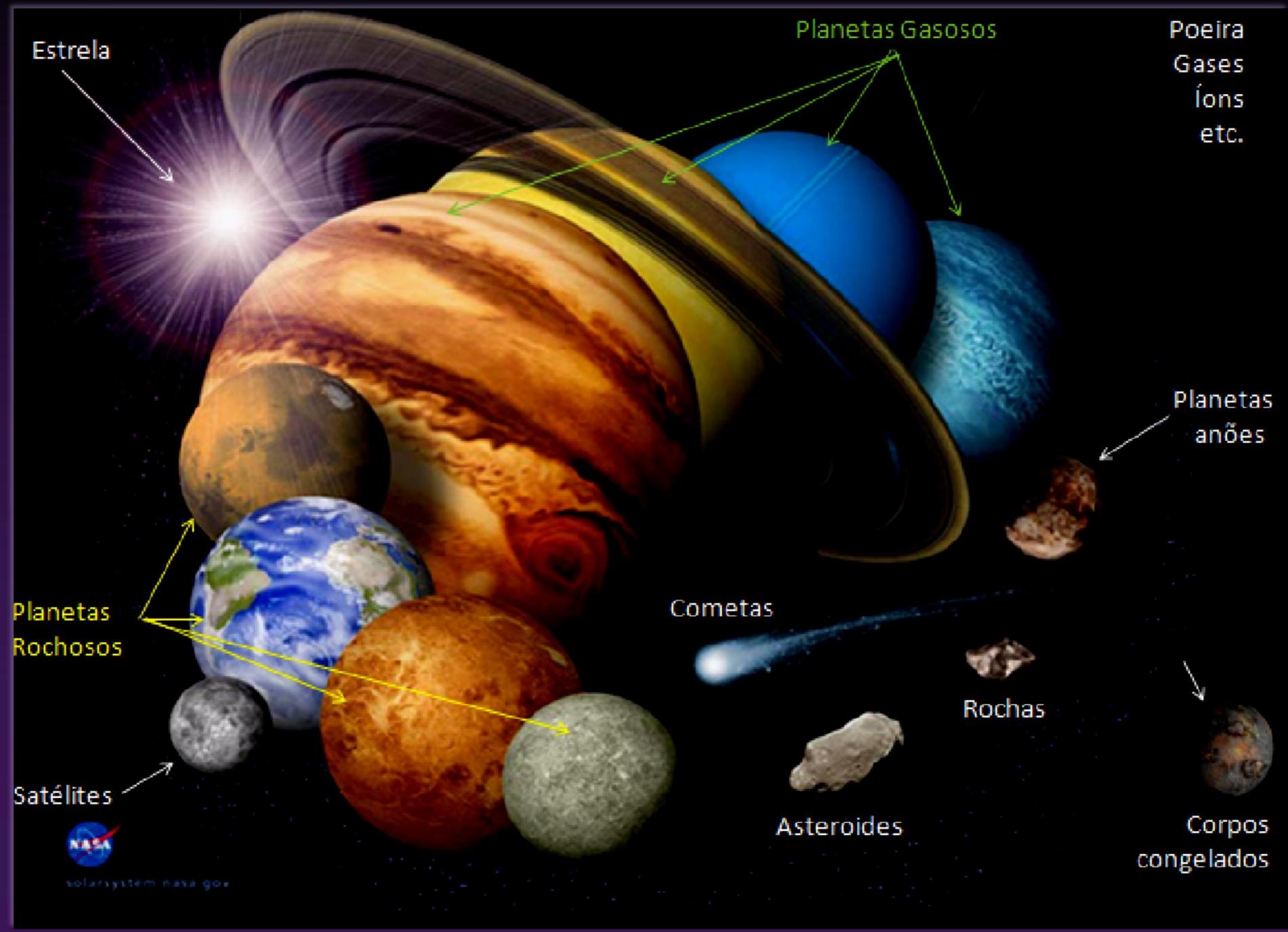


Sistema Solar. A família do Sol



Enos Picazzio
Astronomia para a Terceira Idade
IAGUSP - Maio 2024

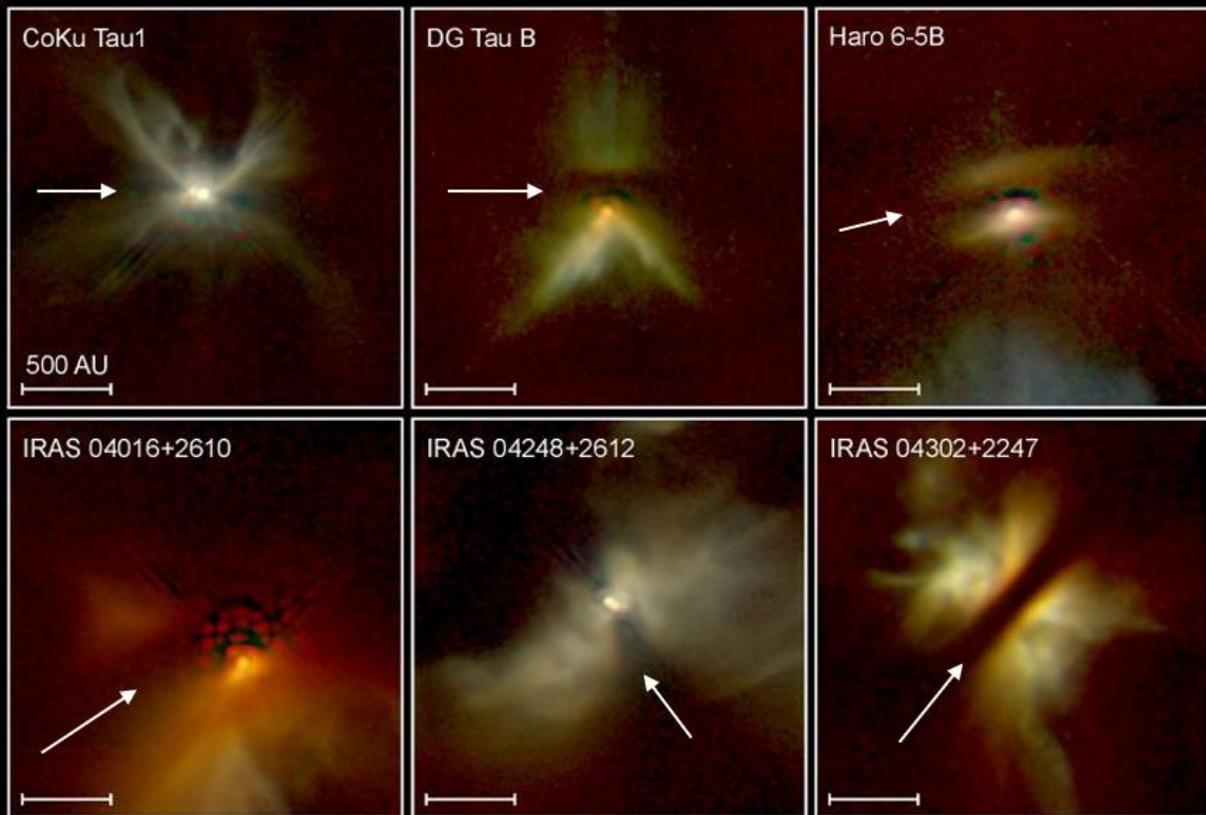
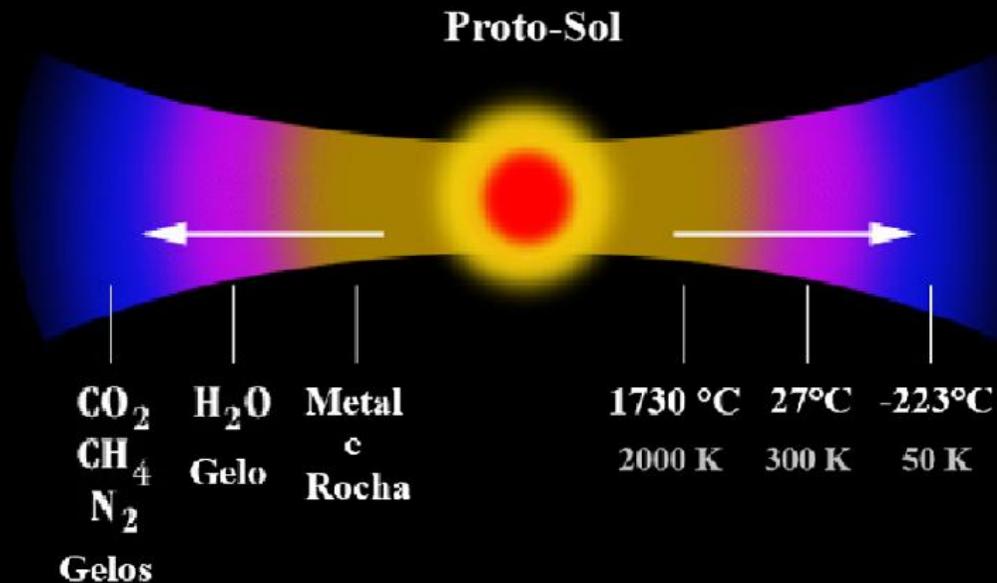
Nebulosa de Órion: um berçário de estrelas que está a cerca de 1.450 anos-luz da Terra.



Sistemas planetários em formação



- ❖ Durante a contração da nuvem forma-se um disco de matéria em torno da estrela nascente (protoestrela).
- ❖ Os objetos do sistema planetário da estrela formam-se nesse disco.



Young Stellar Disks in Infrared

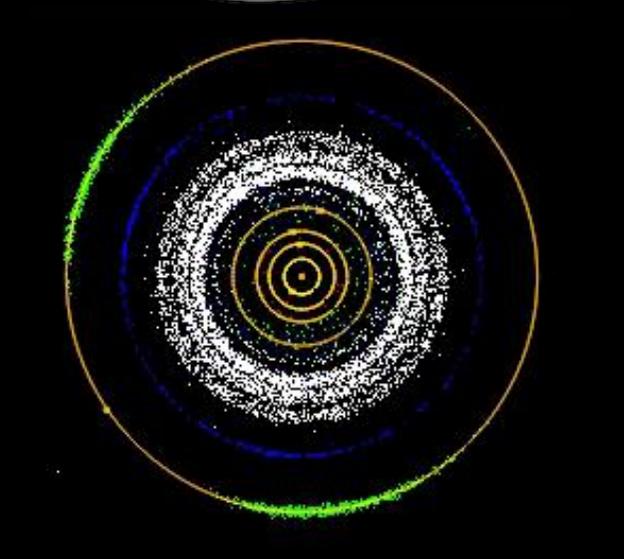
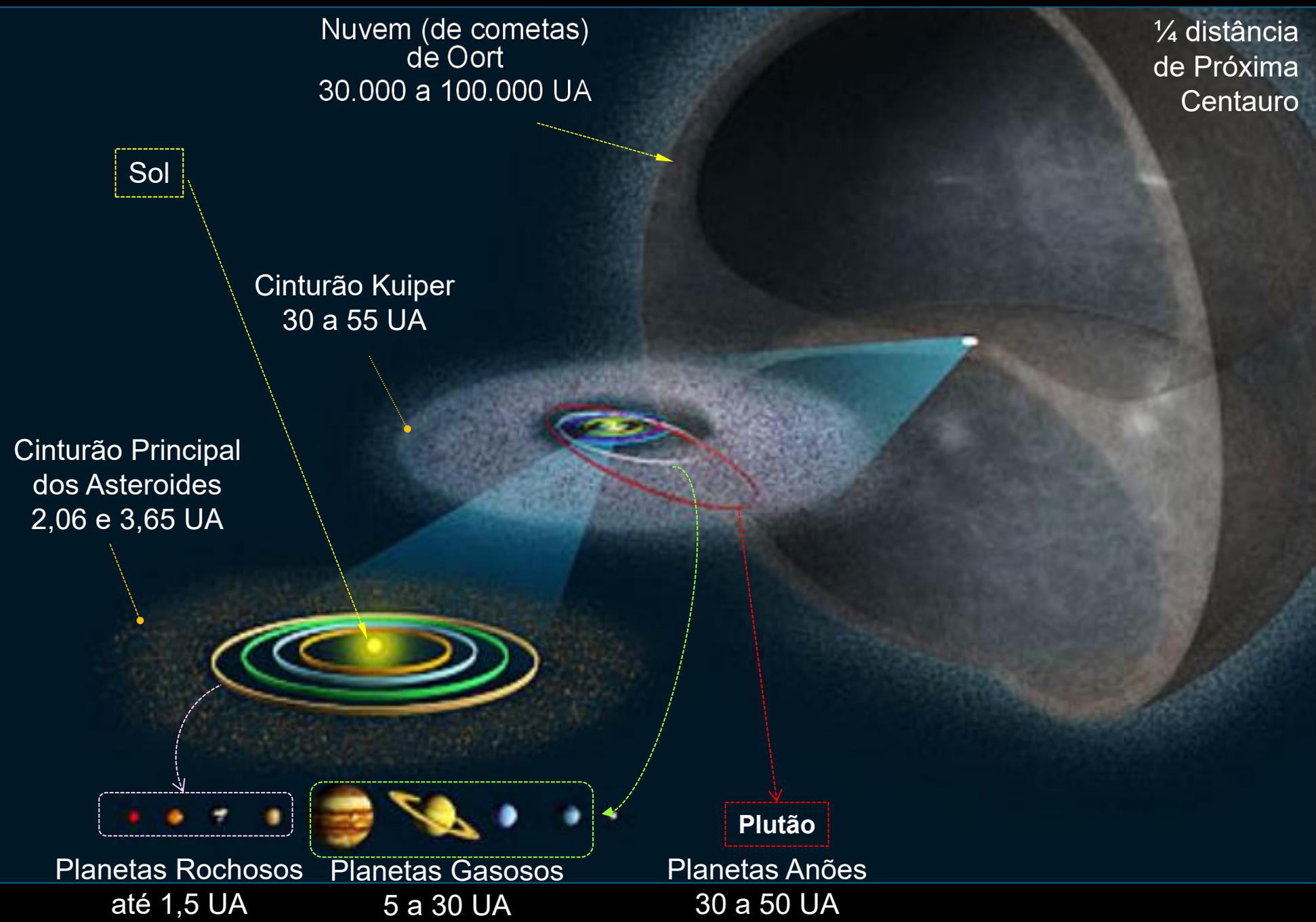
HST • NICMOS

PRC99-05a • STScI OPO

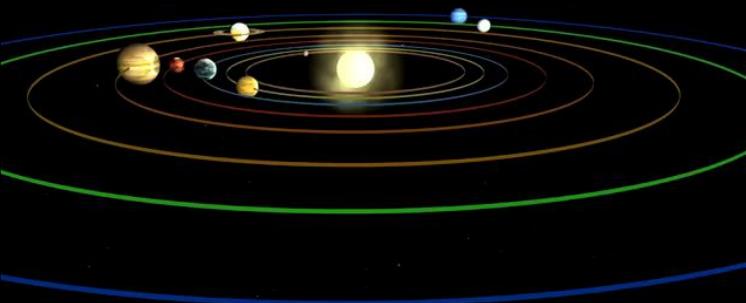
D. Padgett (IPAC/Caltech), W. Brandner (IPAC), K. Stapelfeldt (JPL) and NASA



Tamanho e forma do Sistema Solar

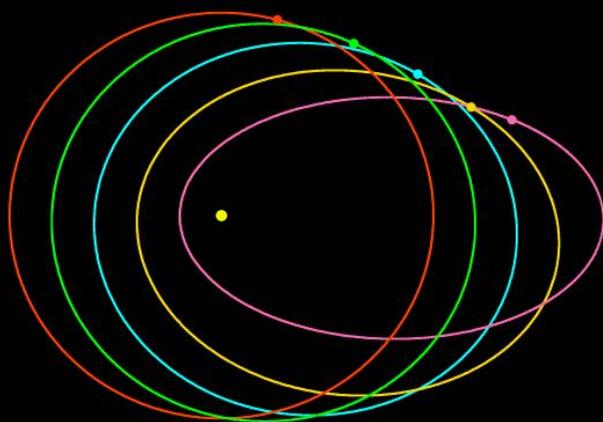


A estrutura do Sistema Solar

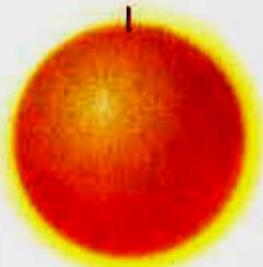


The Solar Svstem

2020-04-14 00:00 Orbital eccentricity



Órbita Circular:
Excentricidade é "0"
Velocidade é constante

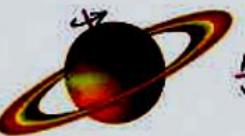


Sun

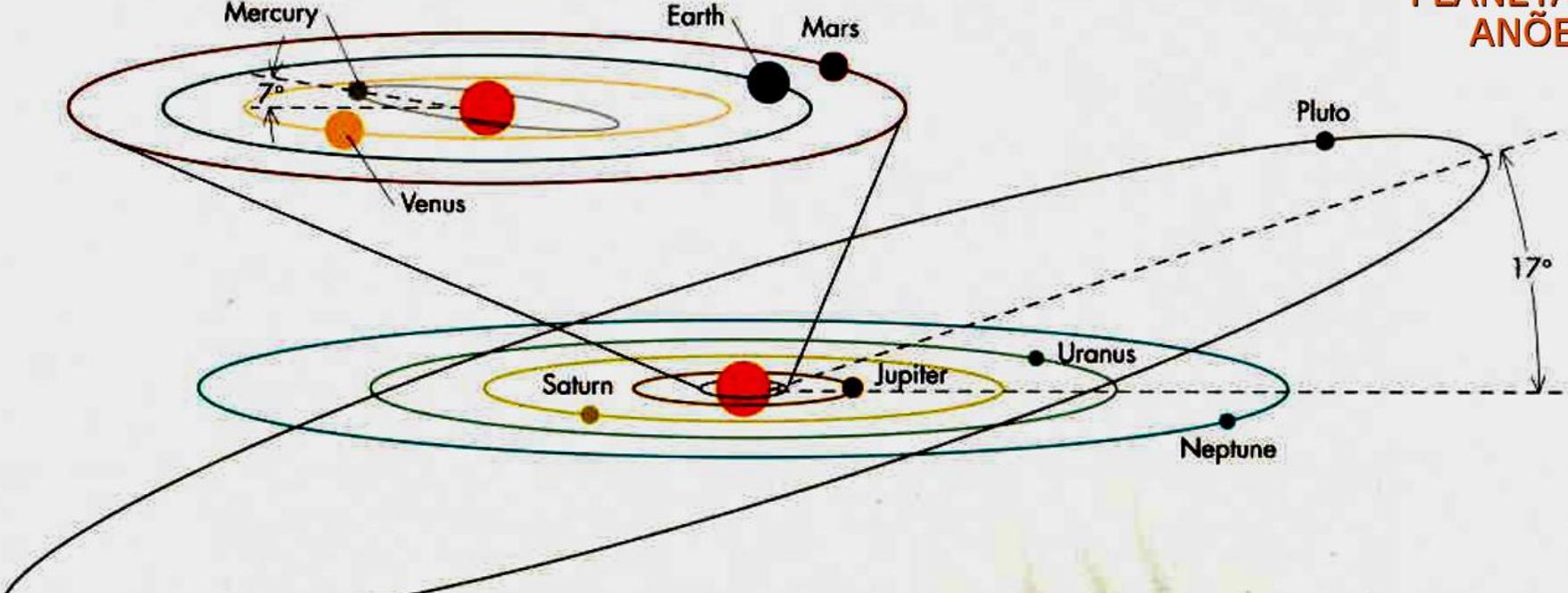
ROCHOSOS

0°	177.4°	23.5°	25.2°	
				
Mercury	Venus	Earth	Mars	Asteroids

GASOSOS

3.1°	26.7°	97.9°	28.3°	122.5°
				
Jupiter	Saturn	Uranus	Neptune	Pluto

PLANETAS ANÕES



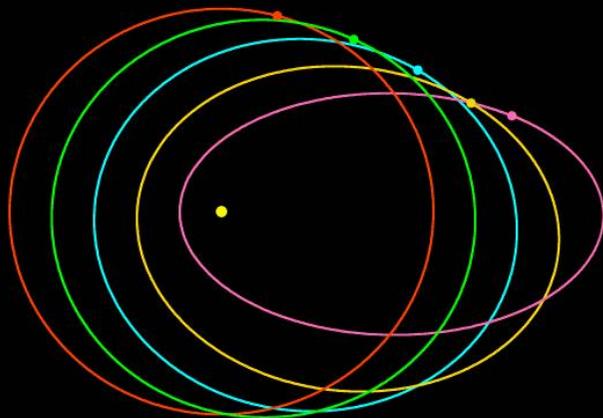
O plano básico do Sistema Solar é aquele que contém a eclíptica.
As órbitas dos planetas têm baixa excentricidade e estão praticamente sobre ele.

A estrutura do Sistema Solar

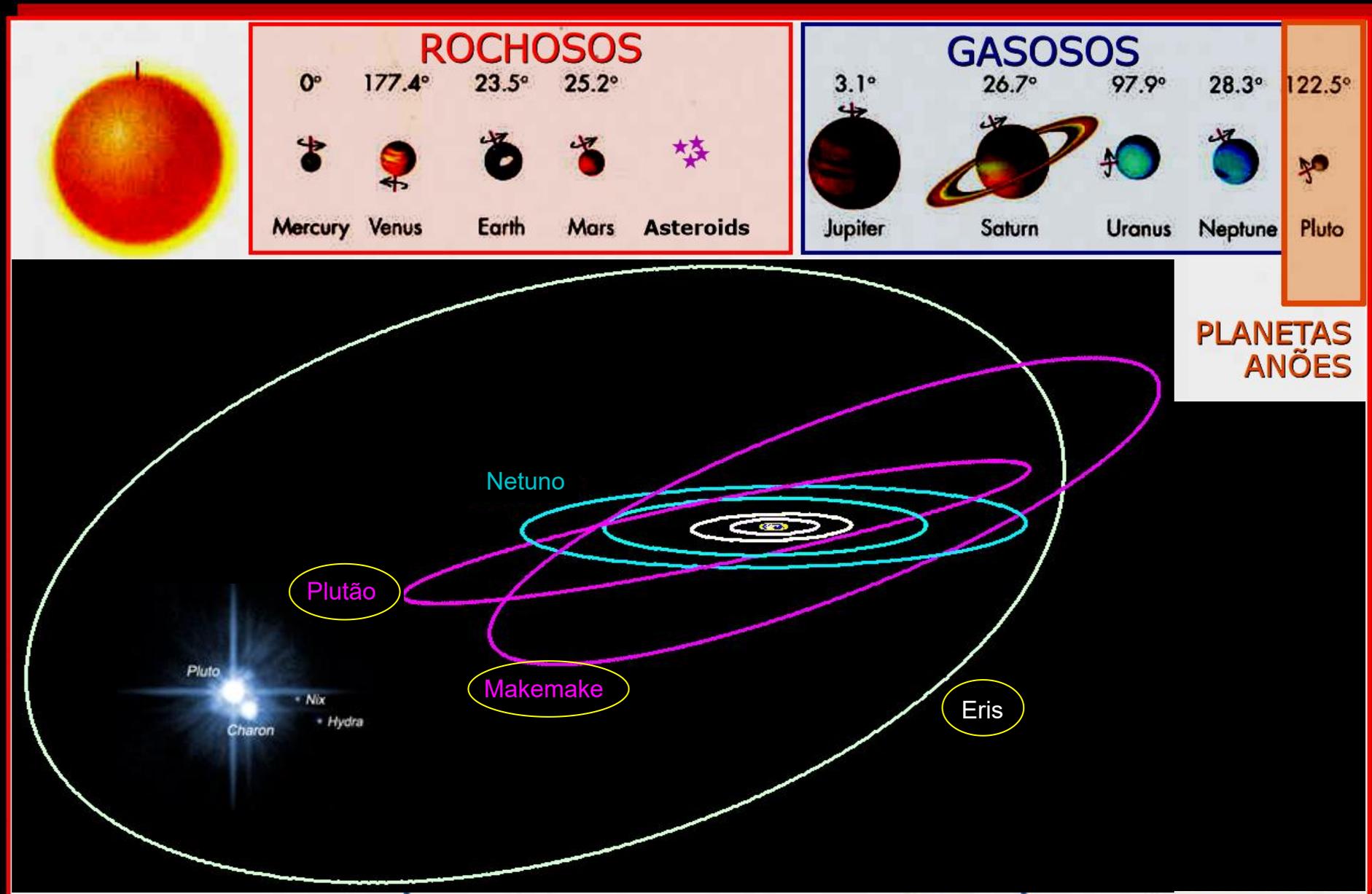


The Solar System

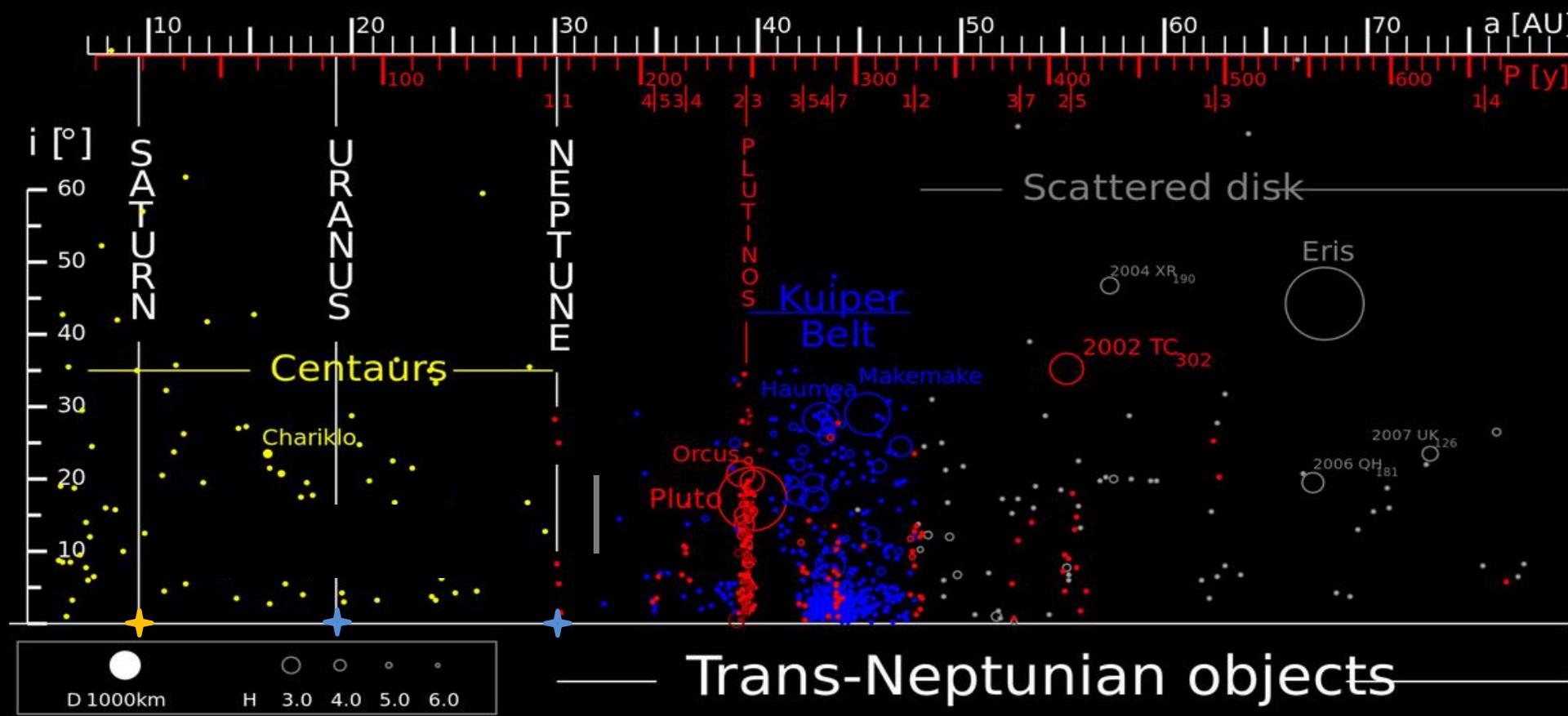
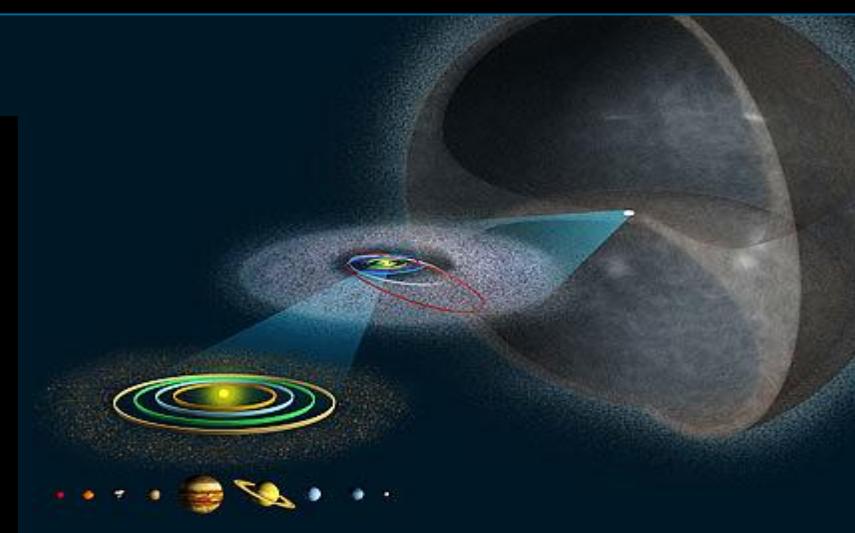
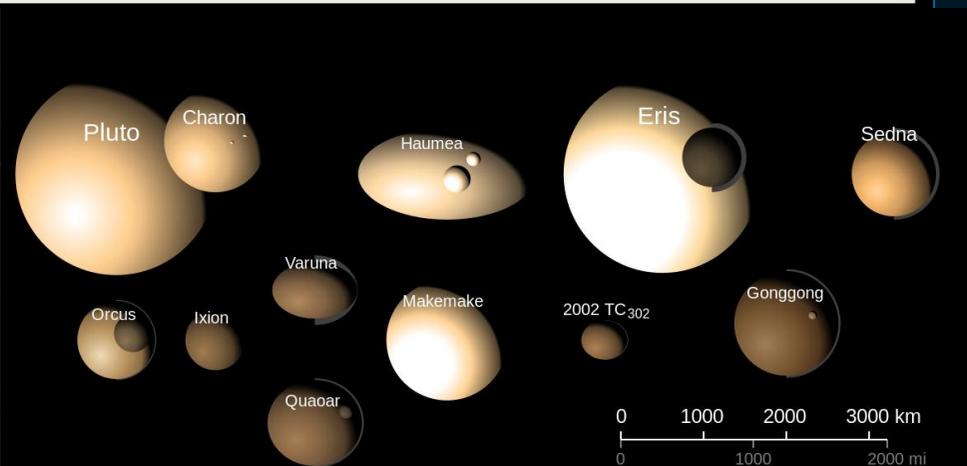
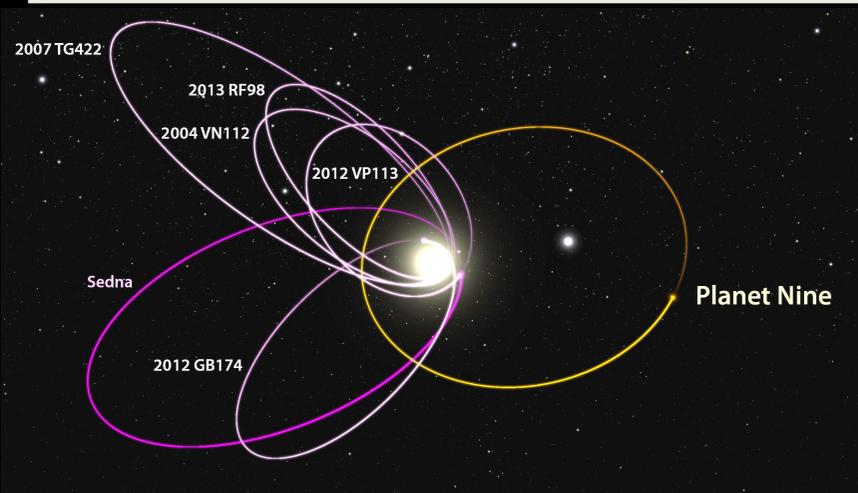
2020-04-14 00:00 Orbital eccentricity



Órbita Circular:
Excentricidade é "0"
Velocidade é constante



Região Transnetuniana



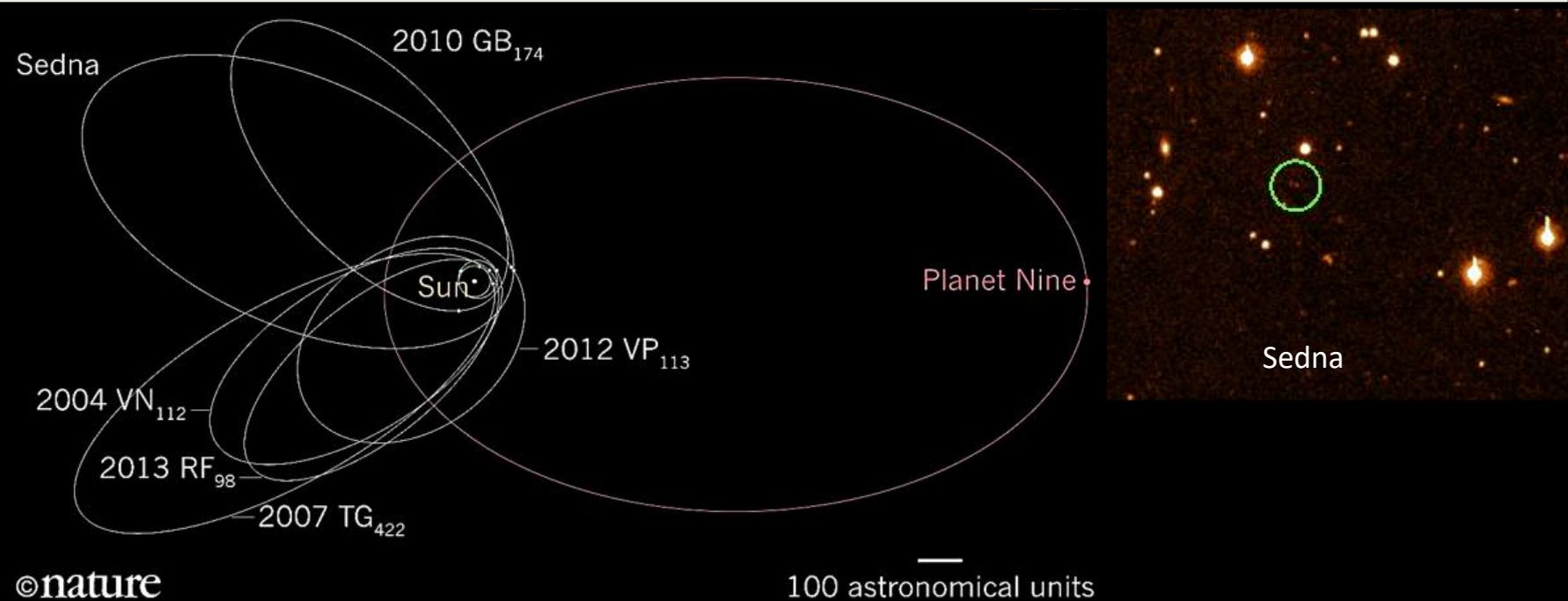
Nono planeta?



Mike Brown

A existência do nono planeta poderia explicar as formas estranhas das órbitas de vários objetos (órbitas em branco) do Cinturão de Kuiper

- Massa: ~ 6,3 vezes a da Terra
- Período: ~ 9.900 anos
- Periélio: ~ 340 u.a.
- Afélio: ~ 560 u.a.



Um planeta semelhante à Terra, com:

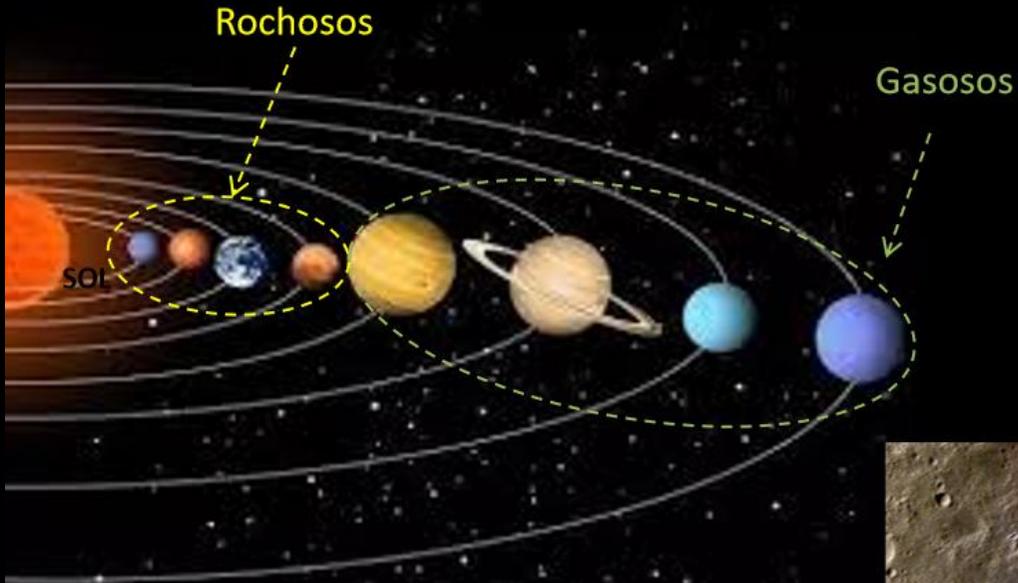
- Massa - de 1,5 e 3 M_T
- Distância - de 250 e 500 u.a
- Periélio ~ 200 ua
- Inclinação - 30°

pode explicar algumas propriedades do Cinturão de Kuiper:

Patryk Sofia Lykawka & Takashi Ito

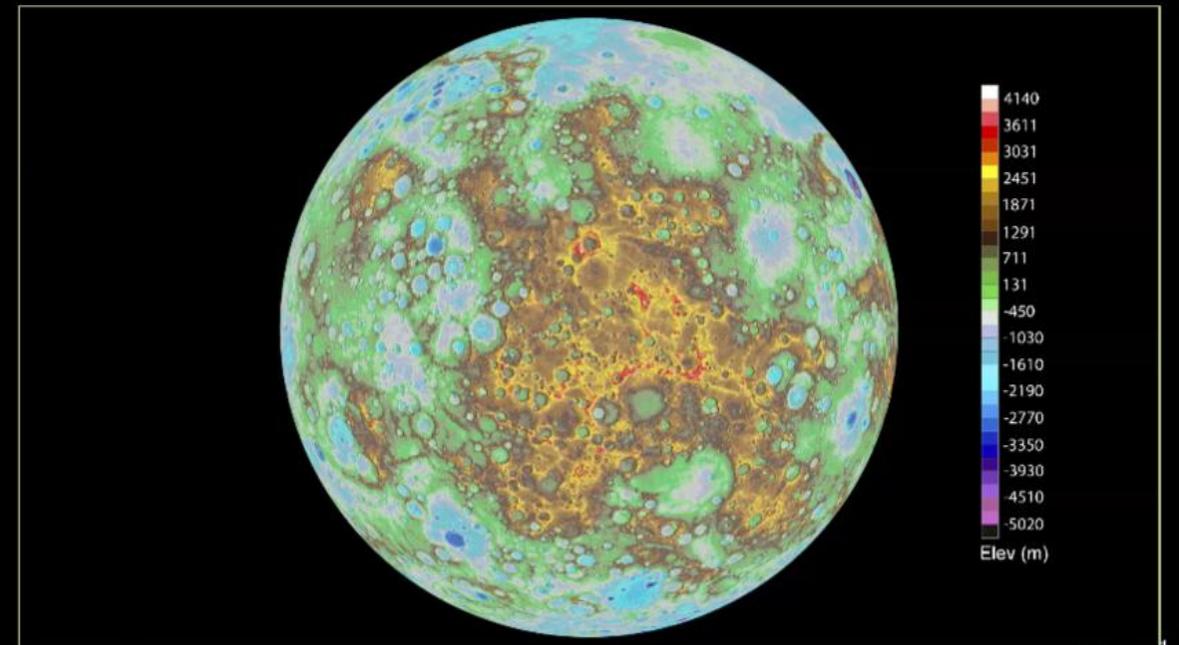
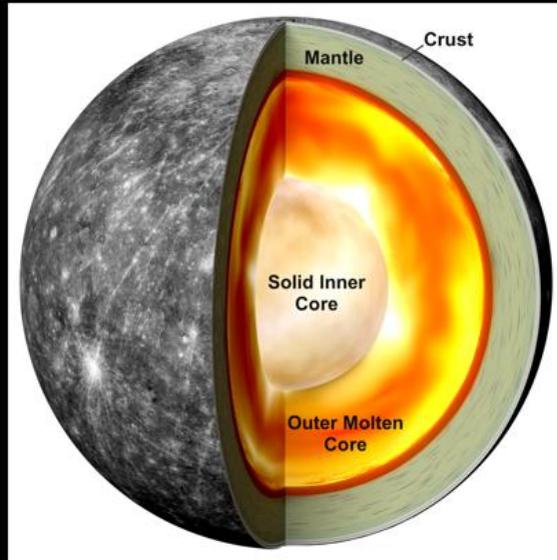


Mercúrio: o planeta mais próximo do Sol



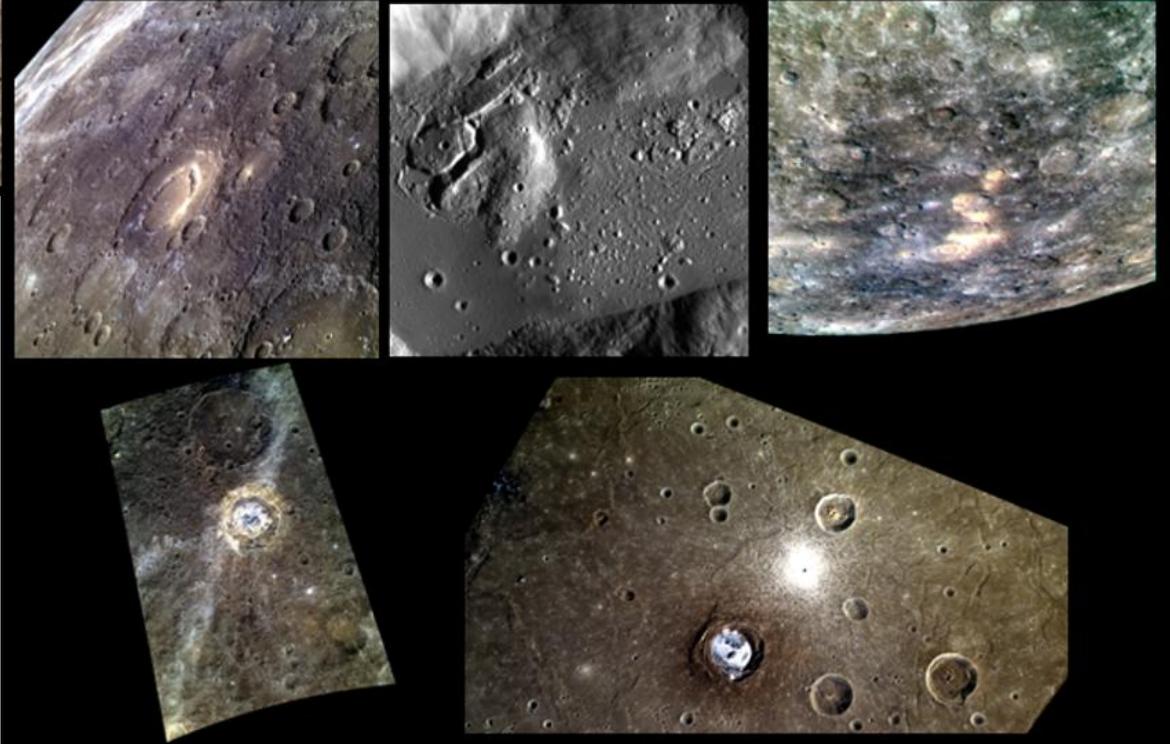
Tamanhos relativos

Temperatura: de 180°C a 430°C
Dia solar (um ciclo dia-noite completo)
equivale a 176 dias terrestres – pouco
Ano: 88 dias



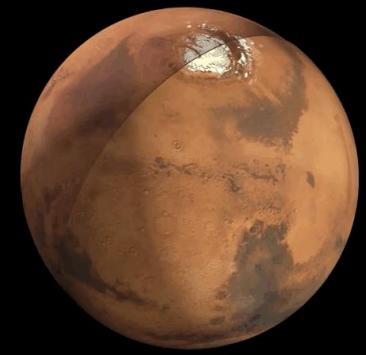
MESSENGER
Mercury Surface, Space Environment, Geochemistry, and Ranging

NASA CARNegie INSTITUTION FOR SCIENCE JPL of the University of California JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY

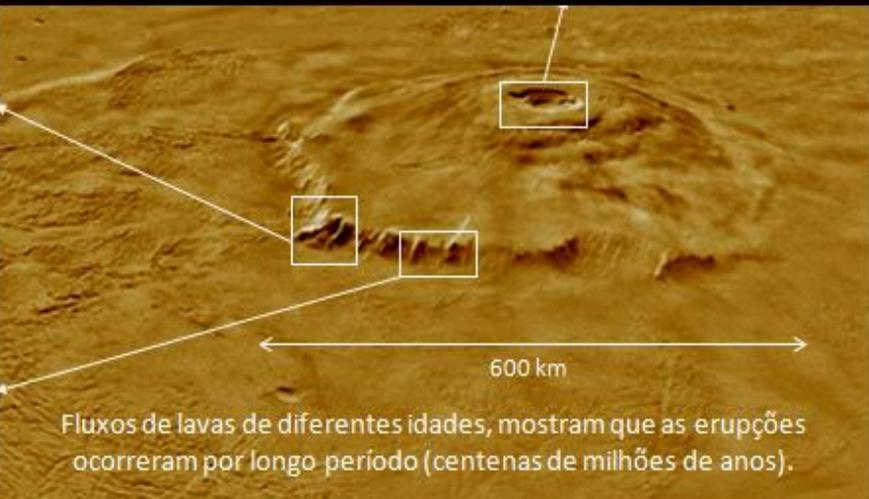
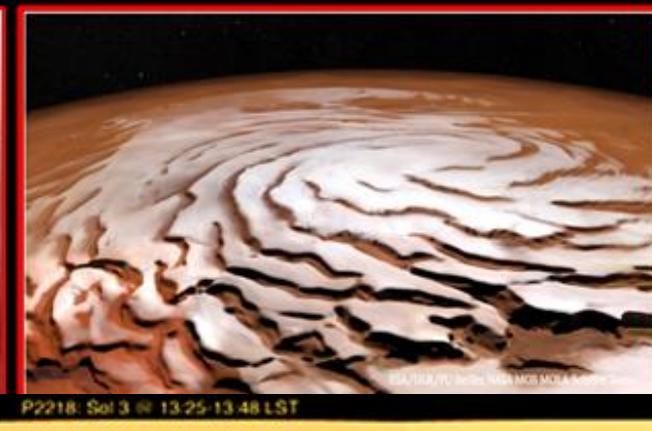
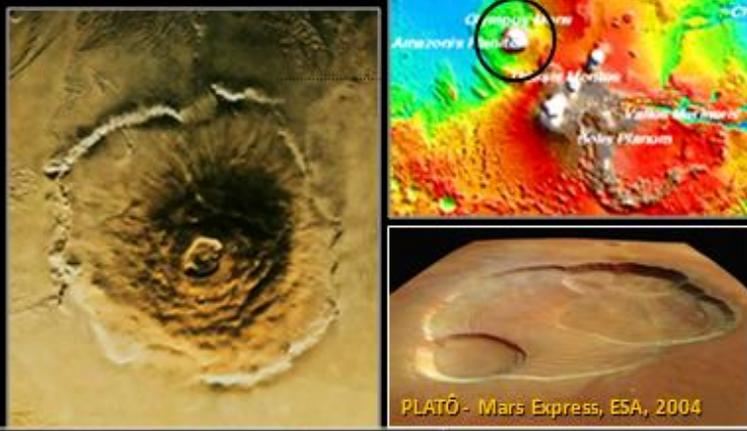


Marte. Pequeno, árido e vermelho

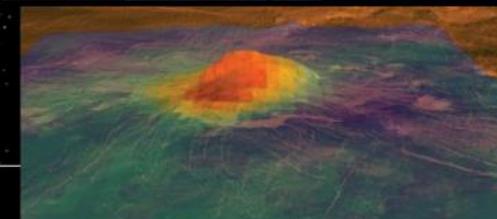
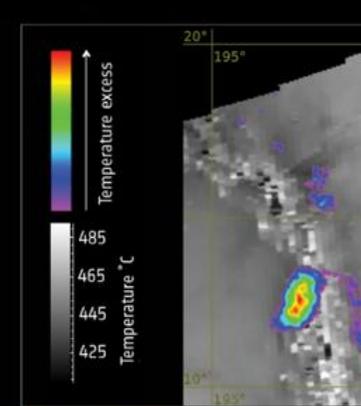
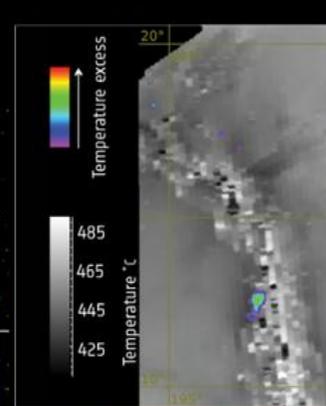
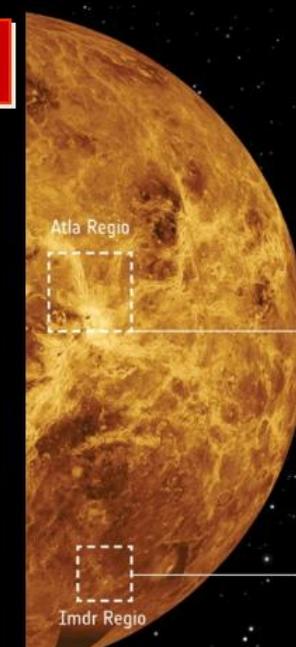
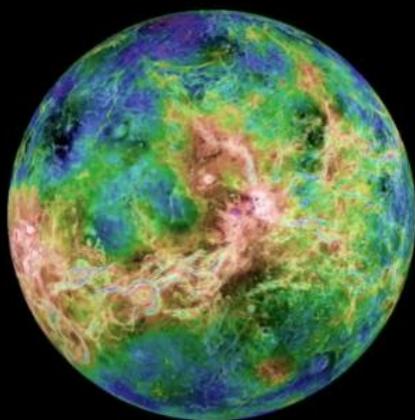
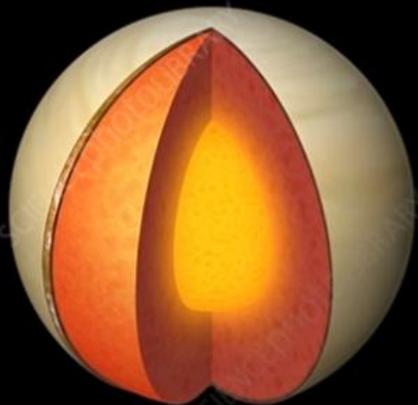
(Dia = 1d 0h 37m; Ano = 687 dias; Temperatura = de -125 °C a 22 °C)



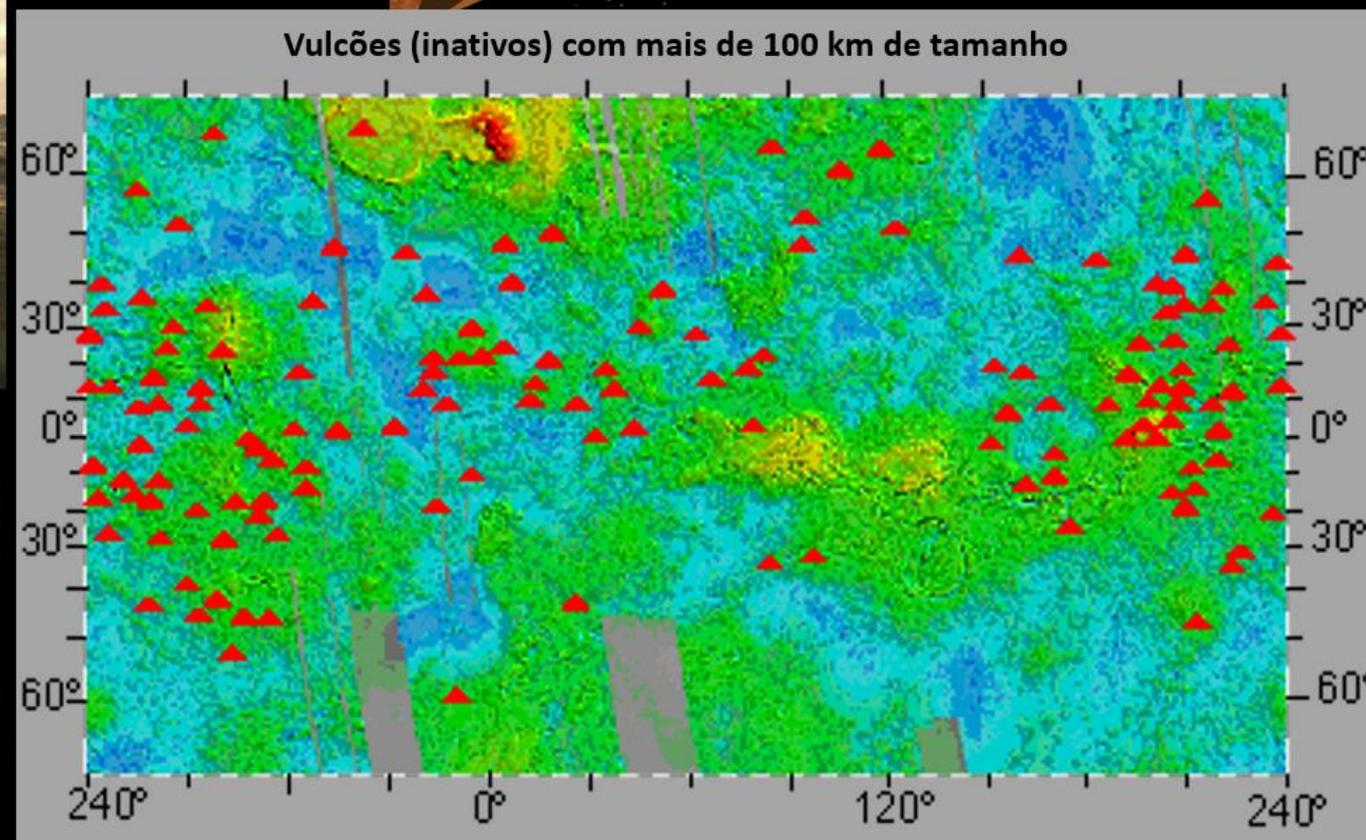
Dióxido de Carbono (CO₂) e Água (H₂O) congelados



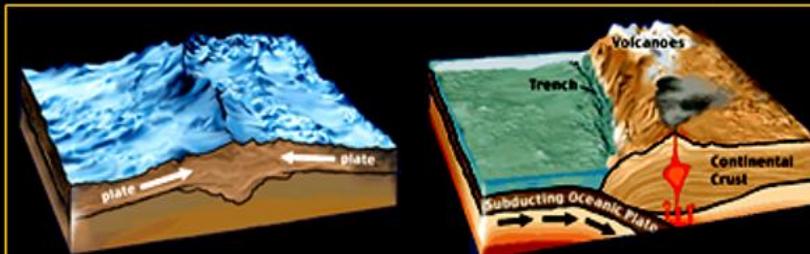
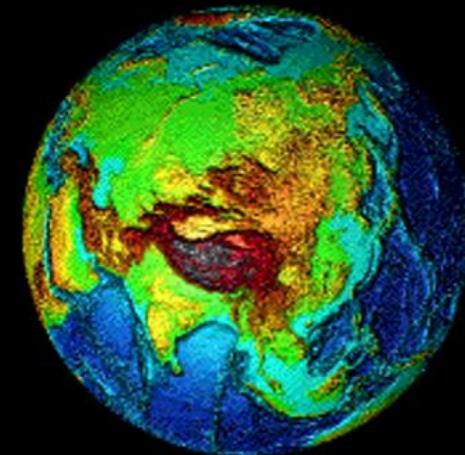
Vênus. Um ambiente tórrido (Dia solar: 116d 18h; Ano: 225d; Temp: 475 °C)



Sonda russa Venera

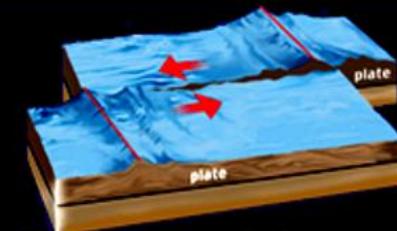


Terra. Um planeta dinâmico



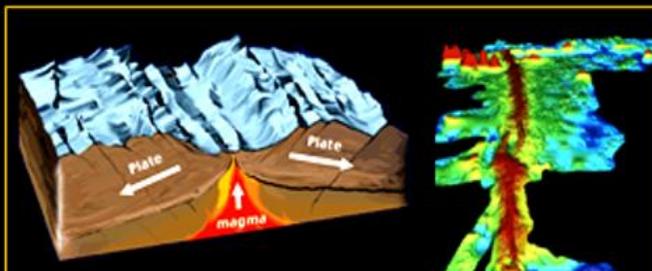
Tectonismo por colisão entre placas

Margens Destrutivas
(convergência)



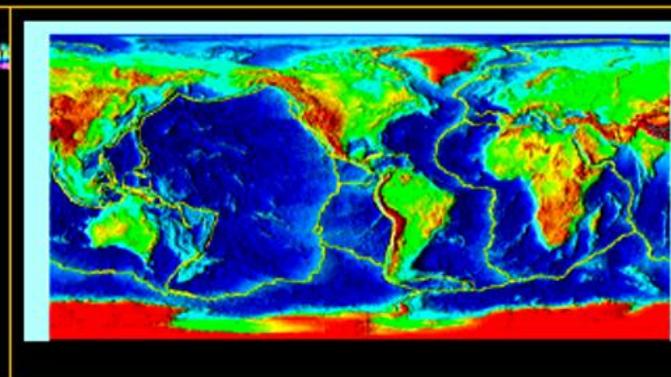
Tectonismo por deslocamento lateral entre placas

Margens Conservativas
(deslocamento relativo)



Tectonismo por separação entre placas

Margens Construtivas
(centros de espalhamento)



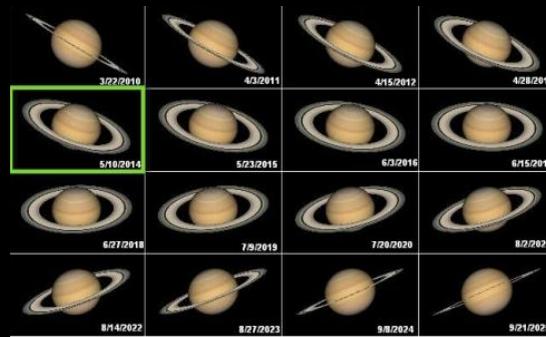
Os Planetas Gigantes Gasosos

(Júpiter: Dia= 09h56m; Ano=11,78 anos / Netuno: Dia=16h06m; Ano=165 anos)

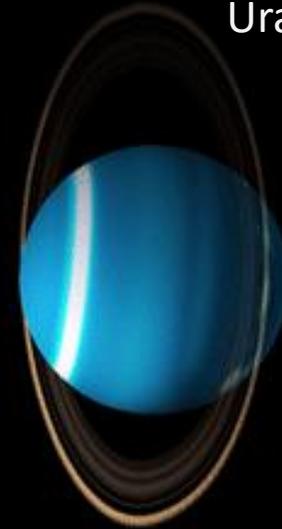
Júpiter



Saturno



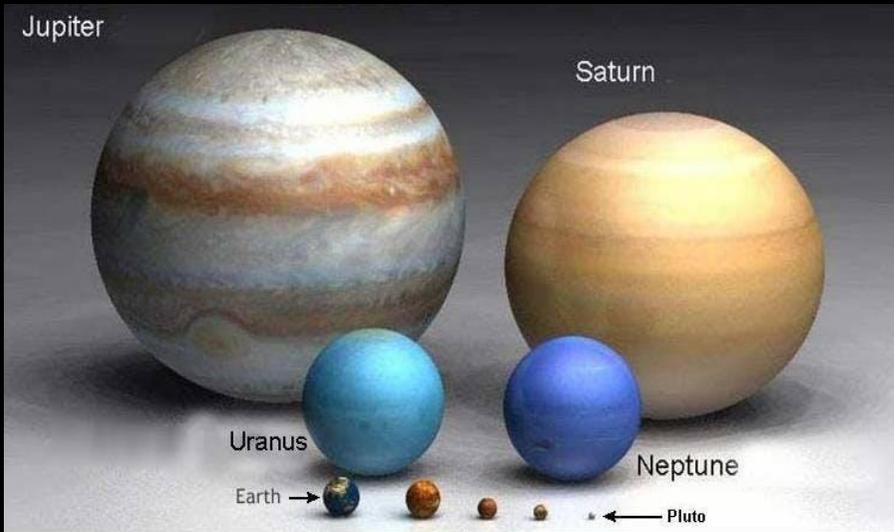
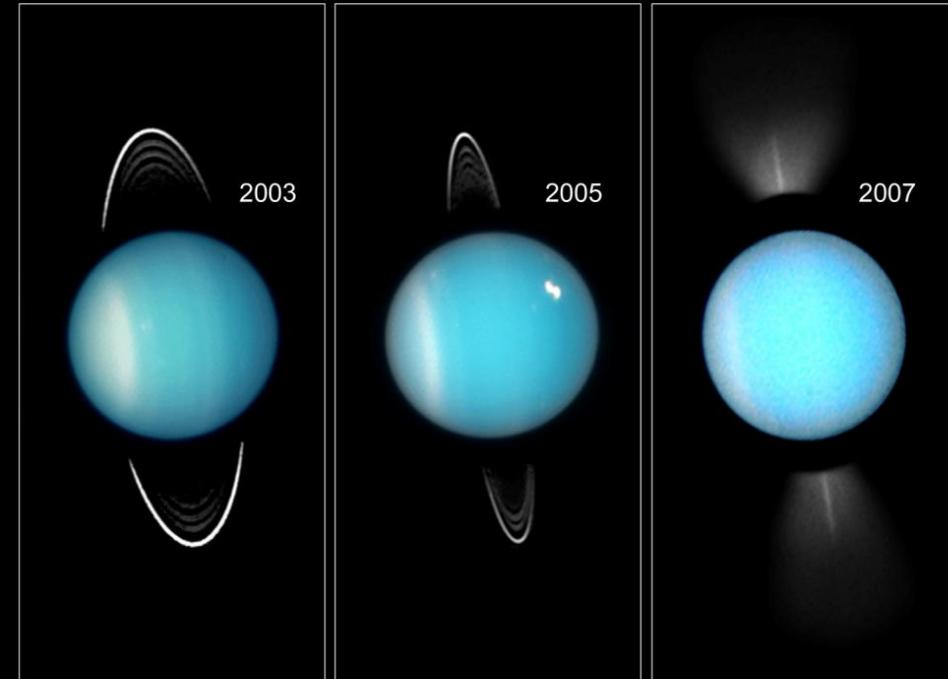
Urano



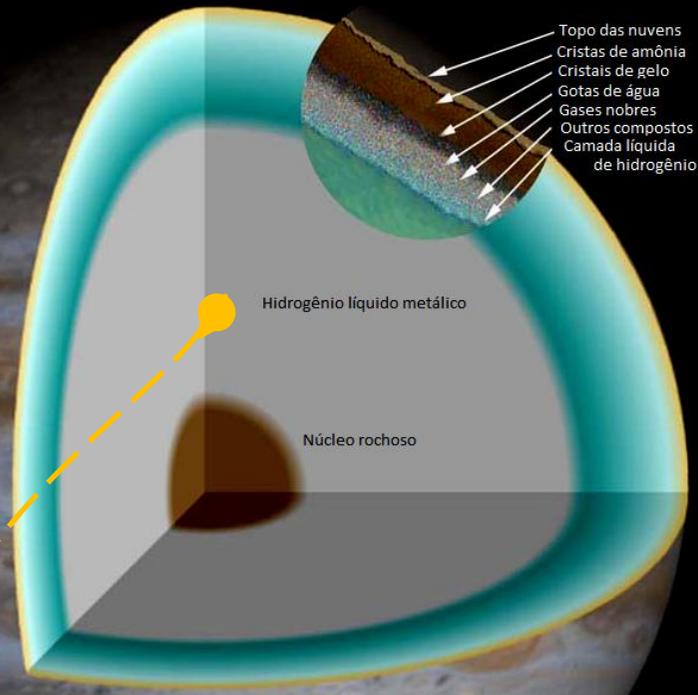
Netuno



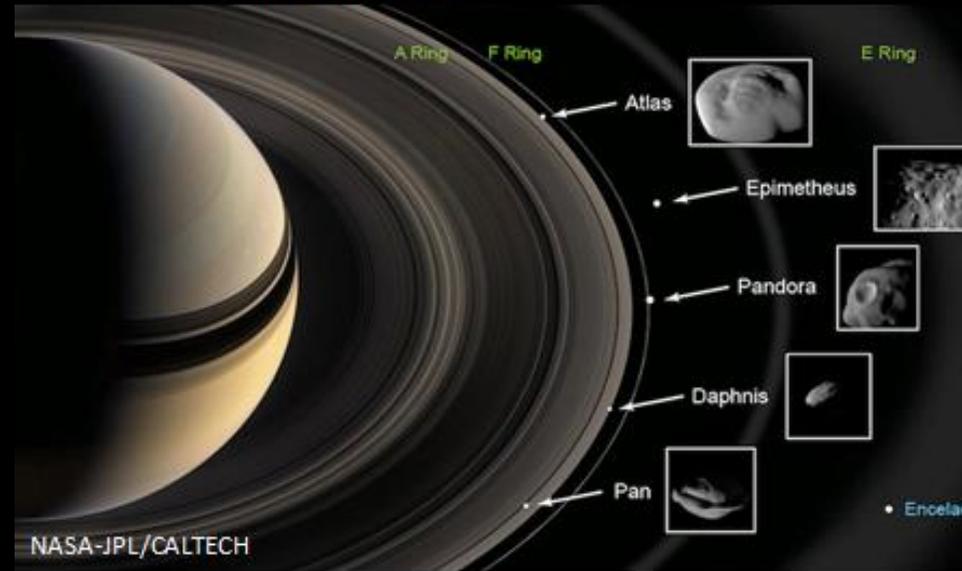
Urano ■ Hubble Space Telescope ACS/HRC WFPC2



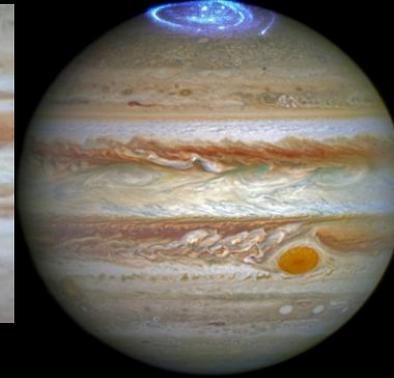
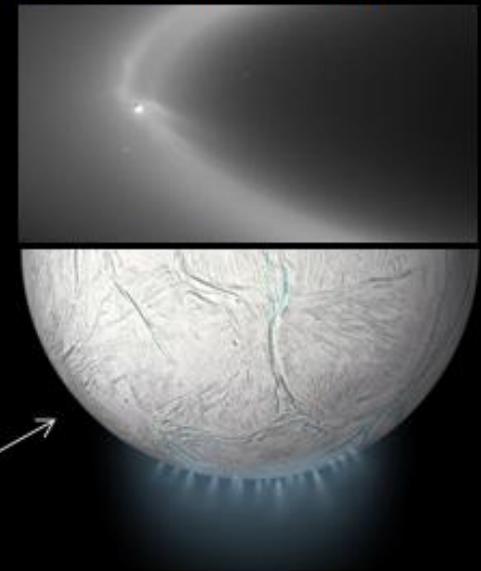
Júpiter e Saturno: os maiores planetas



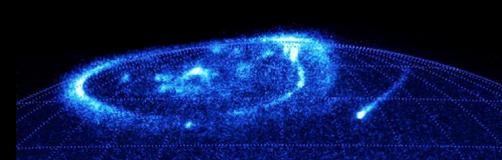
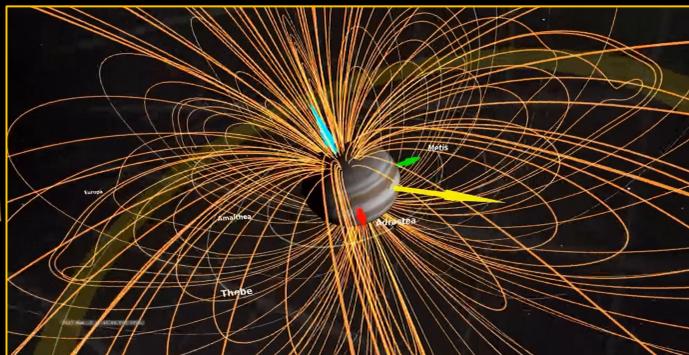
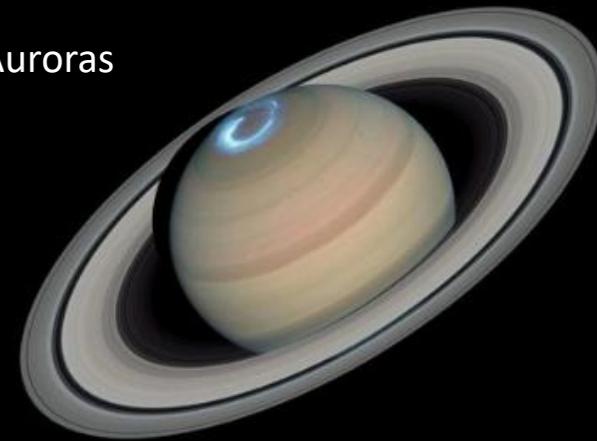
Anéis e pequenos satélites



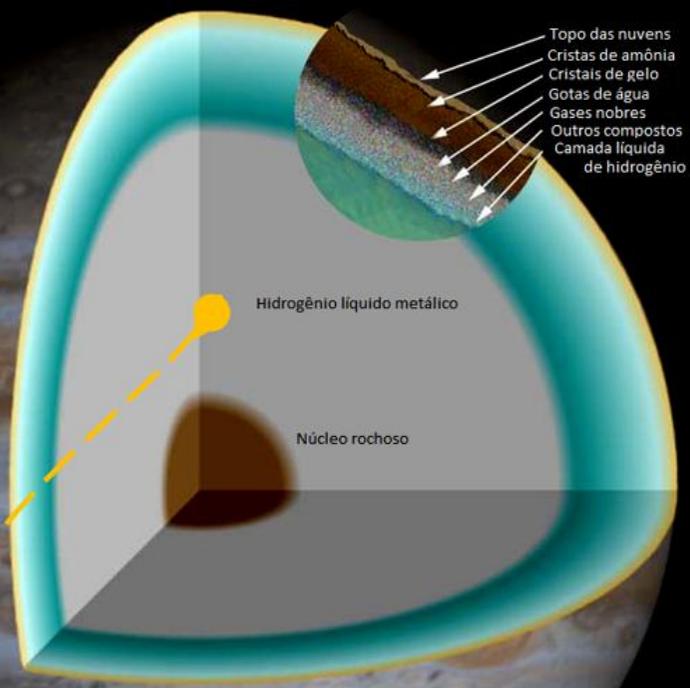
Encélado é o responsável pelo Anel E



Auroras



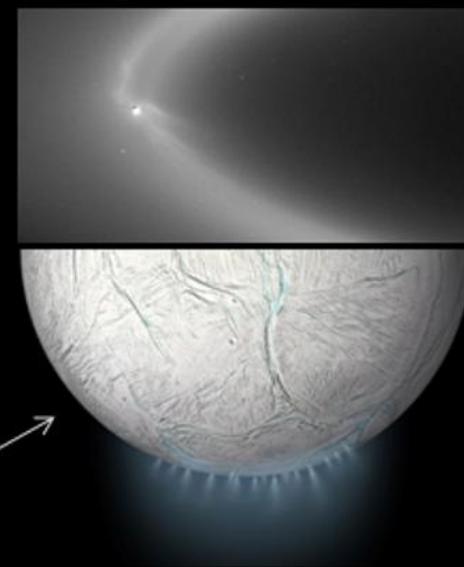
Júpiter e Saturno: os maiores planetas



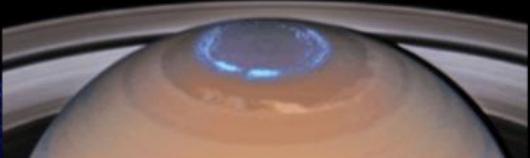
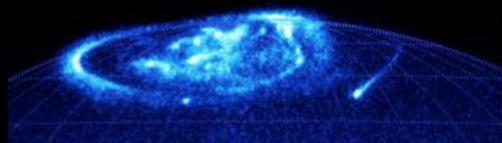
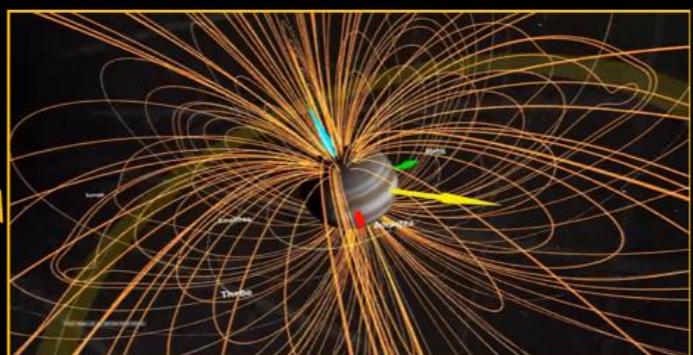
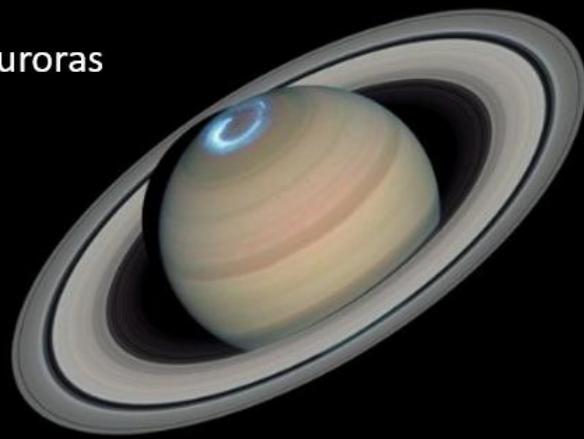
Anéis e pequenos satélites



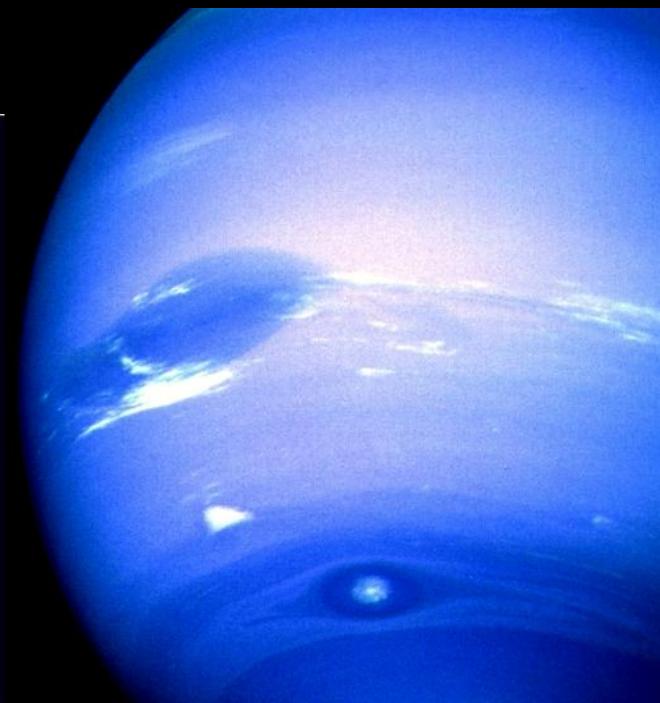
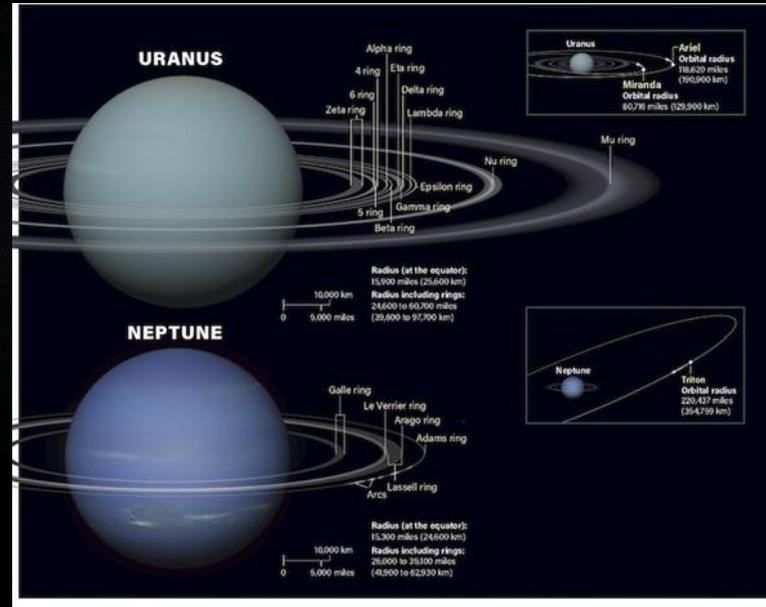
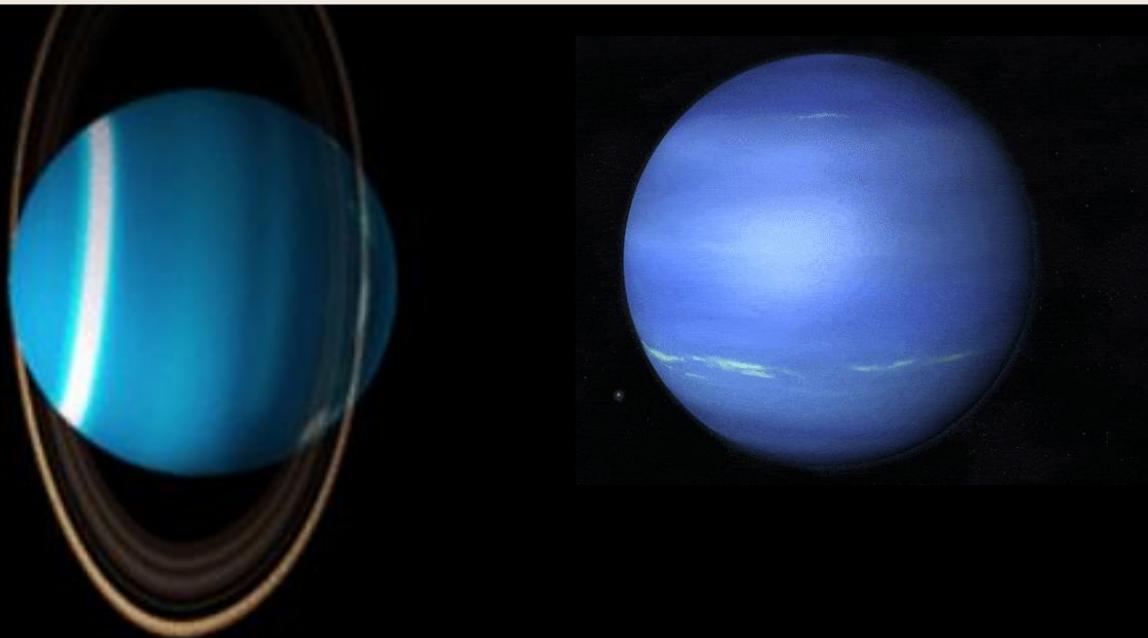
Encélado é o responsável pelo Anel E



Auroras

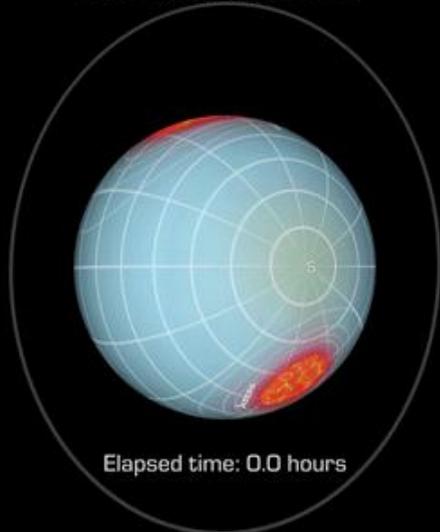


Urano e Netuno. Os gasosos congelados



Urano e Netuno são conhecidos como **gigantes de gelo**, porque são mais ricos em gases mais densos que Júpiter e Saturno. Mas apresentam diferenças significativas. (NASA / JPL / PlanetS)

Uranus: Oct. 2021



NASA/ESO imagery



Satélites



Ganymede
Jupiter



Titan
Saturn



Callisto
Jupiter



Io
Jupiter



Moon
Earth



Europa
Jupiter



Triton
Neptune



Titania
Uranus



Rhea
Saturn



Oberon
Uranus



Iapetus
Saturn



Charon
Pluto



Umbriel
Uranus



Ariel
Uranus



Dione
Saturn



Tethys
Saturn



Enceladus
Saturn



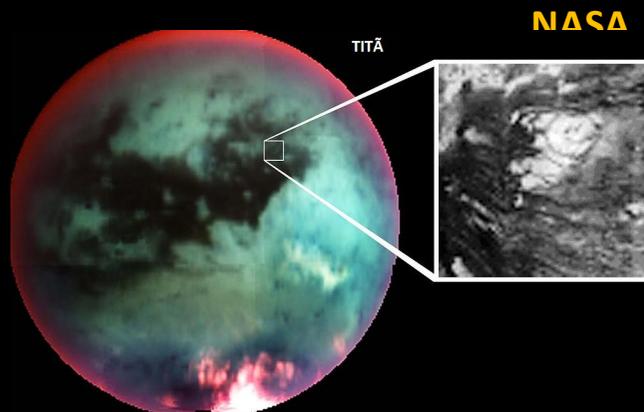
Miranda
Uranus



Proteus
Neptune



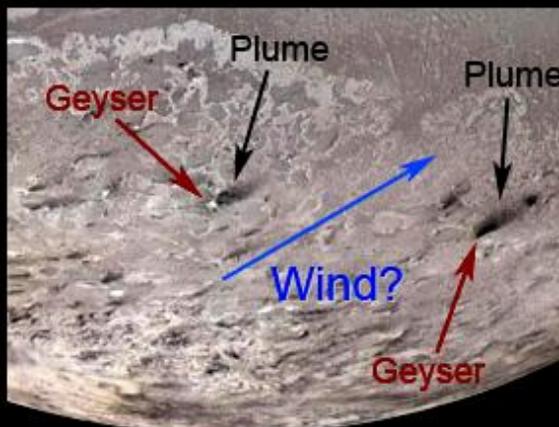
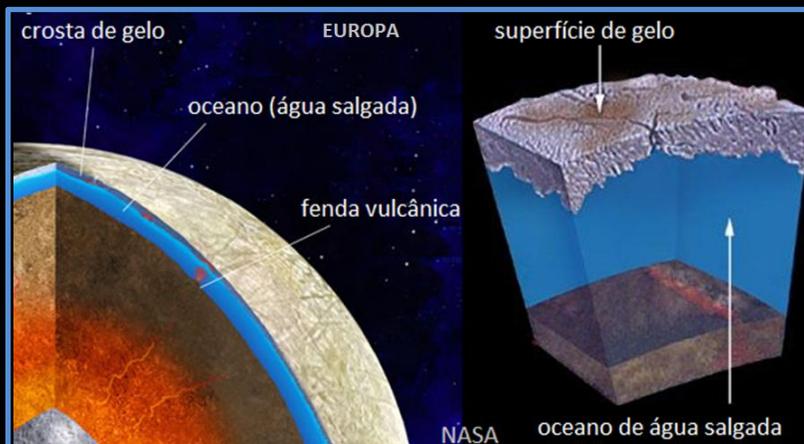
Mimas
Saturn



NASA

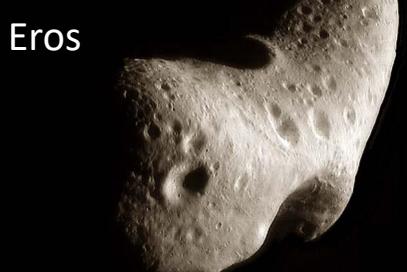
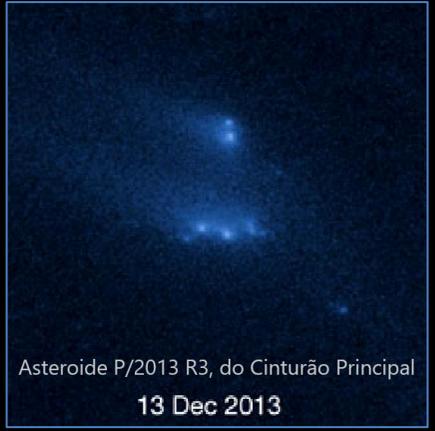
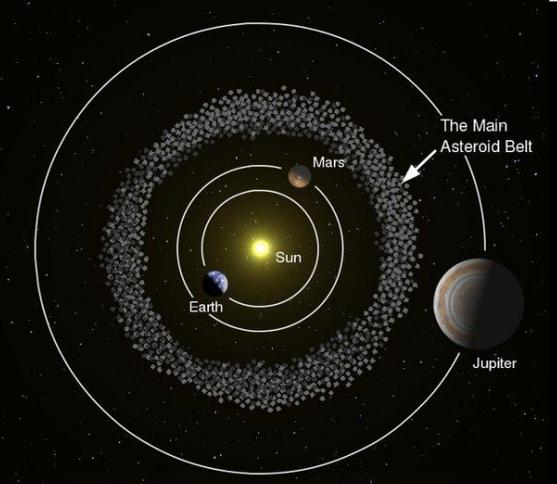
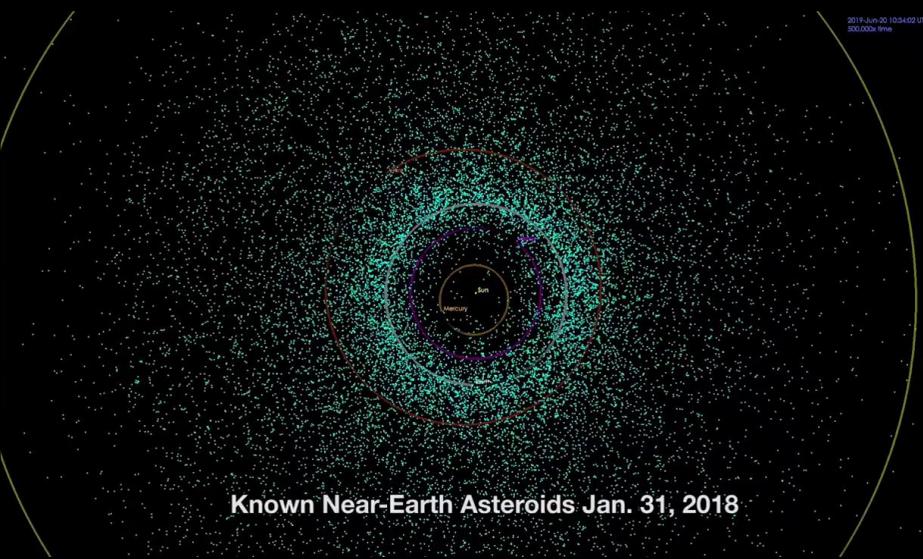


Io



TRITÃO

Asteroides



Eros



Itokawa



Dáctilo



Gaspra

Os maiores corpos do cinturão principal de asteroides



Planeta anão

Ceres

939 km



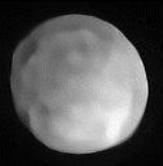
Vesta

525 km



Pallas

512 km



Hygiea

434 km

Asteroides



Vesta

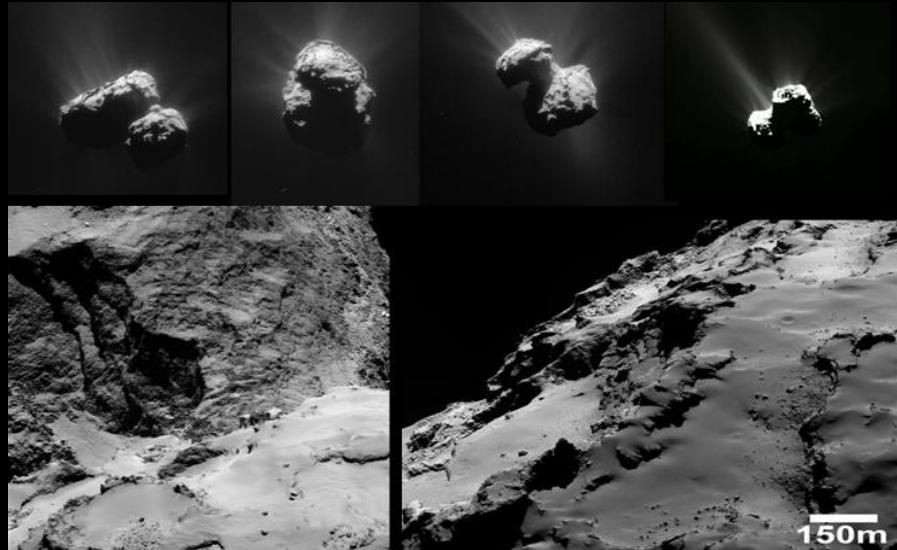
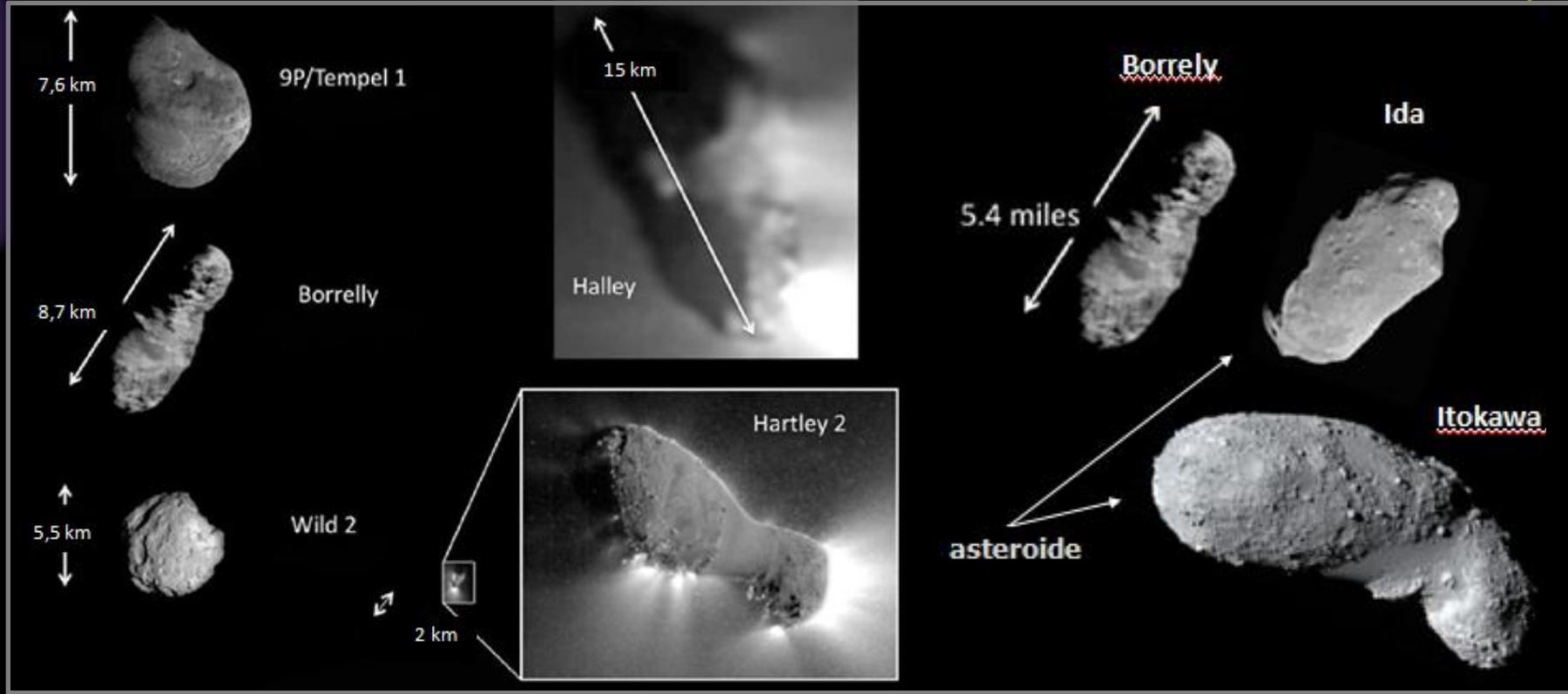


Ryugu: Imagens da sonda japonesa Hayabusa

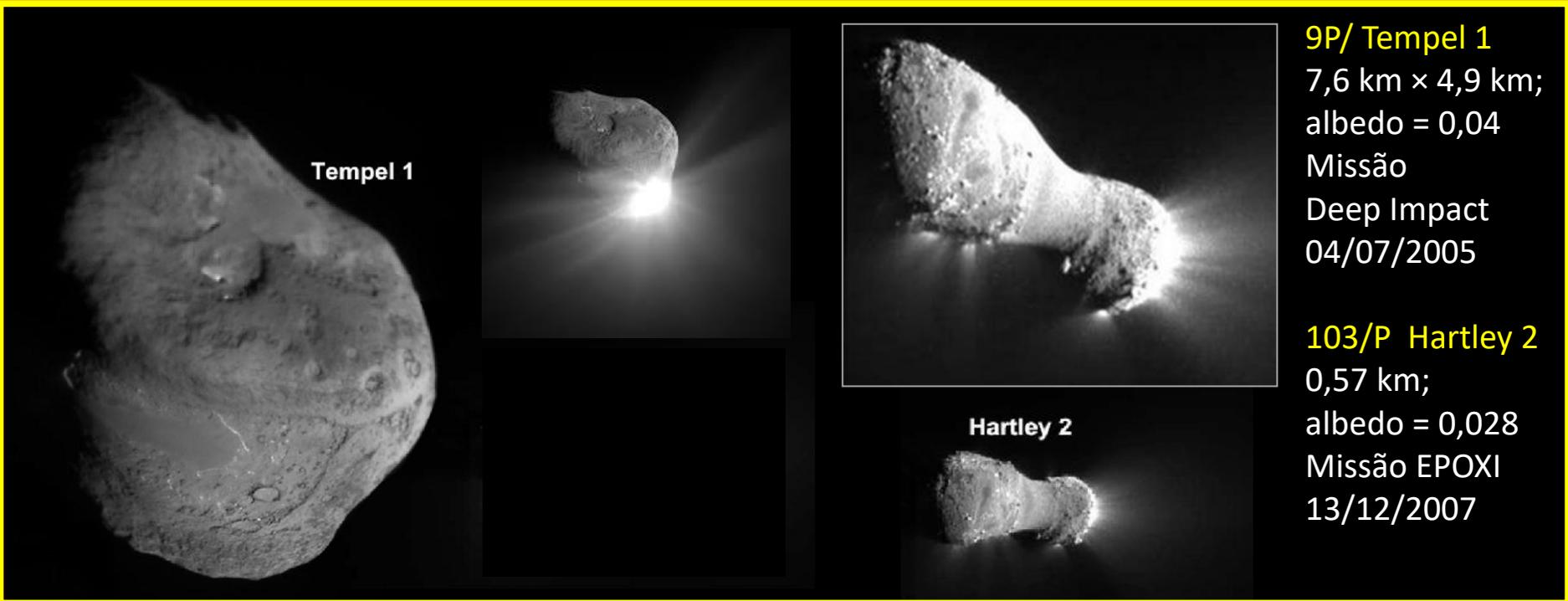


Cometas

67P/Churyumov-Gerasimenko



Núcleos de cometas

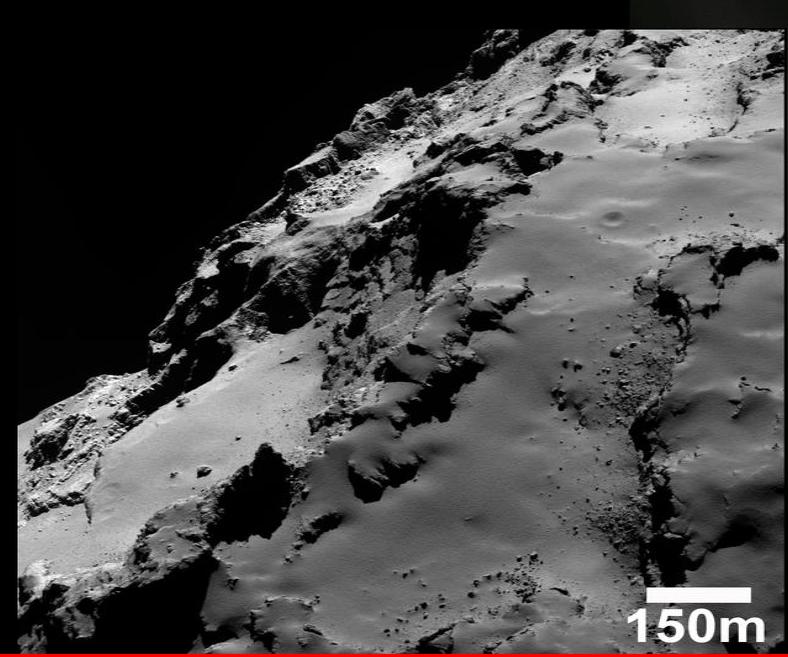
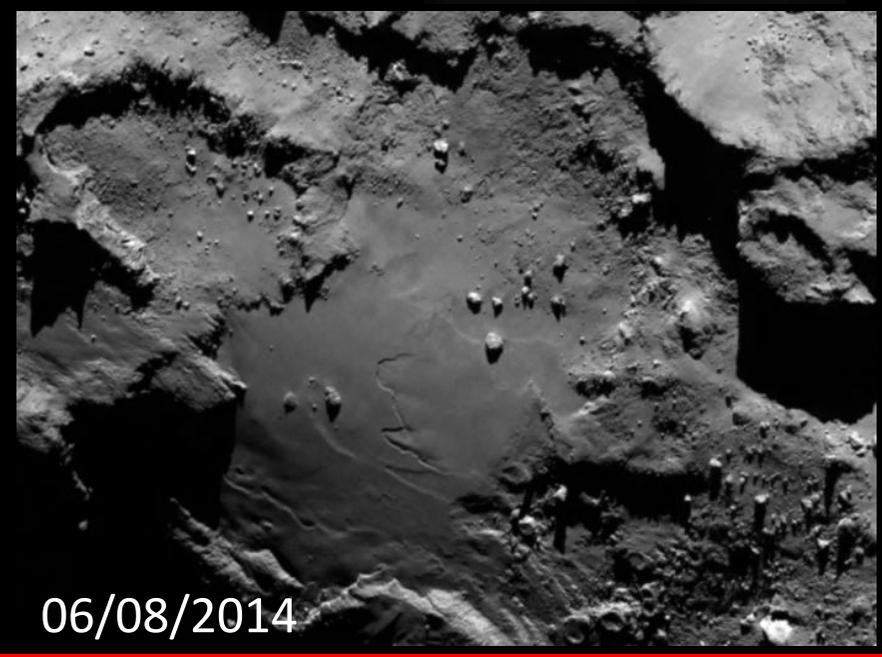


Tempel 1

Hartley 2

9P/ Tempel 1
7,6 km × 4,9 km;
albedo = 0,04
Missão
Deep Impact
04/07/2005

103/P Hartley 2
0,57 km;
albedo = 0,028
Missão EPOXI
13/12/2007



Alguns exemplos de grandes cometas

Leonard (C/2021 A1) **cerca de 1 km**



McNaugh (C/2006 P1) **cerca de 250 km**

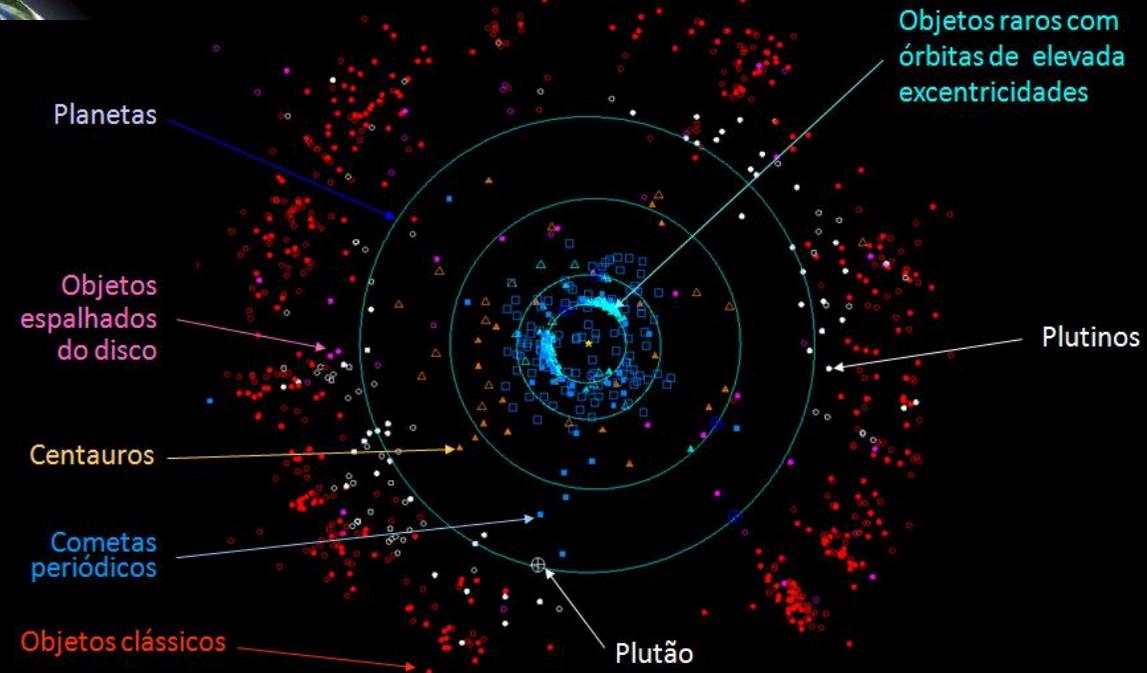
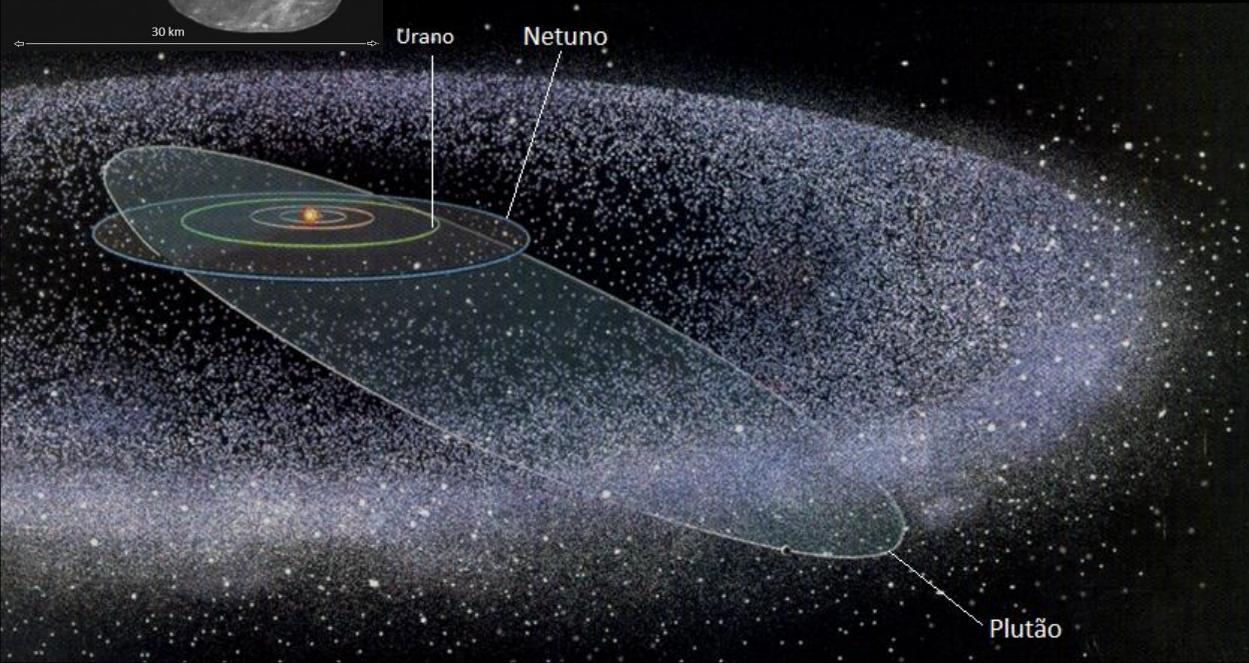
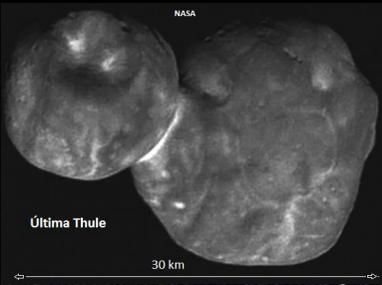
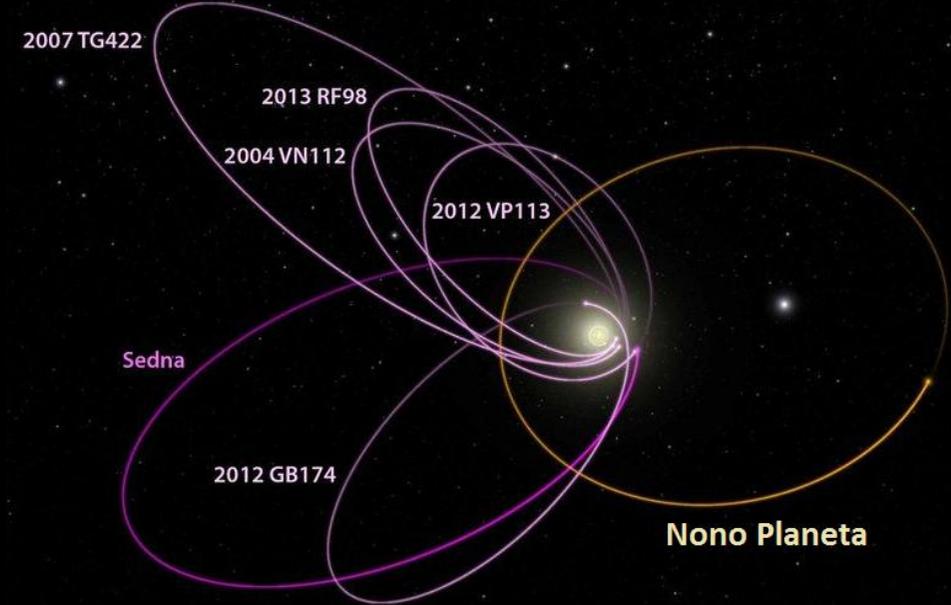
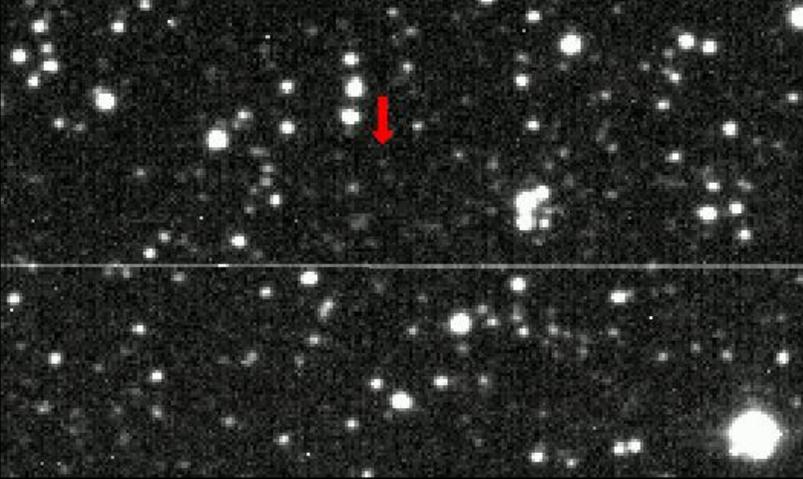


West (C/1975 V1) **menor que 10 km**



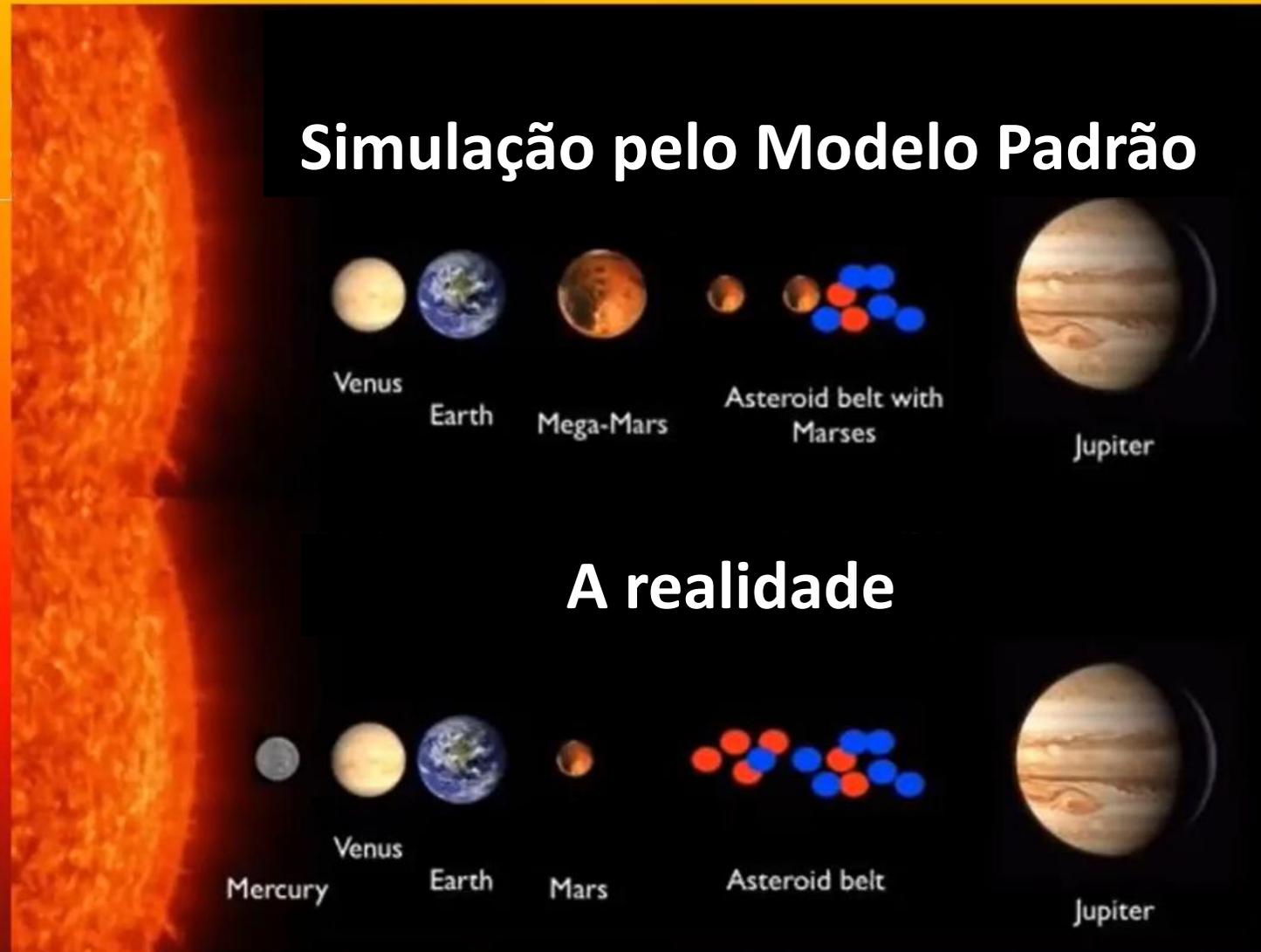
C/2014 UN271 (Bernardinelli-Bernstein)
Diâmetro **120 km?** ; Afélio 39,3 UA ; Periélio 10,9 UA (Jan 2031)
Período 2,75 milhões de anos

Objetos do Cinturão de Kuiper

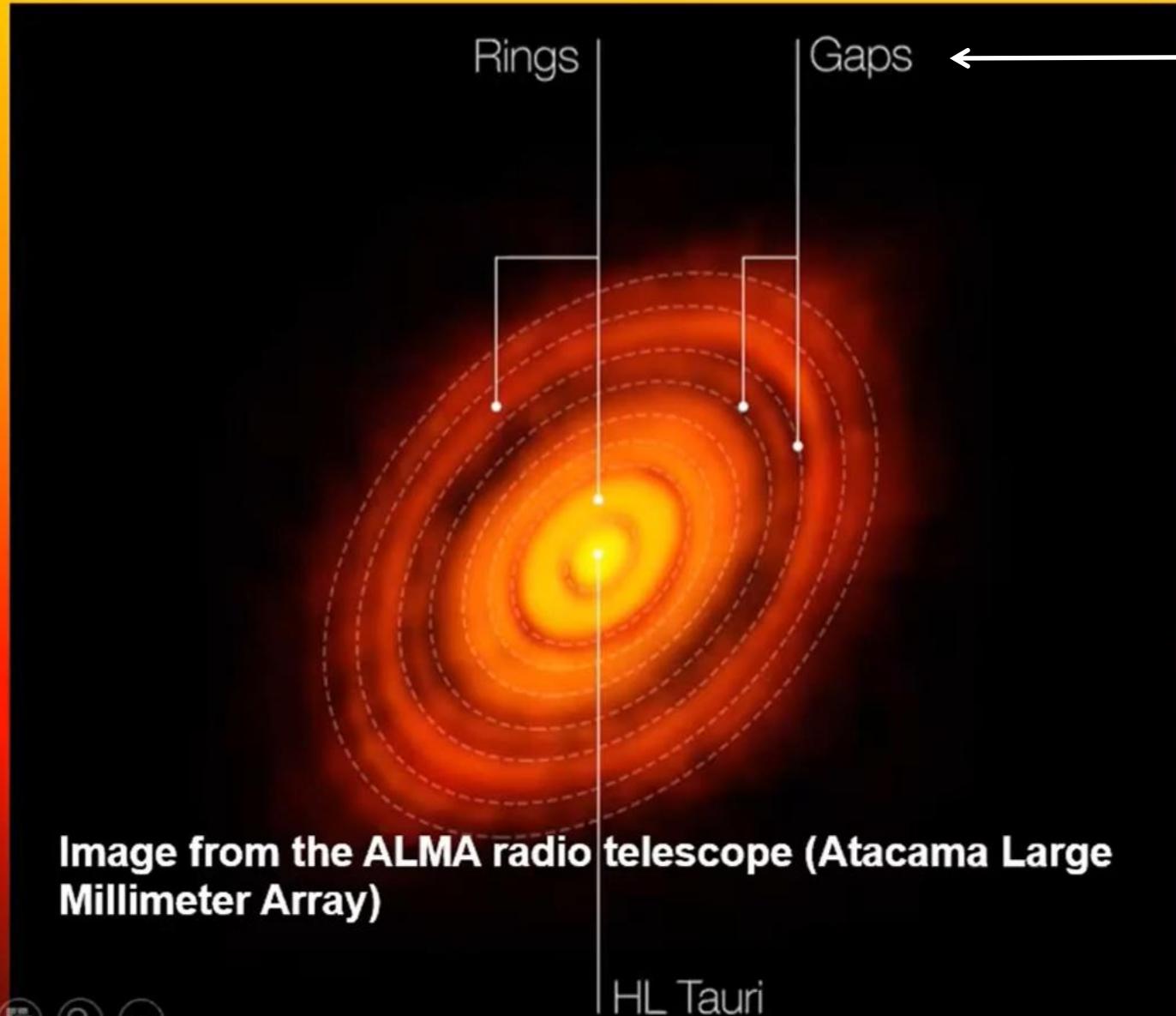


Plot prepared by the Minor Planet Center (2002 Oct.23).

Problemas com as simulações computacionais



Um Sistema Exoplanetário em formação



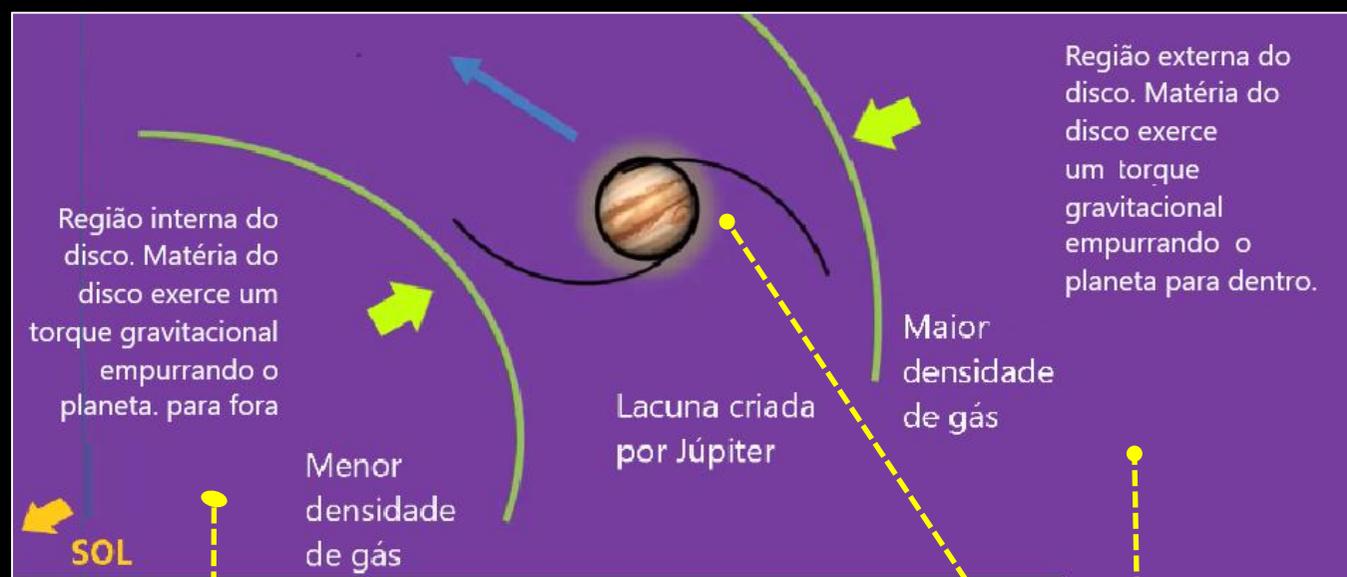
← onde formam-se os planetas

66 antenas:
54 de 12 m de diâmetro +
12 de 7 m de diâmetro
(área coletora total: 26.276 m²)



Modelo da Grande Aderência (Grande Virada)

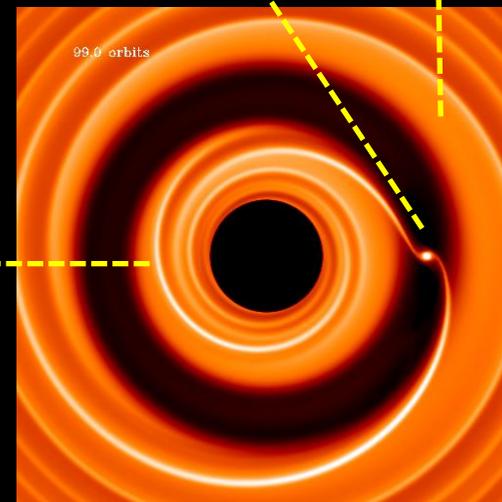
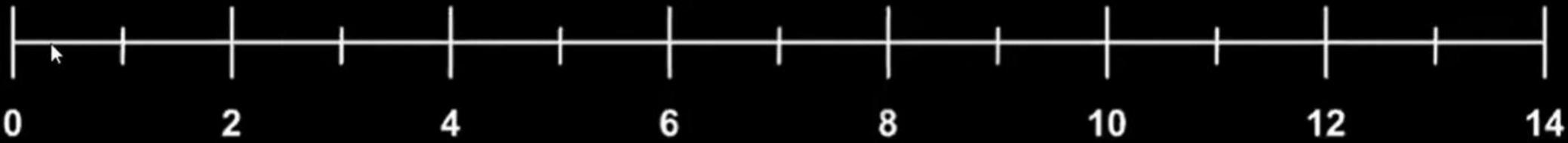
Júpiter se formou a uma distância de 3,5 UA do Sol. A interação gravitacional com a matéria do disco protoplanetário fez Júpiter migrar para dentro até para 1,5 UA, antes de reverter o curso devido à captura de Saturno em uma ressonância orbital, eventualmente parando perto de sua órbita atual em 5,2 UA.



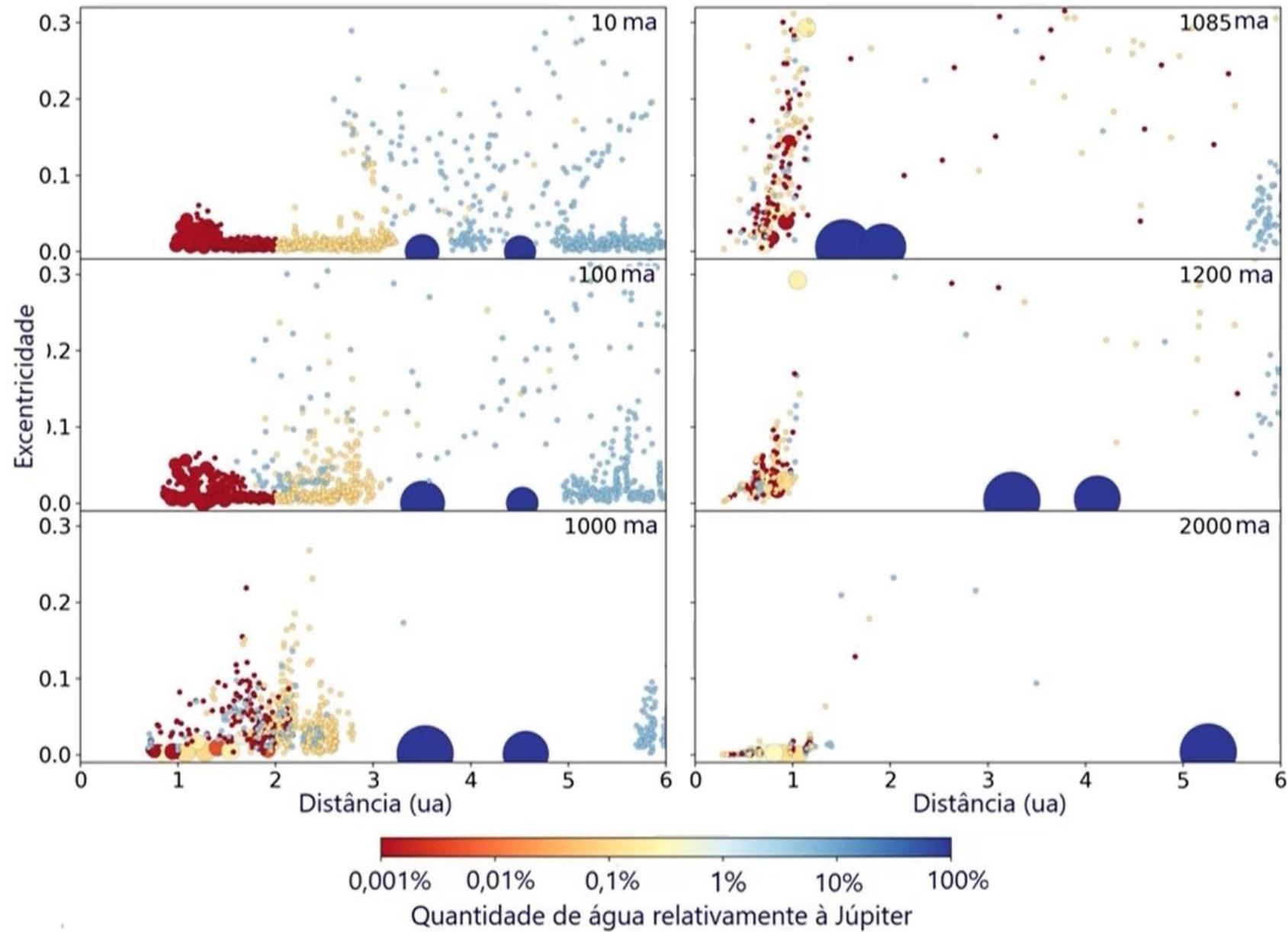
Júpiter e Saturno em formação

Júpiter e Saturno formados

Urano e Nutuno



Adaptado de arXiv:2302.00649 [astro- ph.EP]



MUITAS QUESTÕES ESTÃO SEM RESPOSTAS.

AS MAIS EVIDENTES:

- **Por que não há “Júpiteres Quentes” nem “Super Terras” no Sistema Solar?**
- **Por que Marte é tão pequeno? Era de se esperar um planeta maior do que a Terra.**
- **Por que não há um grande planeta rochoso no local do Cinturão Principal de Asteroides?**
- **Por que as órbitas dos planetas são quase circulares e coplanares?**
Era de se esperar o oposto.

SÃO CARACTERÍSTICAS DOMINANTES NOS SISTEMAS ESTELARES CONHECIDOS

Conclusão: O Sistema Solar e, em especial, a Terra parecem ser casos incomuns.

**Terra antes
da
vida?**



Vida primitiva ?

<https://epicazzio.blogspot.com/>



Galatea - Um Espaço Para A Astronomia

A intenção deste blog é discutir de forma objetiva assuntos de Astronomia, com ênfase em Ciências Planetárias.

Vamos Falar De Astronomia?

CANAL YOUTUBE

Onde está o centro? Uma discussão que durou 23 séculos. Parte 1. Introdução.



ENOS PICAZZIO - março 11, 2024



Em 1632, sob uma licença formal da Inquisição, Galileu Galilei publicou seu famoso livro "Diálogo sobre os dois principais sistemas do mundo". De forma muito competente, Galileu compara o sistema heliocêntrico de Copérnico, com o tradicional sistema geocêntrico de Ptolomeu. No ano seguinte, em 1633, o livro foi incluído no Índice de Livros Proibidos e Galileu foi considerado "veementemente suspeito de heresia". O preço pela heresia foi muito alto. Galileu ficou em pris...



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[LEIA MAIS »](#)