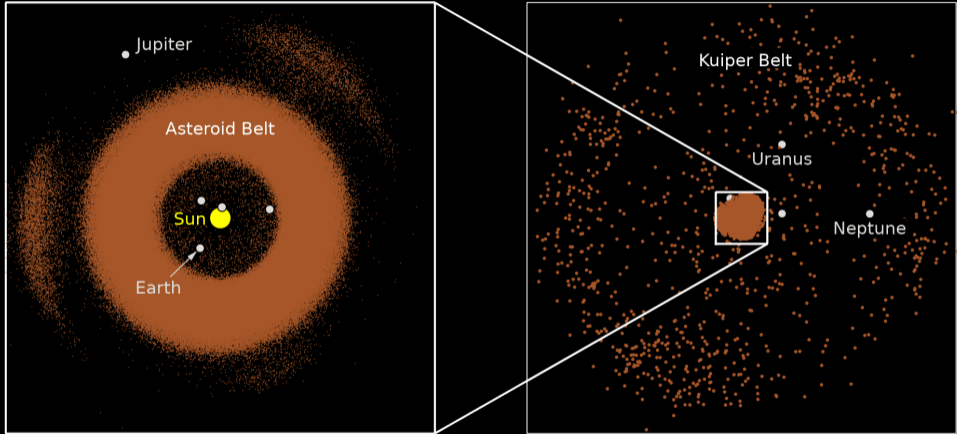
Belts help us find exoplanets



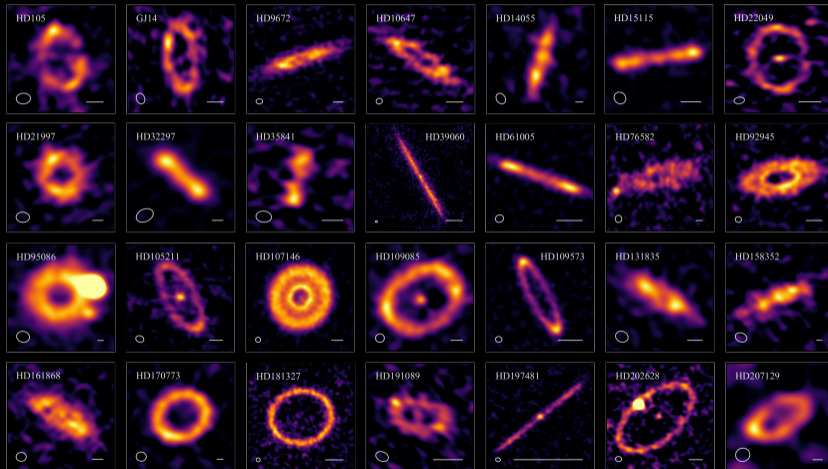
Conclusions



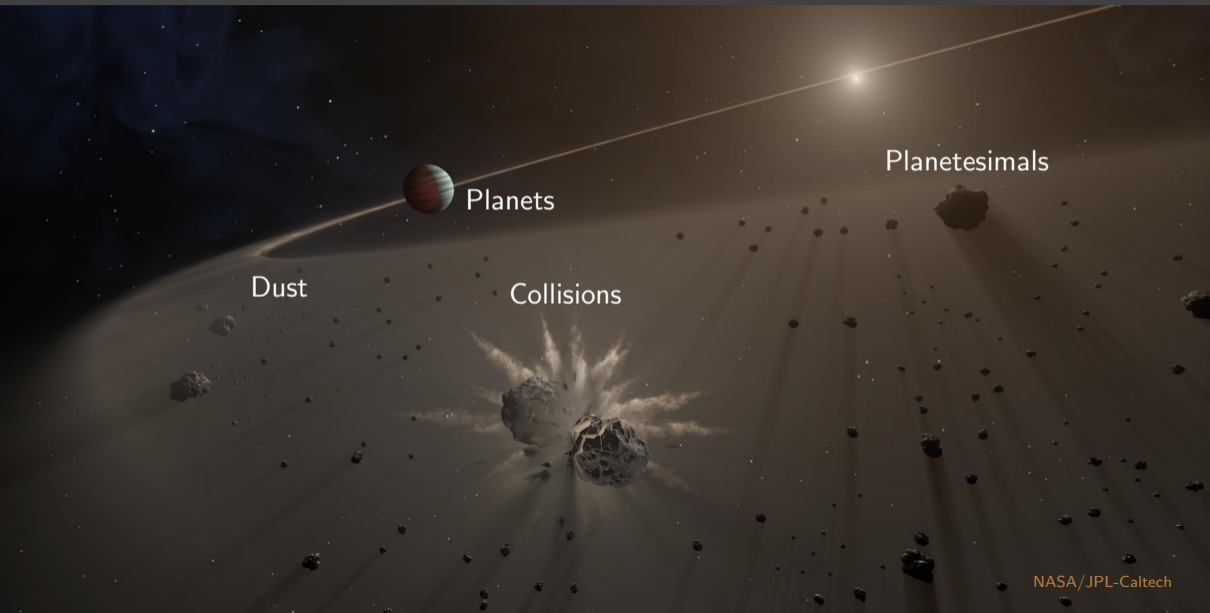
Conclusions



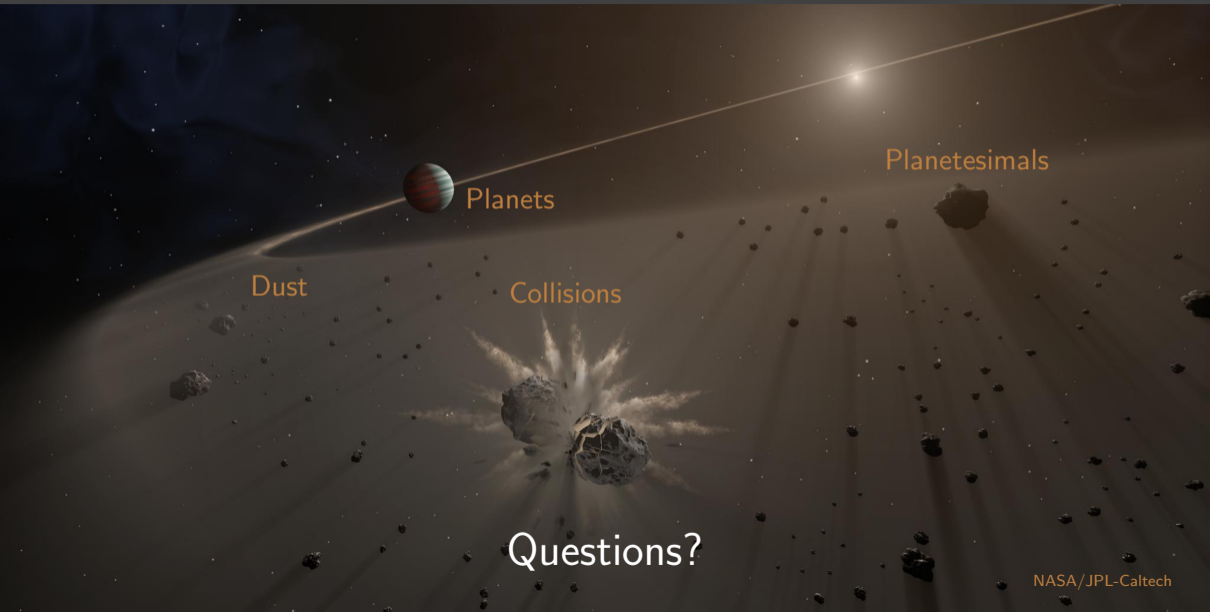
Conclusions



Conclusions



Conclusions



Planets

Planetesimals

Dust

Collisions

Questions?

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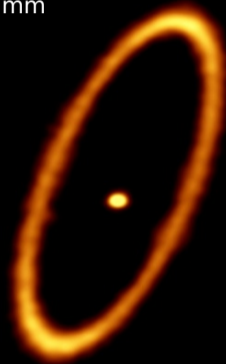
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Extra slides

Different dust grains have different distributions



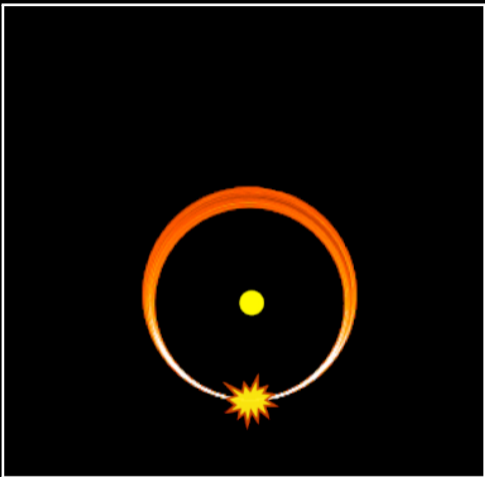
ALMA
1.3 mm



Fomalhaut

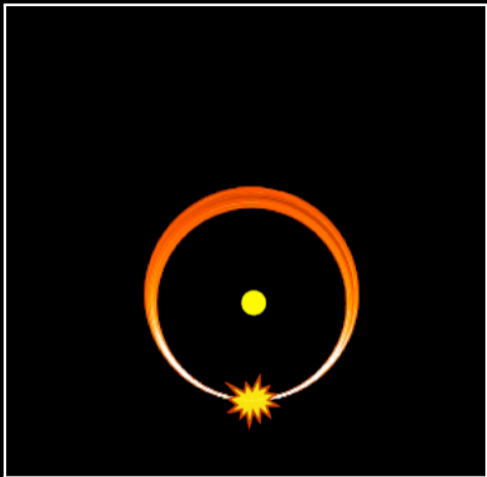
Small dust and large dust behave differently

Small dust and large dust behave differently

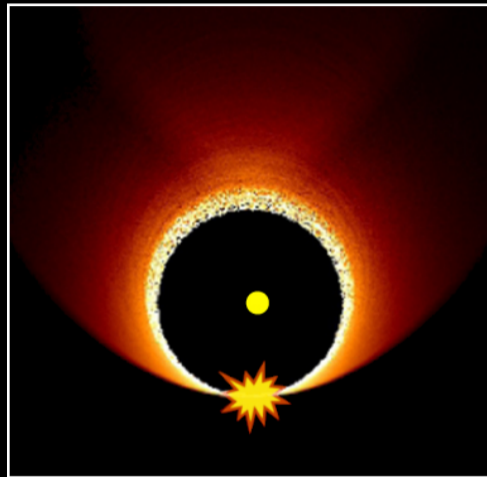


Large grains

Small dust and large dust behave differently



Large grains



Small grains