



Enceladus -home of extraterrestrial life?

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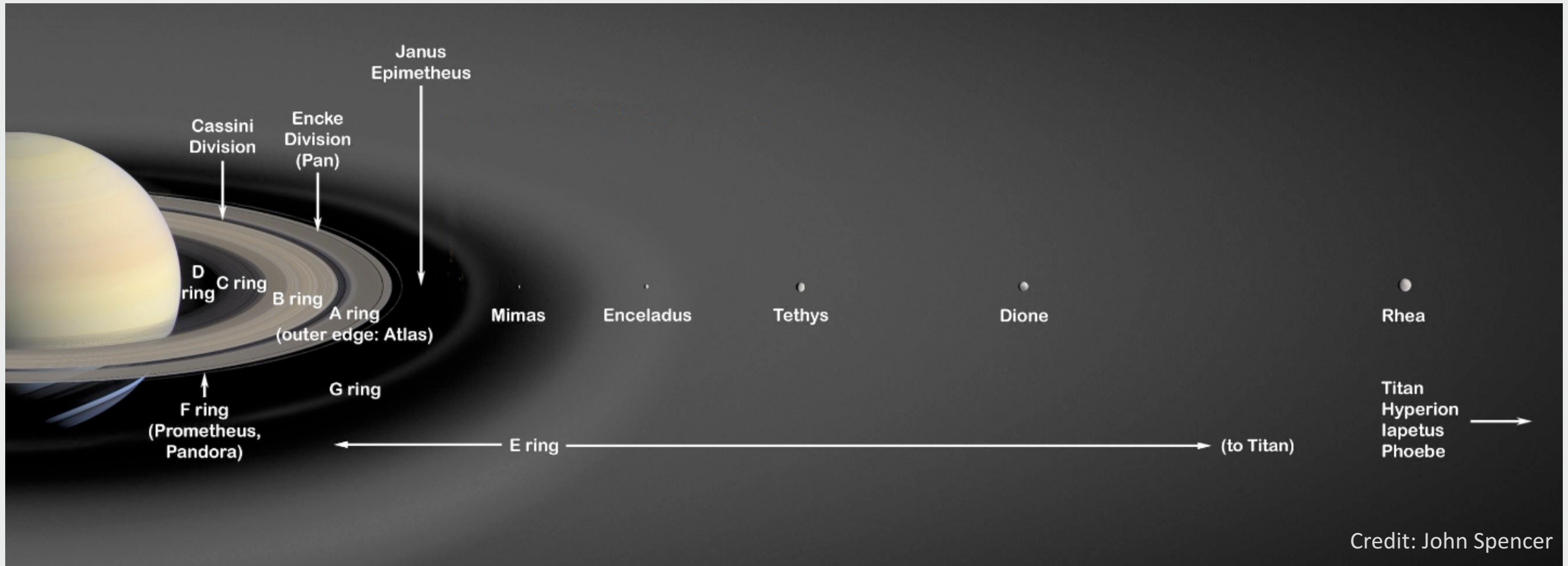


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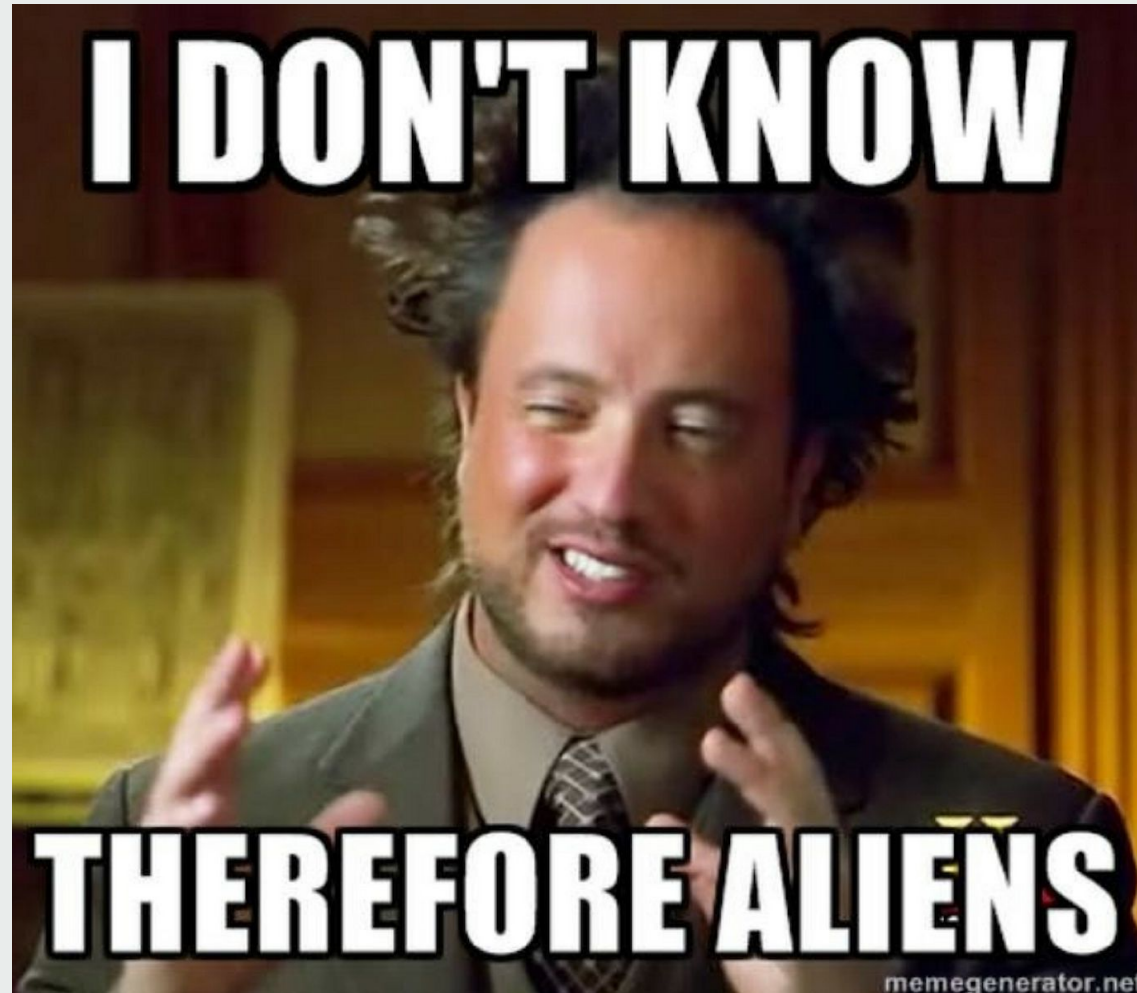
**German
Aerospace Center**

Just one of Saturn's icy moons?



With a position at 10 AU, Enceladus is far outside the habitable zone!

...but as we all know, aliens must exist....



Credit: John Spencer

Credit: Image.google.de

So, let's have a closer look:

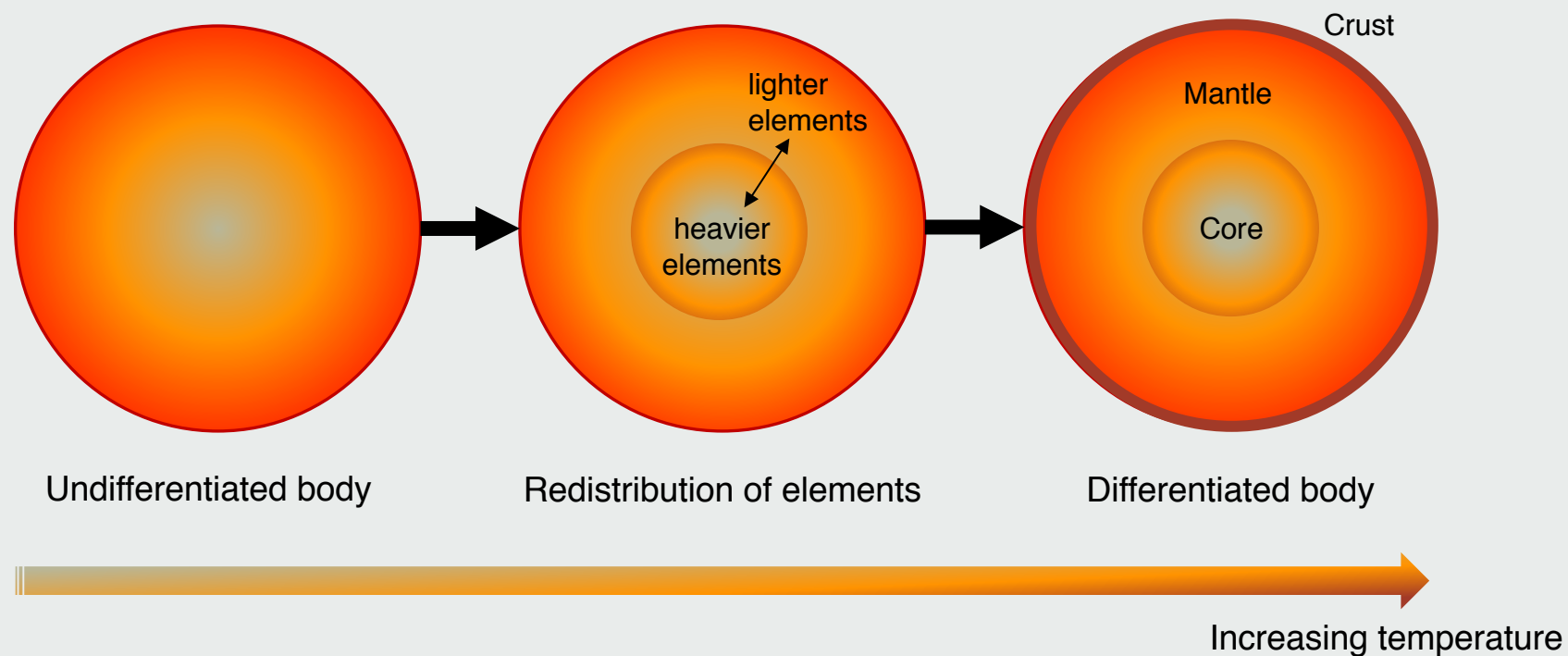
- Diameter of about 500 km
- Surface temperature of about $-200\text{ }^{\circ}\text{C}$
- Very high albedo
 - > Due to young icy surface
 - > **Geologically active body**
- Moment of inertia = 0.335 (0.4 for homogenous rocks)
 - > **Enceladus is a differentiated body**



Enhanced colour image from Cassini. Credit: NASA

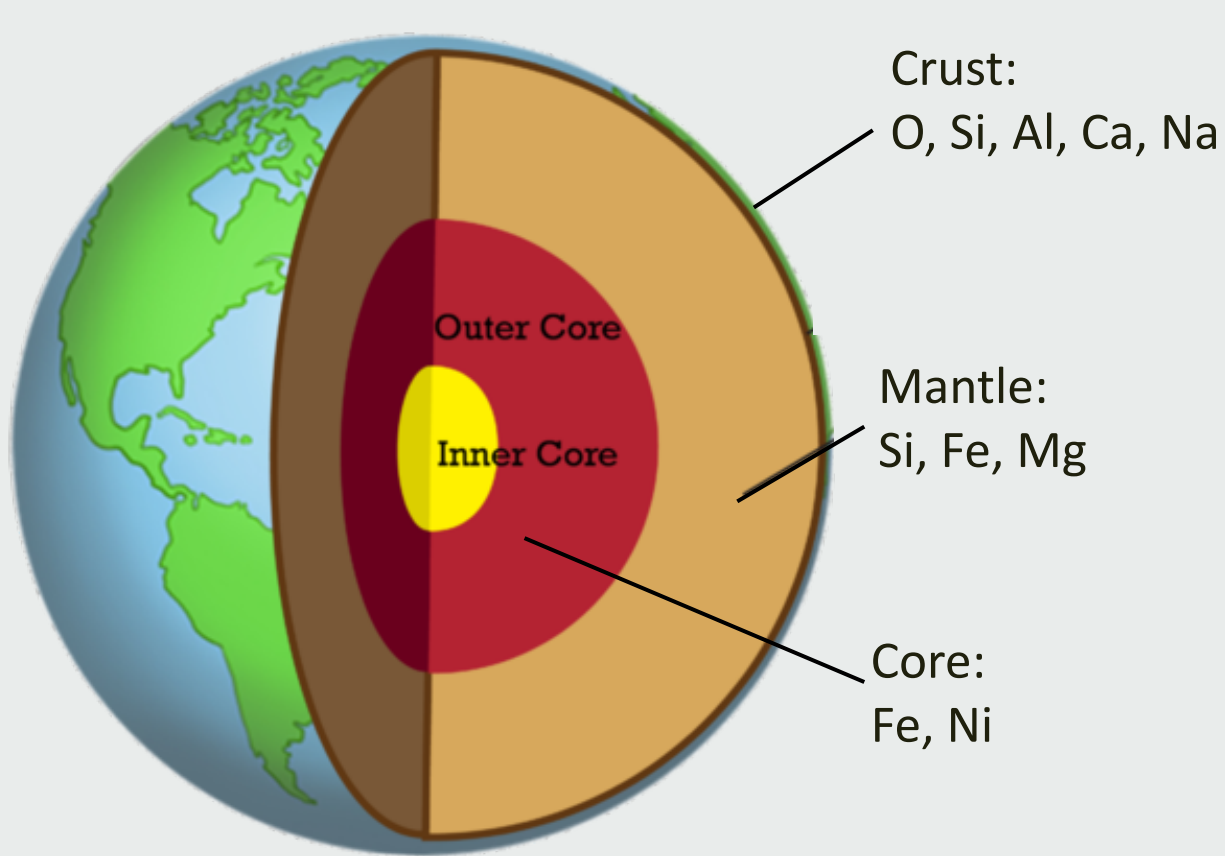
Differentiation of planetary bodies

- Accretion of “random” material in young solar system
 - Heating after accretion due to decay of short-lived (now distinct) isotopes - e.g. ^{26}Al
- > Bodies large and old enough to inherited sufficient short-lived isotopes got melted and have separated



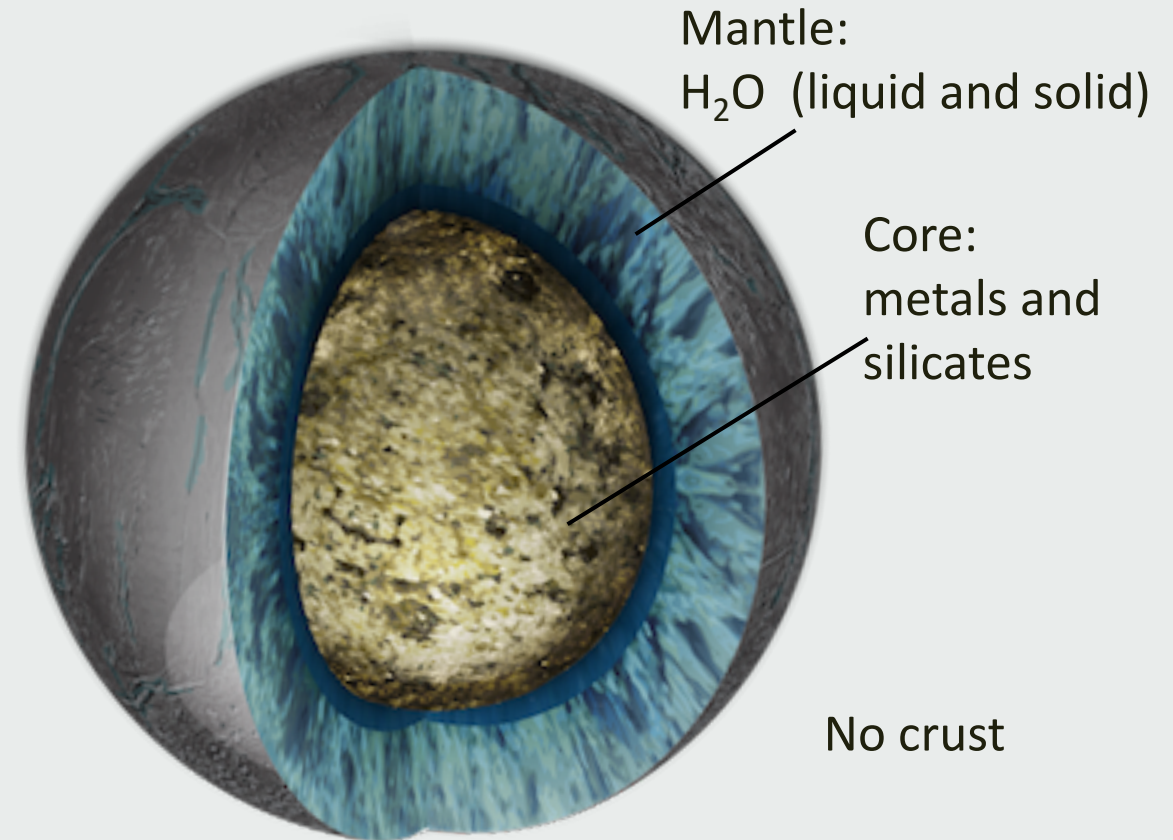
Differentiation of planetary bodies

Earth: bulk density of $\sim 5.5 \text{ g/cm}^3$



Credit: ubisafe.org

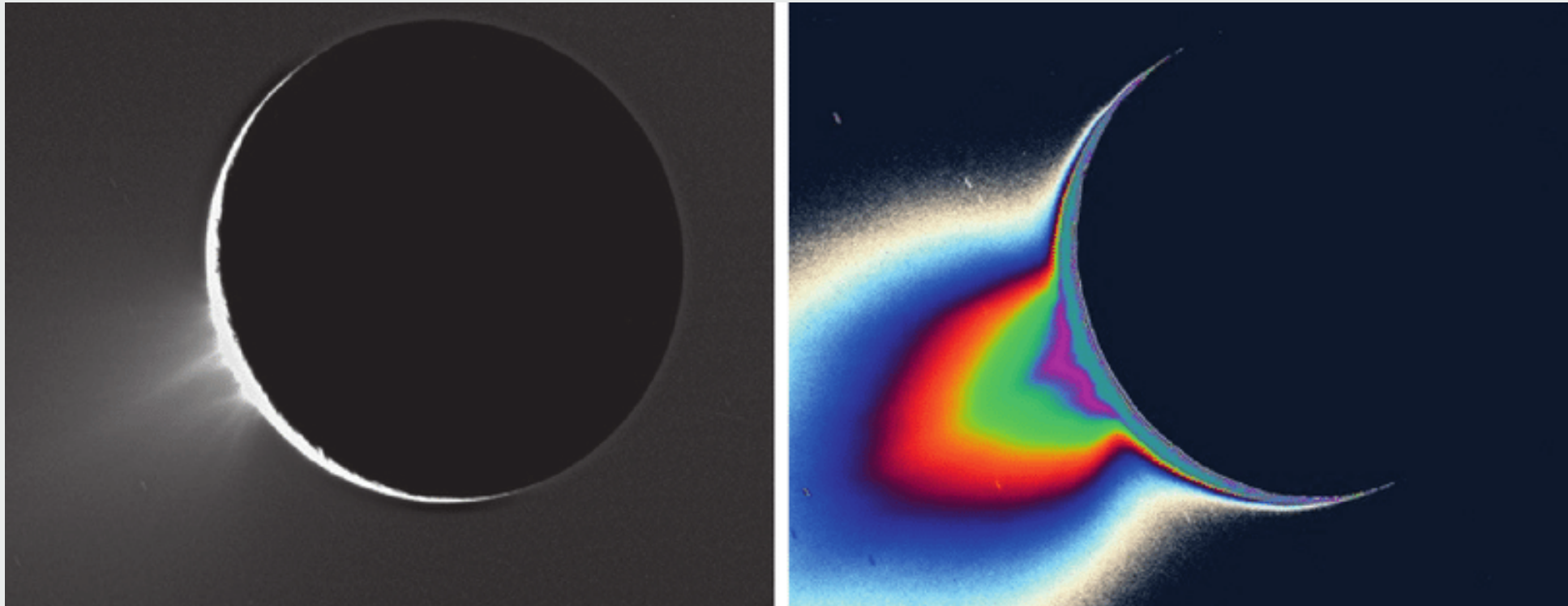
Enceladus: bulk density of $\sim 1.6 \text{ g/cm}^3$



Credit: hagablog.co.uk

Cassini's discoveries I

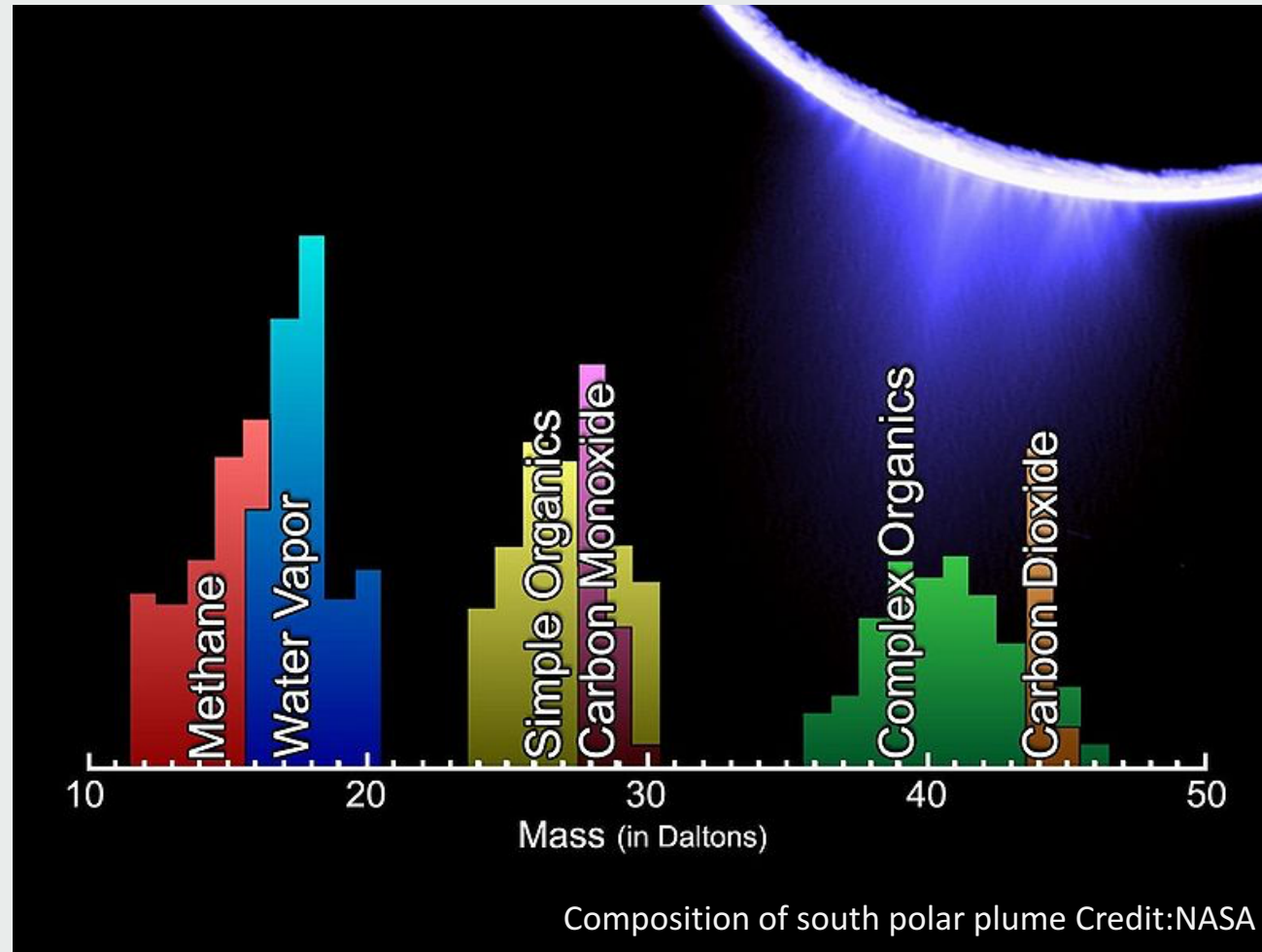
2005: south polar plume (cryovolcanism) on Enceladus discovered by distant high phase imaging
-> Enceladus unite liquid water with thermal energy



Enhanced pseudocolour image from Cassini. Credit: NASA and Porco et al. 2016

Cassini's discoveries II

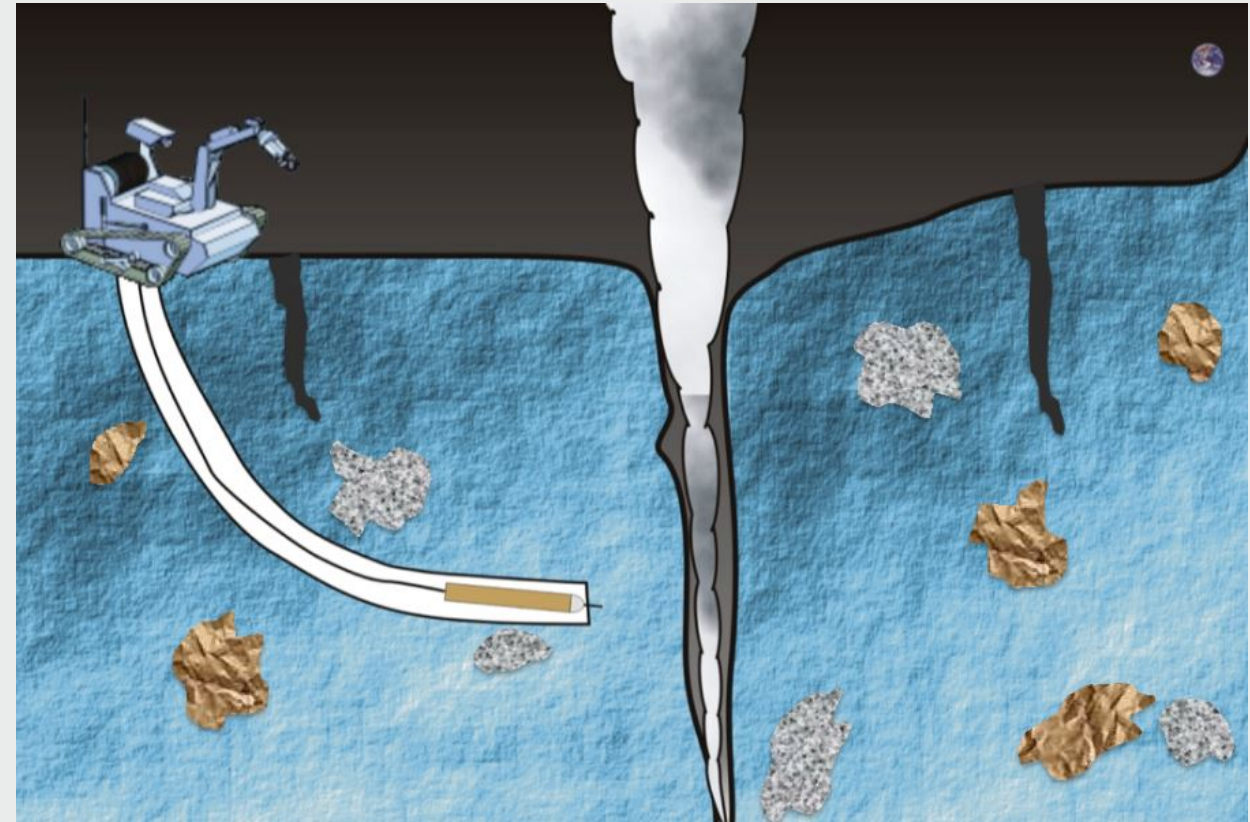
2005: 175 km flyby allowed in situ measurements of plume later in the year



The EnEx-Project

Enceladus Explorer is a planned mission to sample Enceladus' subsurface water

- A melting probe, a.k. icemole, is going to melt its way through the icy crust
- Until it reaches a water-filled crack, supplied by the cryovolcanism
- One major task of this mission is the detection of
 - A good landing side
 - A waterfilled crack
 - Positioning of icemole



EnEx Szenario Credit:FH Aachen

EnEx-AsGAR

Within EnEx-Project:

- Imaging of surface topography (Phase 1)
- Detection of water filled cracks (Phase 2)
- Positioning of icemole (Phase 3)

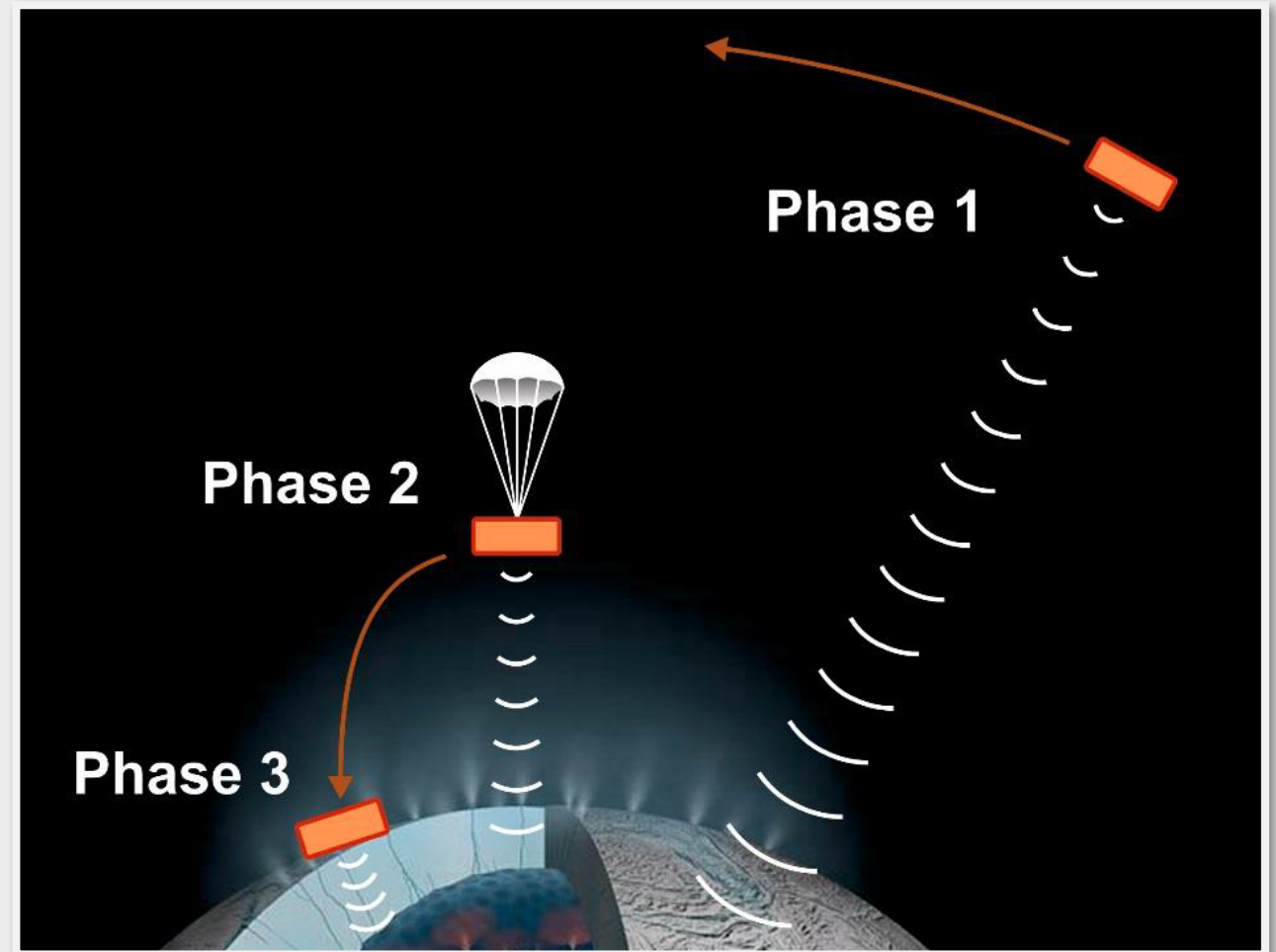
-> Based on radar techniques

Challenges:

Permittivity of ice

Attenuation on ice

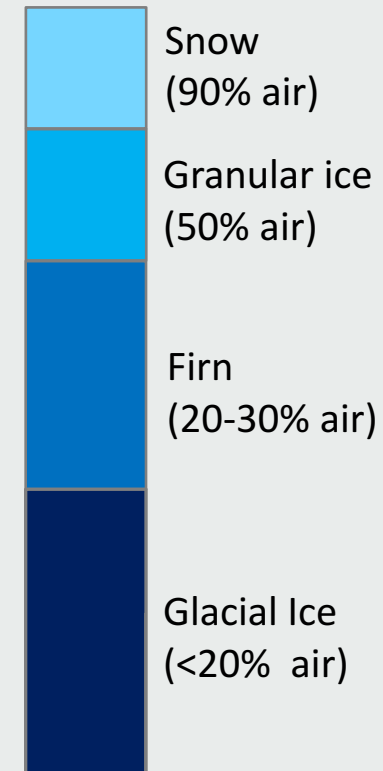
...are unknown on Enceladus



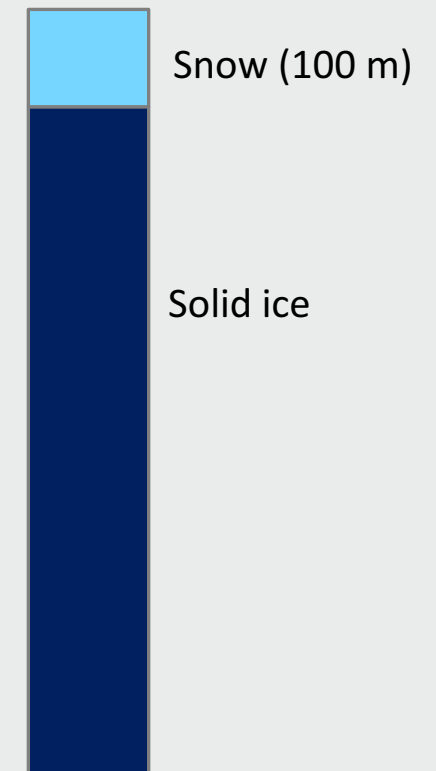
Forefront approaches

Ice properties:	Terrestrial Glacier	Enceladus
Phase	Hexagonal crystals (I_h)	Hexagonal crystals (I_h)
Temperature	Ca. -10 °C	Ca. -200 °C
Water content	Yes	No
Purity	Impure water ice	Pure water ice
Density	30 - 900 kg/m ³	mainly 920 kg/m ³
Layering	Complex stratification	2 layers

Glacier



Enceladus



Conclusion

- Enceladus is one of Saturn's icy moons
- But is special, because it unite liquid water and thermal energy
- Makes him one of the best candidates for extraterrestrial life
- Aim of EnEx-project: sample a subsurface water reservoir with melting probe
- Aim of EnEx-AsGAR: radar-based imaging and positioning techniques for EnEx

-> Challenges:

Permittivity of ice
Attenuation in ice } on Enceladus



How is all this related to astroparticles?

What is not related to astroparticles?

-especially when you manage to end up as a geologist in an astroparticle working group

Thanks for listening!