

The recipe for planet formation – a piece of cake?



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erc

DFG

Deutsche
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Structure

The **baking pan**: protoplanetary disc

The **key ingredient**: dust

The **oven settings**: conditions for planet formation

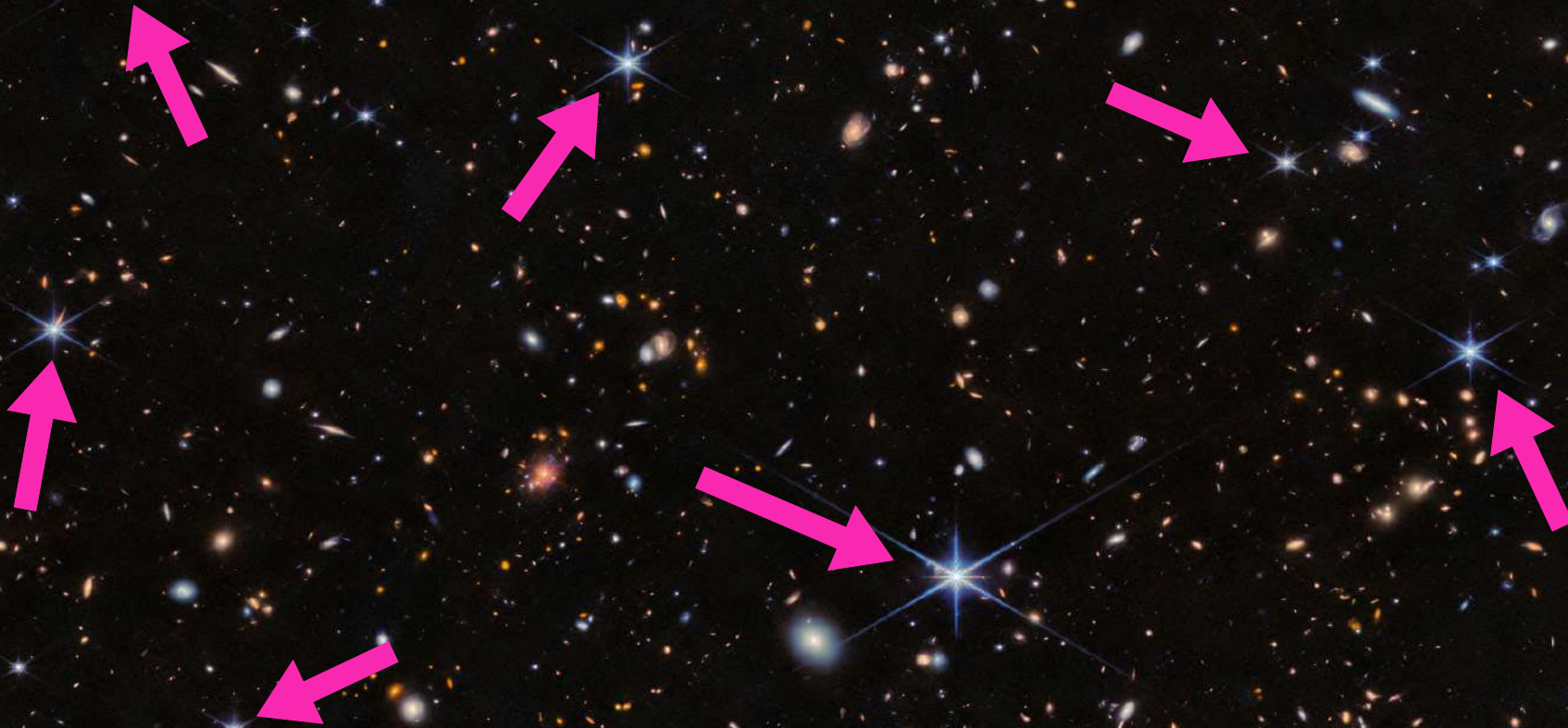
The **baking process**: how do planets form?



Endless Space

A deep-field astronomical image showing a vast field of galaxies. The galaxies are scattered across a black background, appearing in various colors including blue, orange, and white. Some galaxies are bright and clear, while others are faint and distant. The overall appearance is that of a rich, multi-colored galaxy population.

Endless Space

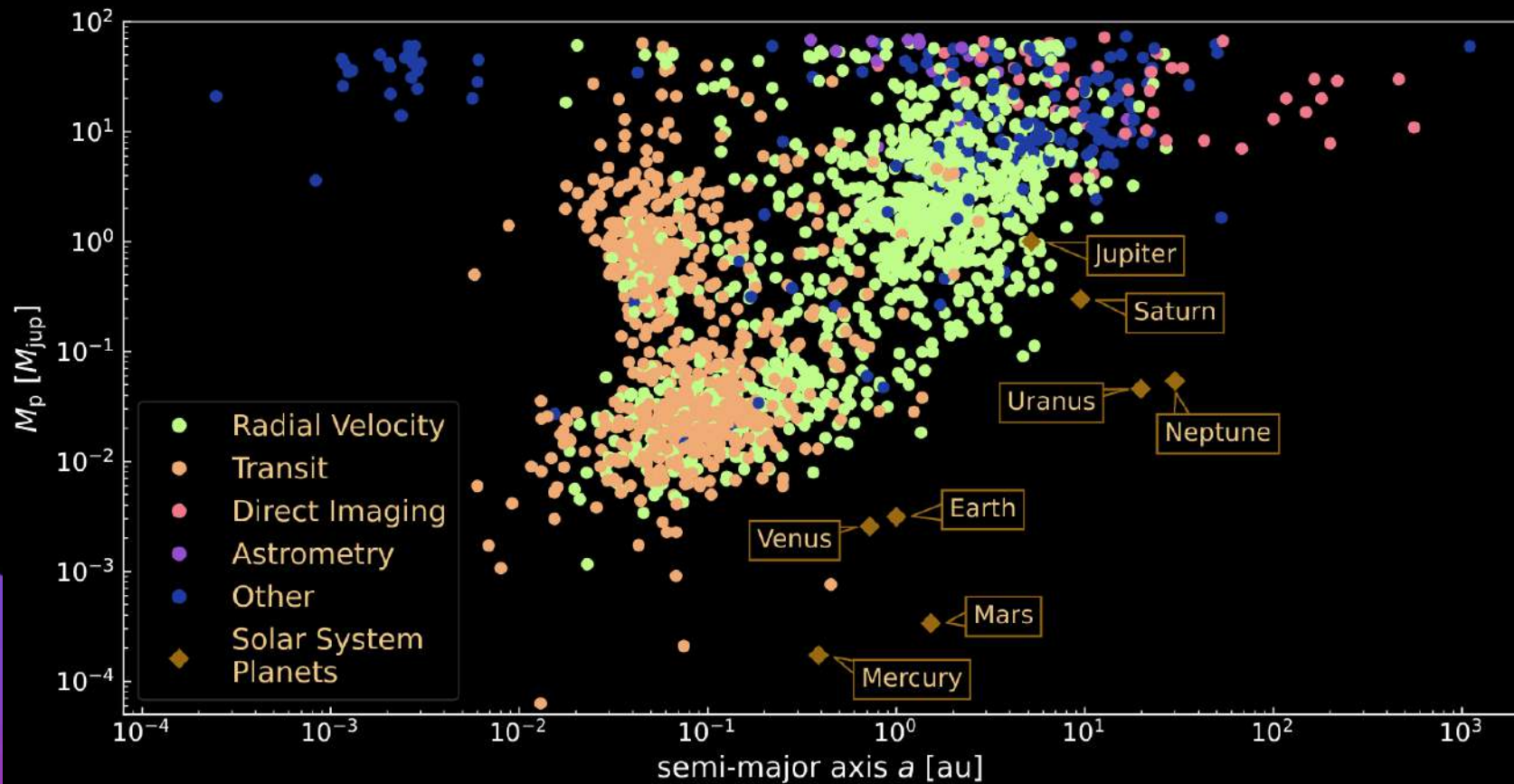


Planets!



Probably more than half of the stars
have at least one planet!

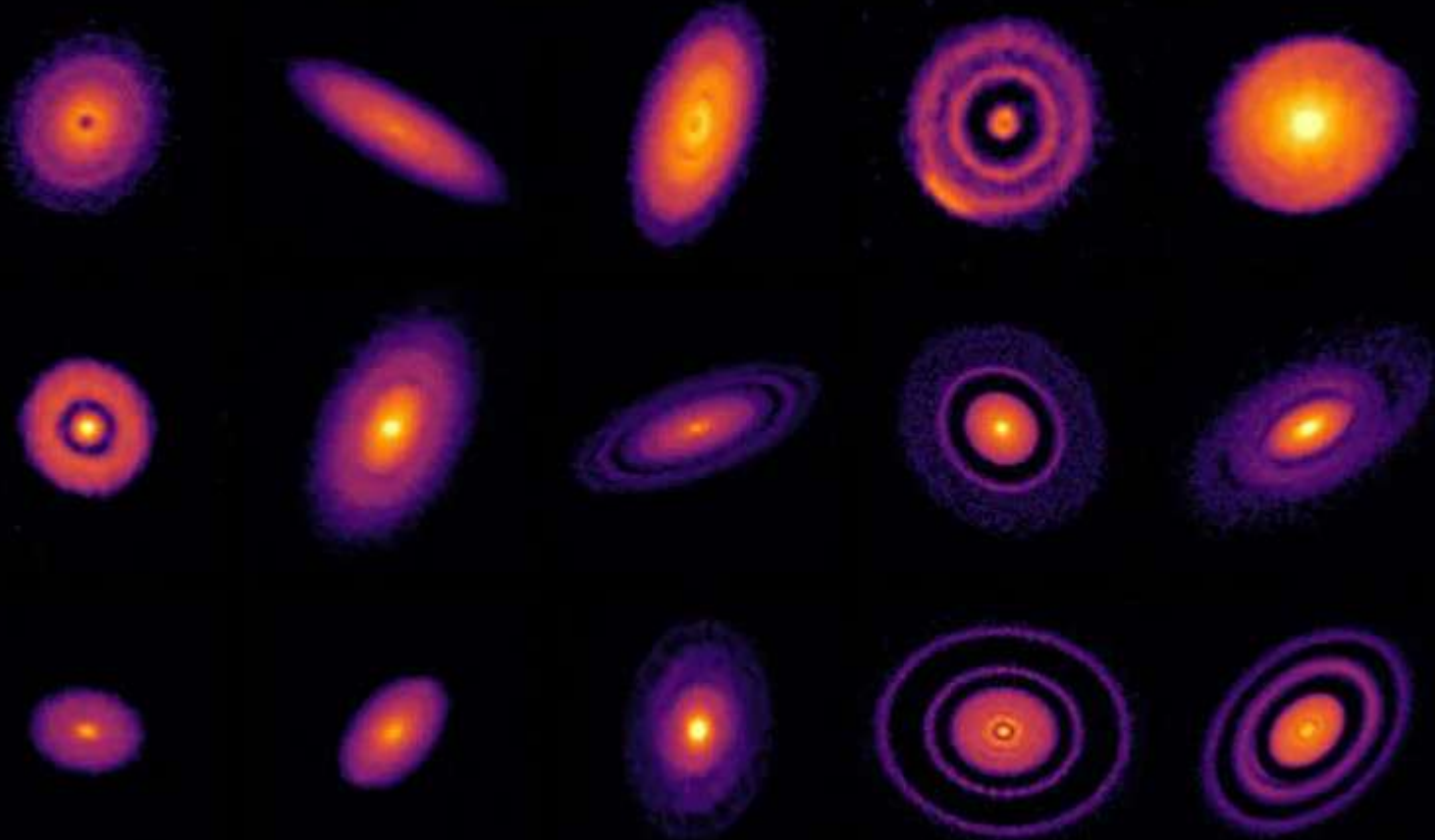
Observed exoplanets



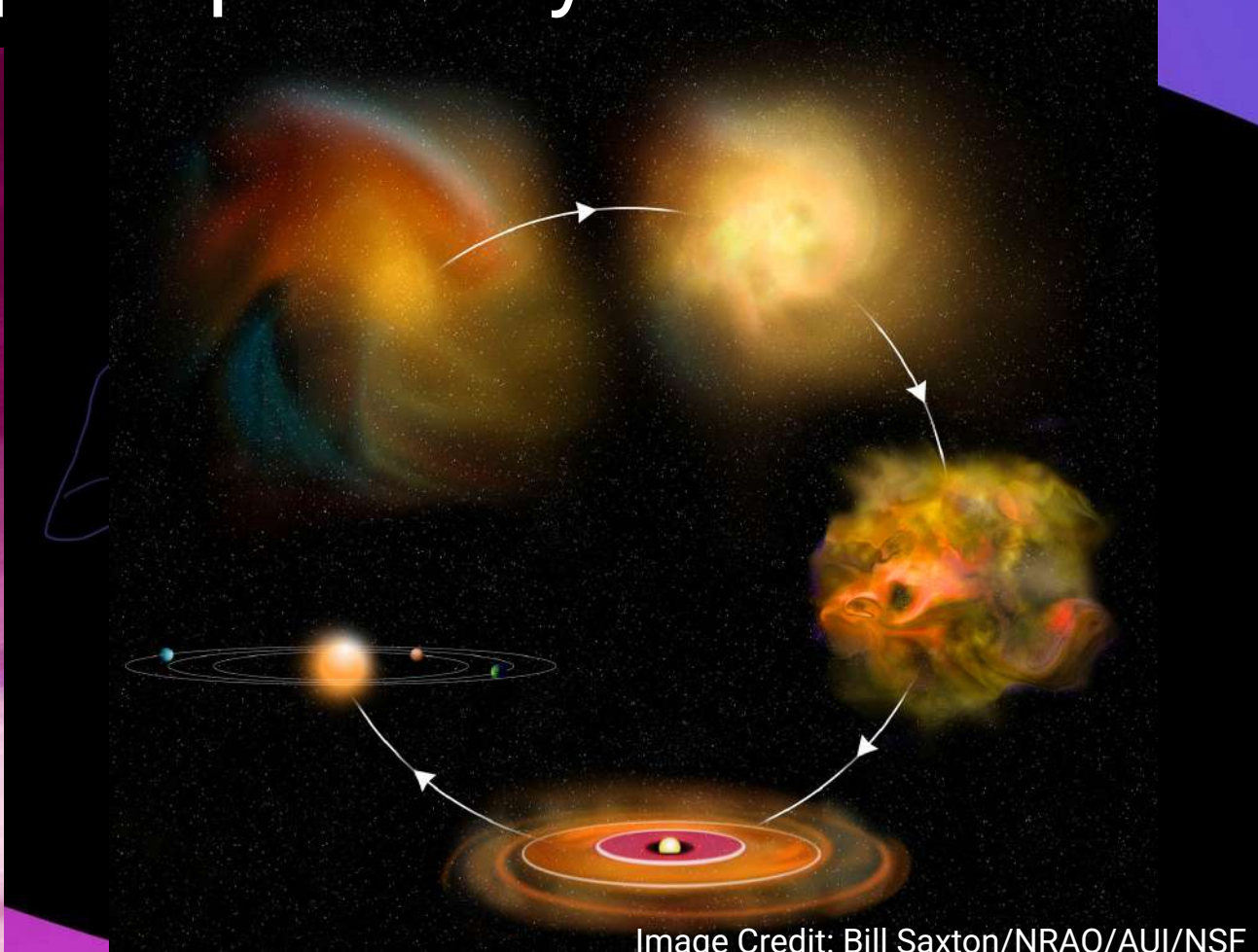
How to bake a planet?



The baking pan: protoplanetary disc



The baking pan: protoplanetary disc



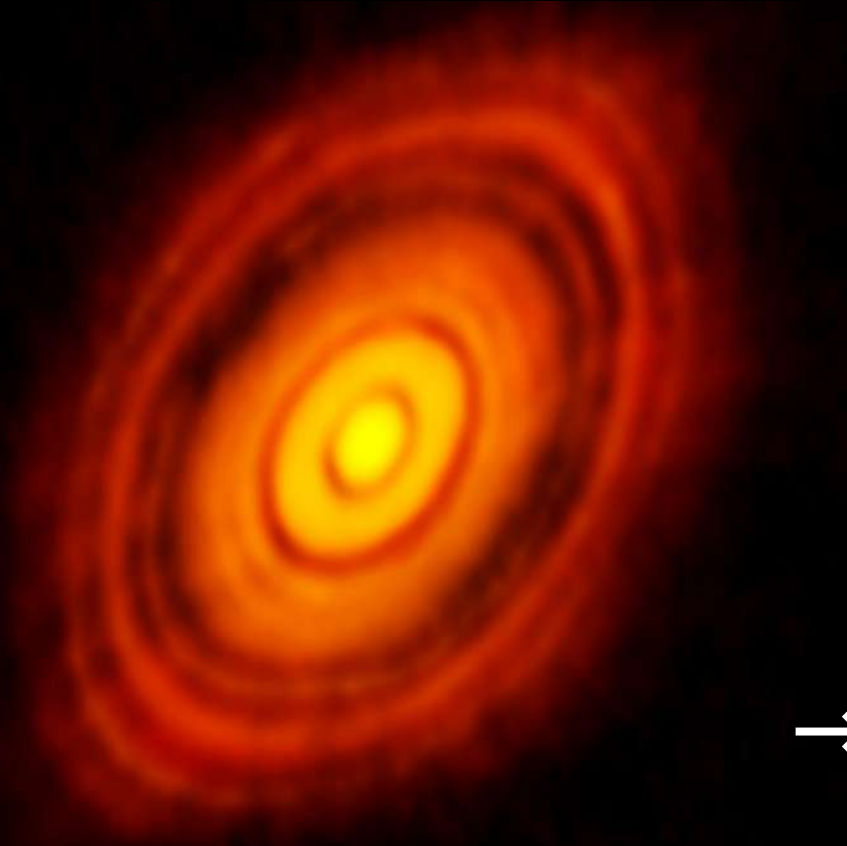
The key ingredient: dust



meteorites



The oven settings: formation conditions



Density / available gas and dust mass

Pressure

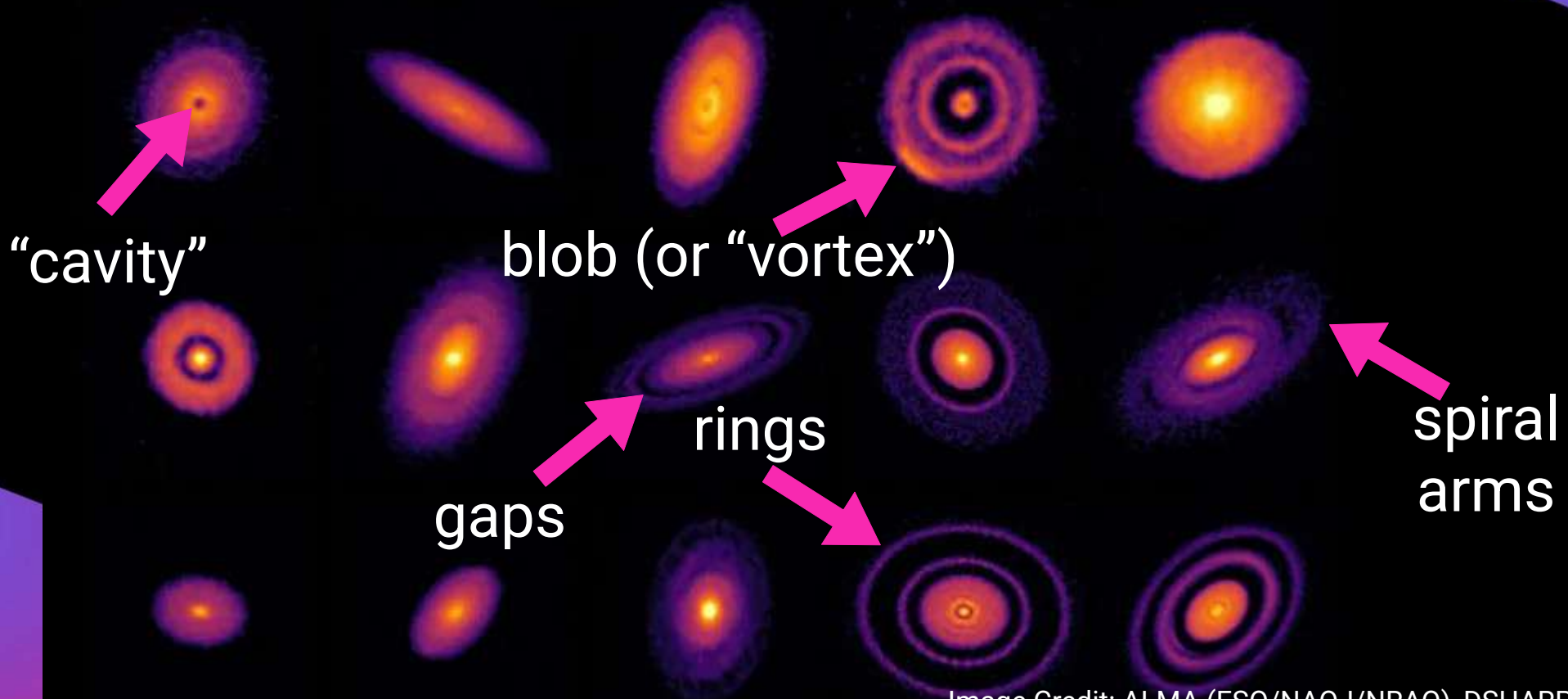
Temperature

...

→ sub-structures in discs

The oven settings: formation conditions

sub-structures:



The oven settings: formation conditions

sub-structures:

Why?

How do they form?



The oven settings: formation conditions research field of protoplanetary discs

Kepler's third law (+ gravity)

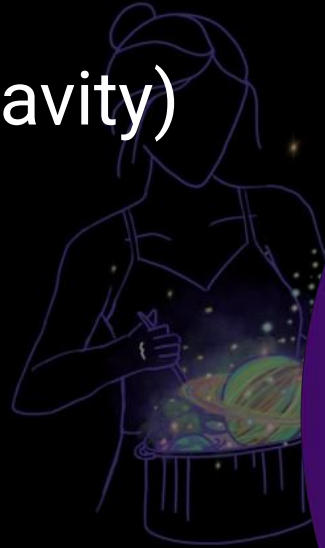
$$F_G = \frac{GM_\star M_p}{r^2} = M_p \frac{v^2}{r} = F_{CF}$$

The oven settings: formation conditions

research field of protoplanetary discs

Kepler's third law (+ gravity)

$$v = \sqrt{\frac{GM_{\star}}{r}}$$



⇒ Gas that is closer to the star is faster than gas further away from the star

The oven settings: formation conditions sub-structures formed by planets?



chicken and egg problem?

solution:

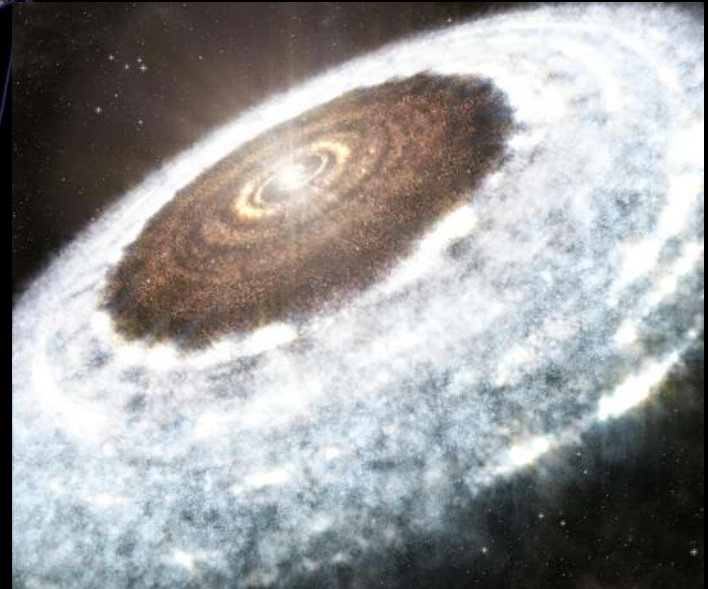
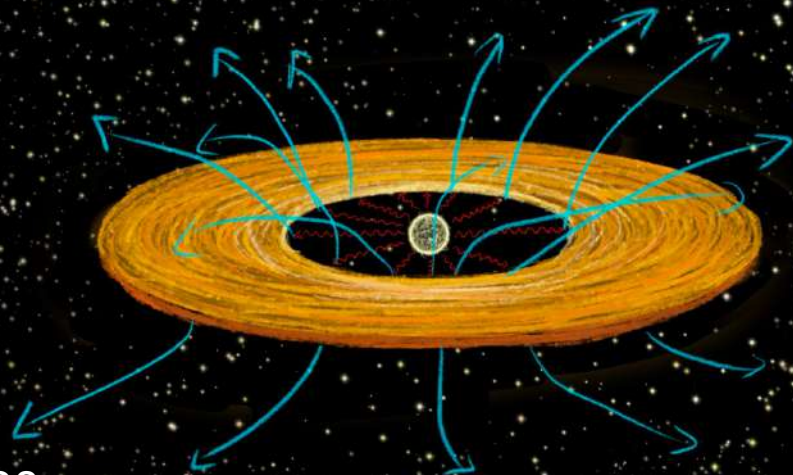
other explanations of the
substructures
(in addition to planets)

The oven settings: formation conditions

sub-structures

radiation from the star:
“photoevaporation”

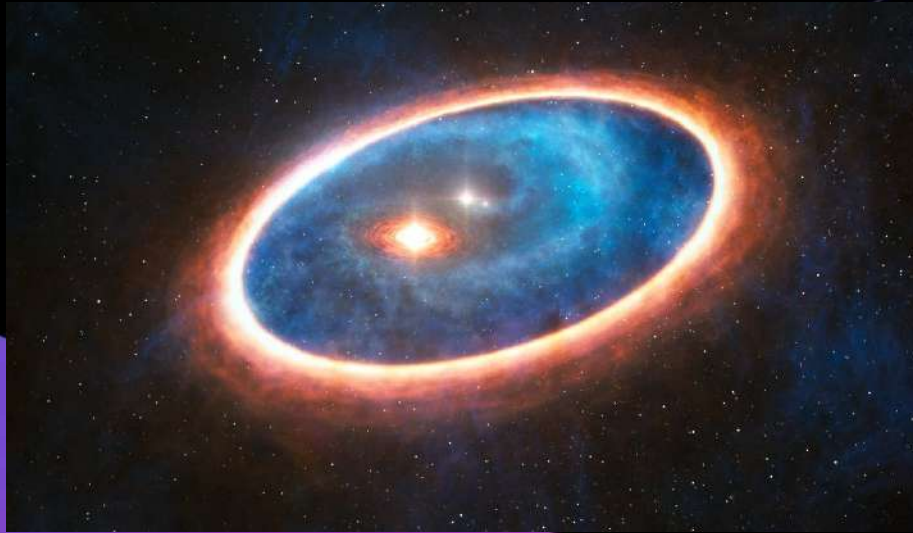
transition from gas phase
to solids: “snow lines”



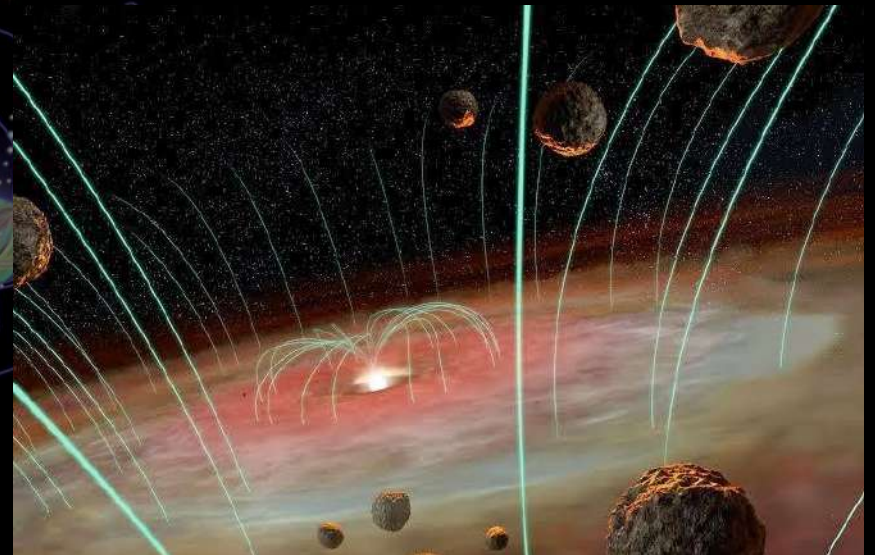
The oven settings: formation conditions

sub-structures

binary stars



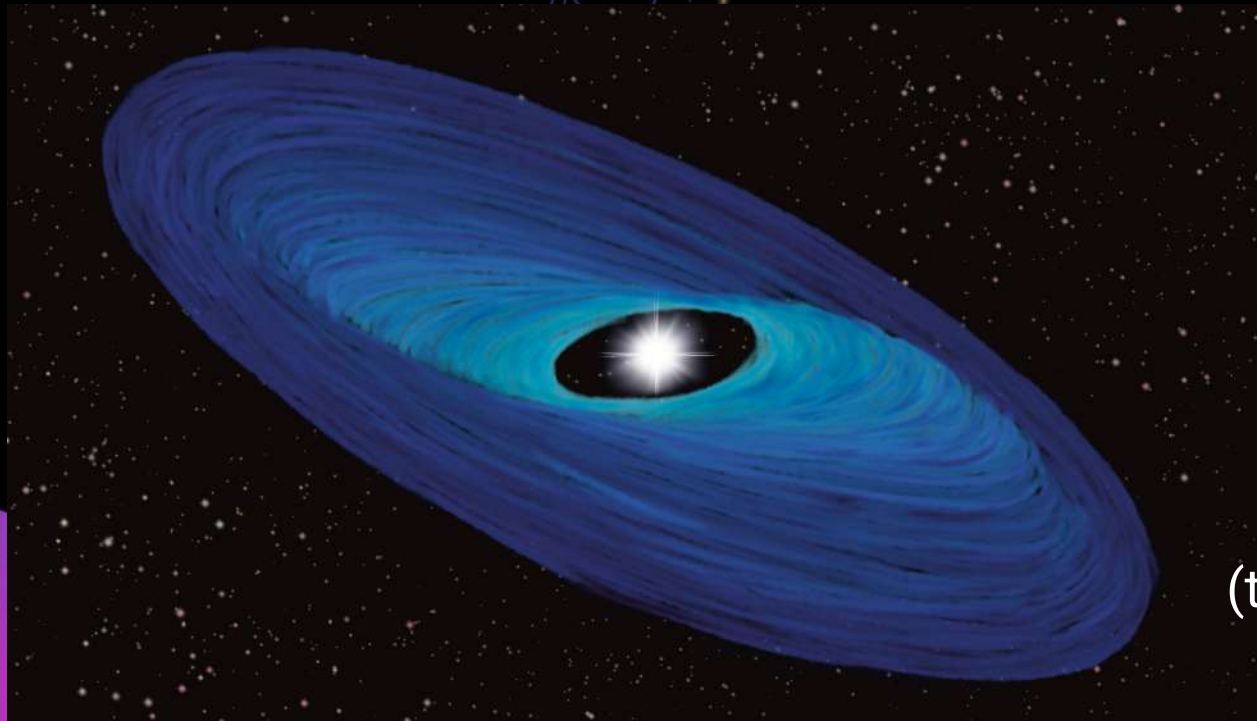
magnetic fields



The oven settings: formation conditions

sub-structures

other “weird” processes: warped disks

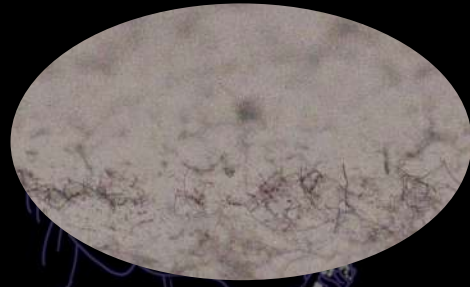
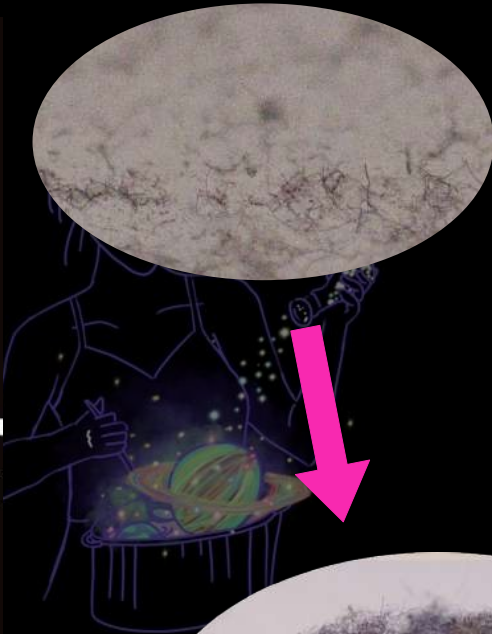
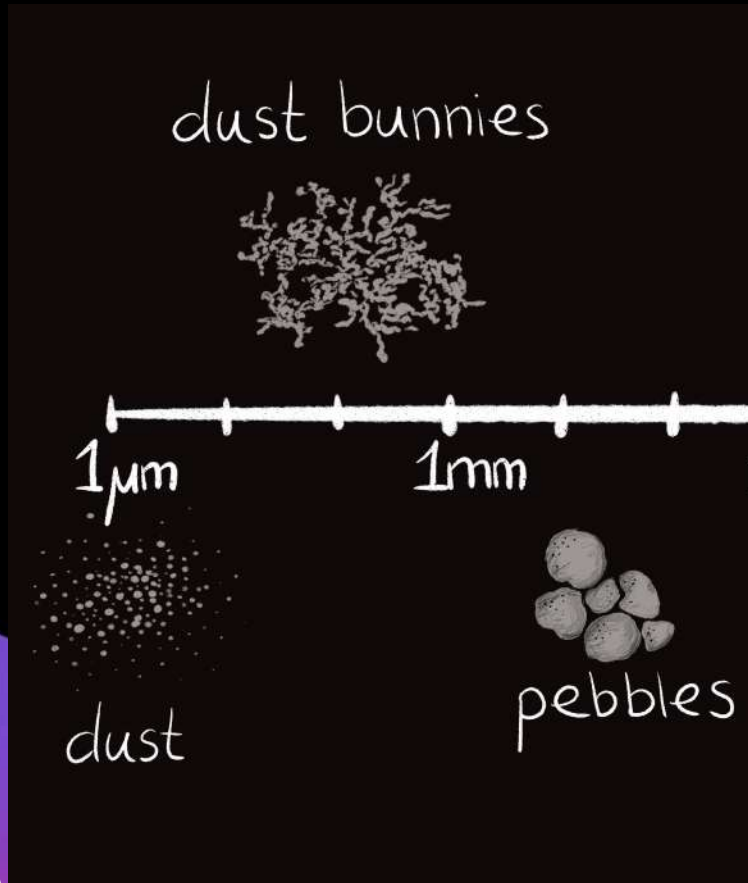


(this is my current
research area)

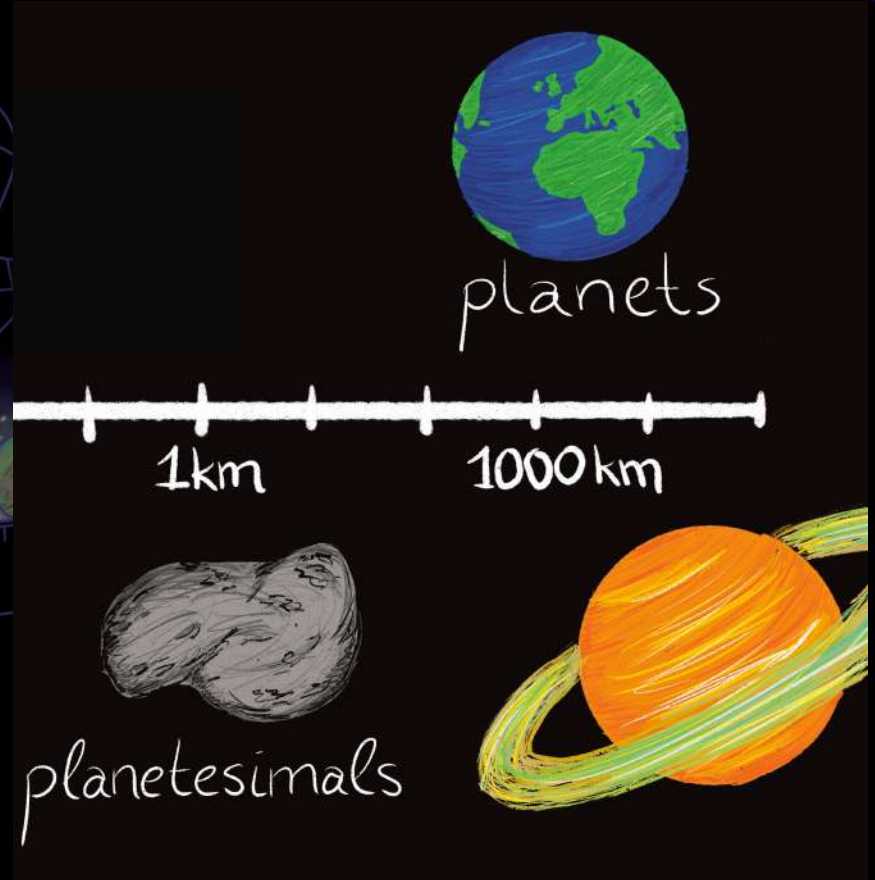
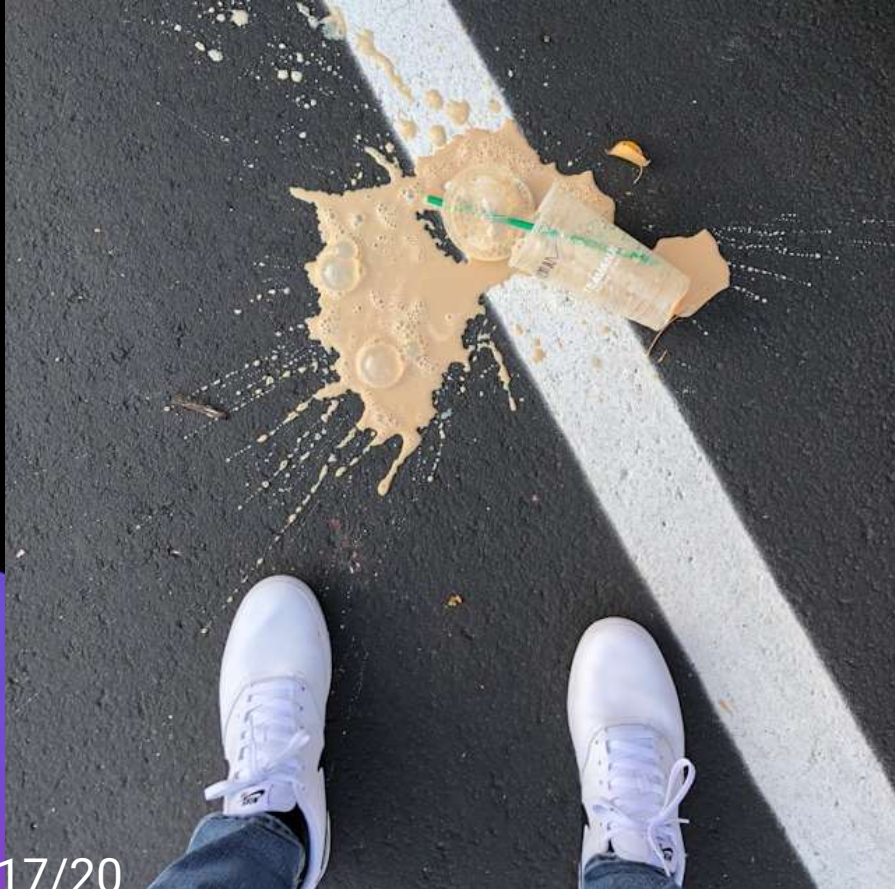
The baking process: how planets form



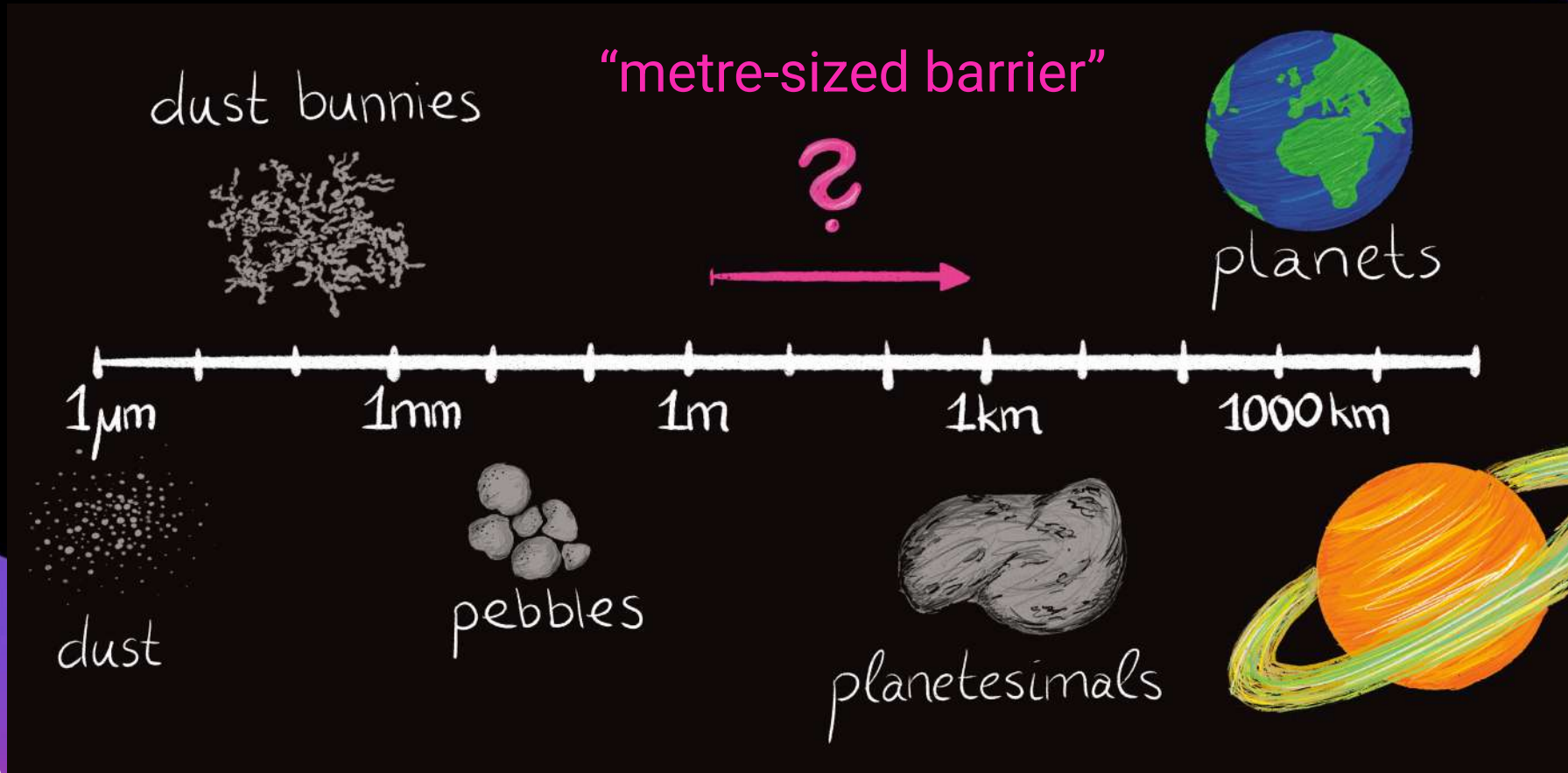
The baking process: how planets form



The baking process: how planets form



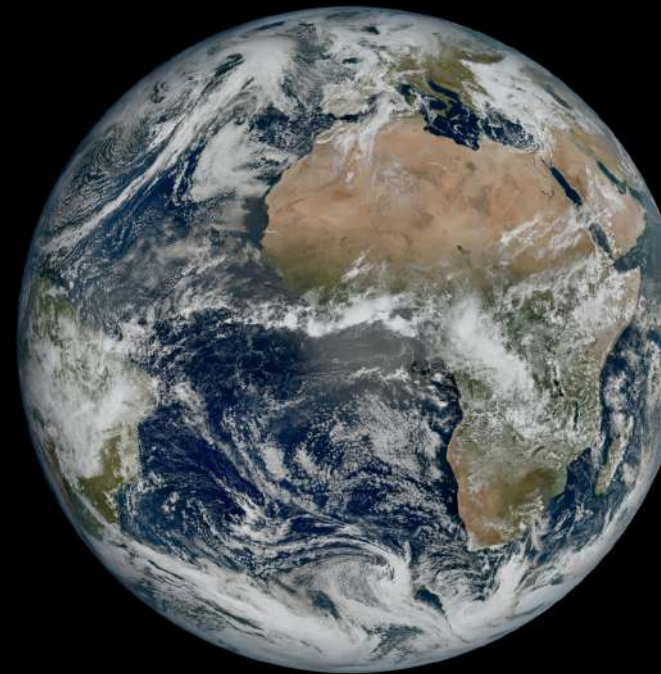
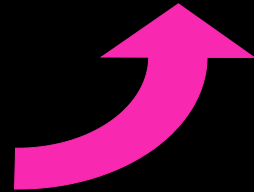
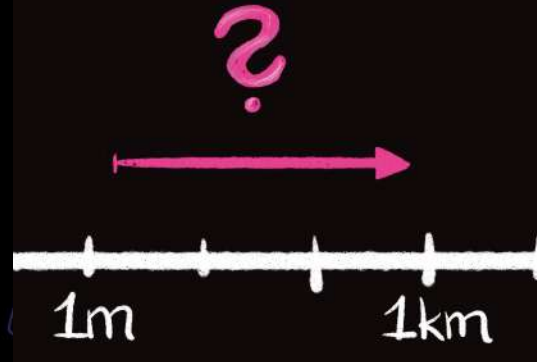
The baking process: how planets form



The baking process: how planets form



“metre-sized barrier”



The baking process: how planets form

solution to the metre-sized barrier: sub-structures!




The baking process: how planets form

Planet formation
caught in the act!

PDS 70



Summary – not a piece of cake...

- Planets are **common**.
 - Protoplanetary discs are the **birth places** of planets.
 - To understand planet formation, we need to understand **protoplanetary discs**.
 - There are still many **unsolved questions**. This is why the research in the field matters!
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Thank you for listening!

Questions?

