



AGA0106

Astronomia de Posição

Prof. Rogério Monteiro

O fenômeno das marés

Agradecimentos: Prof. Roberto Boczko

Aula A14

Tópicos da aula

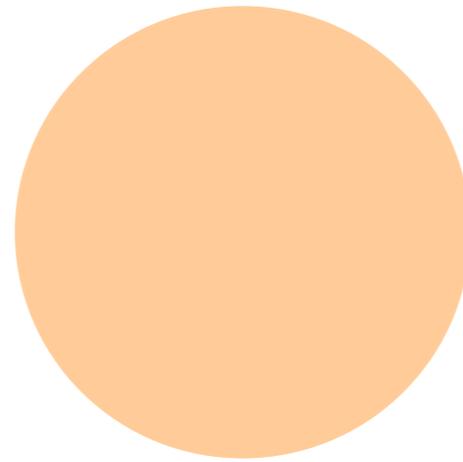
- Eclipses lunares e a determinação da forma da Terra;
- O fenômeno das marés.

O eclipse lunar e a forma da Terra

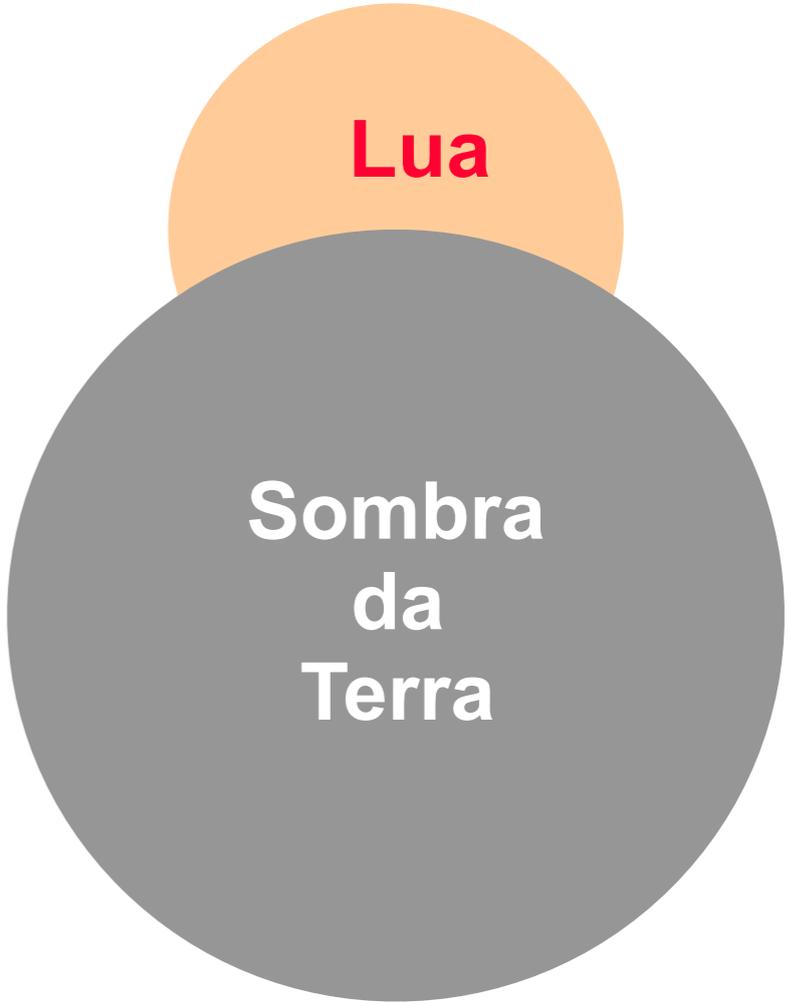
Prova da Esfericidade da Terra

(com um Eclipse Lunar)

**Lua
Cheia**



Lua



**Sombra
da
Terra**

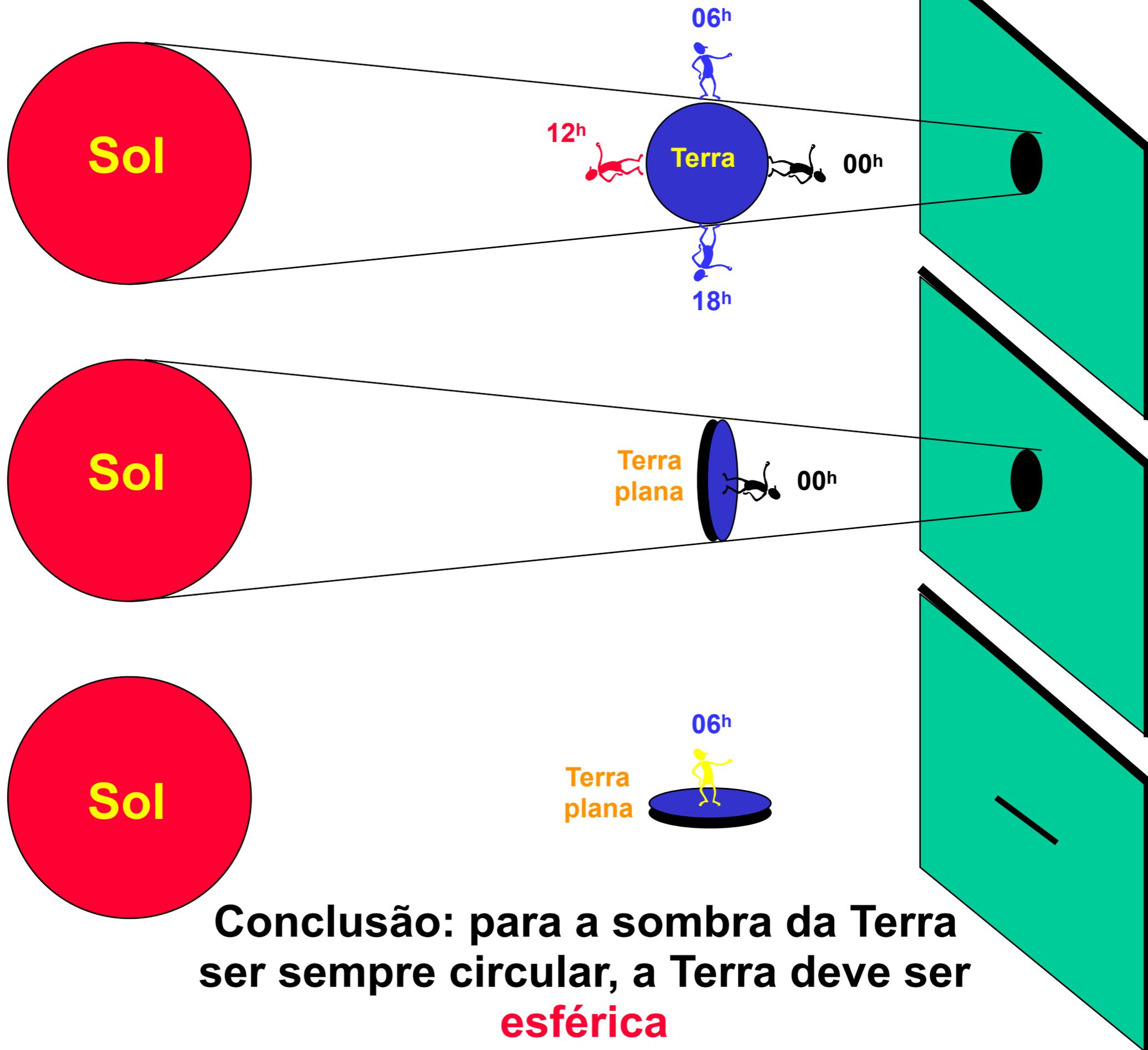
**A sombra da Terra
não cabe
completamente na
Lua.**

**Lua
Sombra
da Terra**



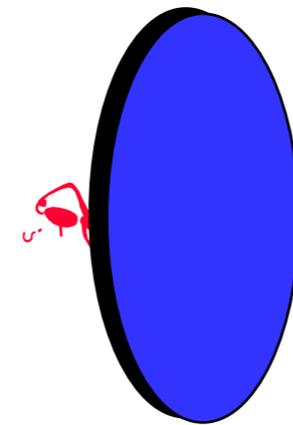
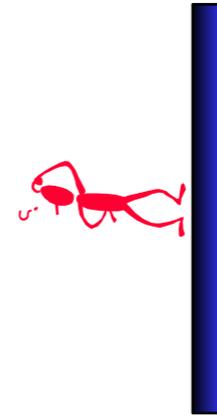
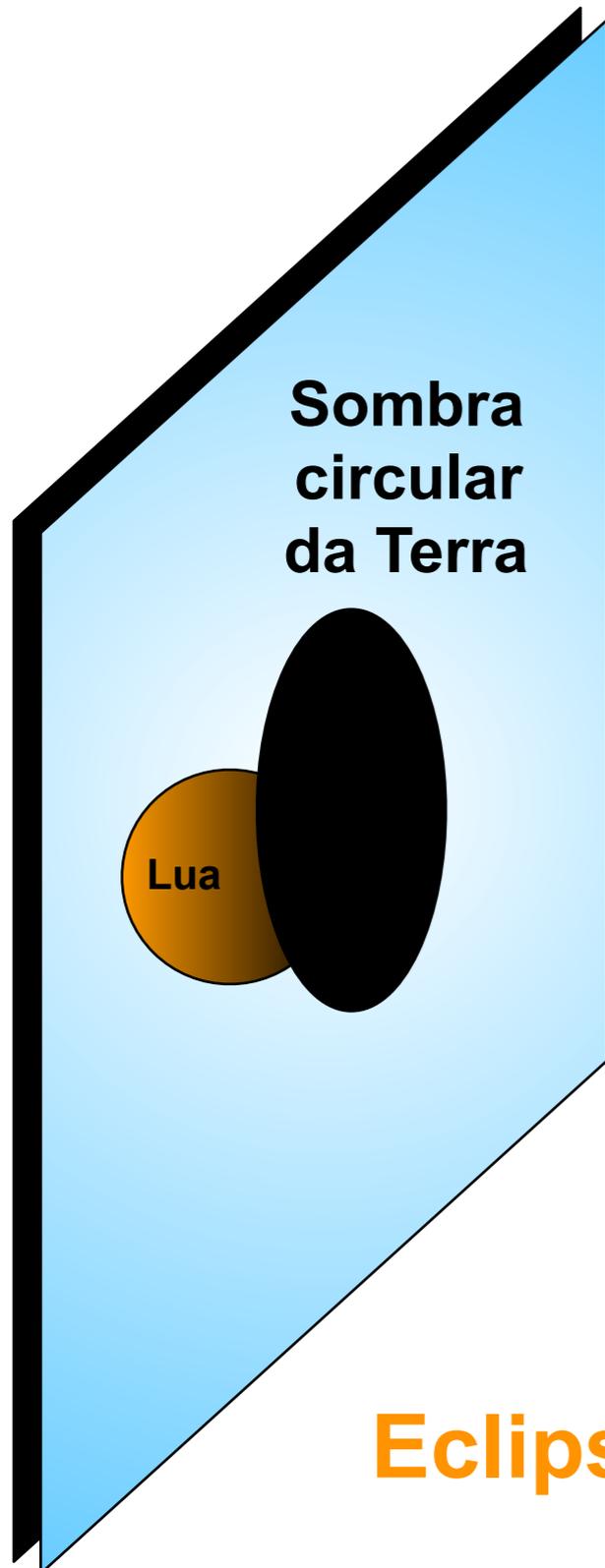
Isso nunca ocorre!

Sombra sempre circular da Terra

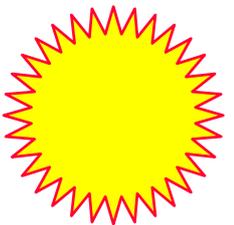


Conclusão: para a sombra da Terra ser sempre circular, a Terra deve ser esférica

Terra plana?



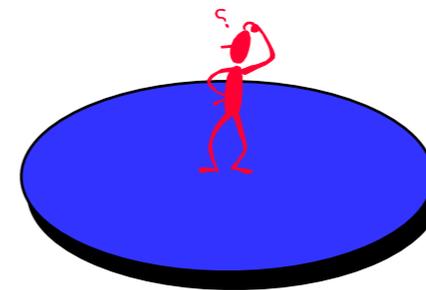
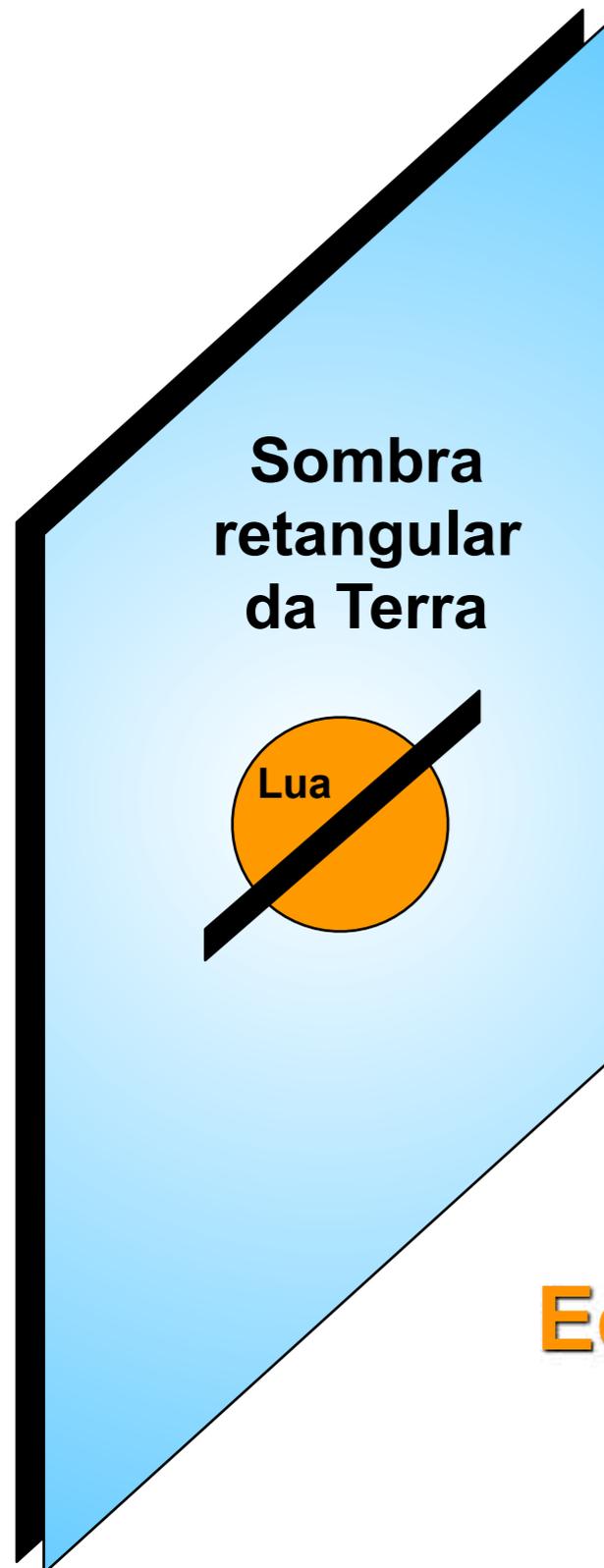
Terra plana



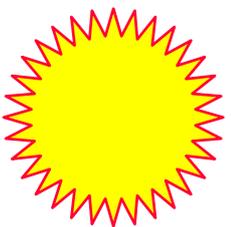
Eclipse lunar à meia-noite

Funciona!

Terra não é plana!



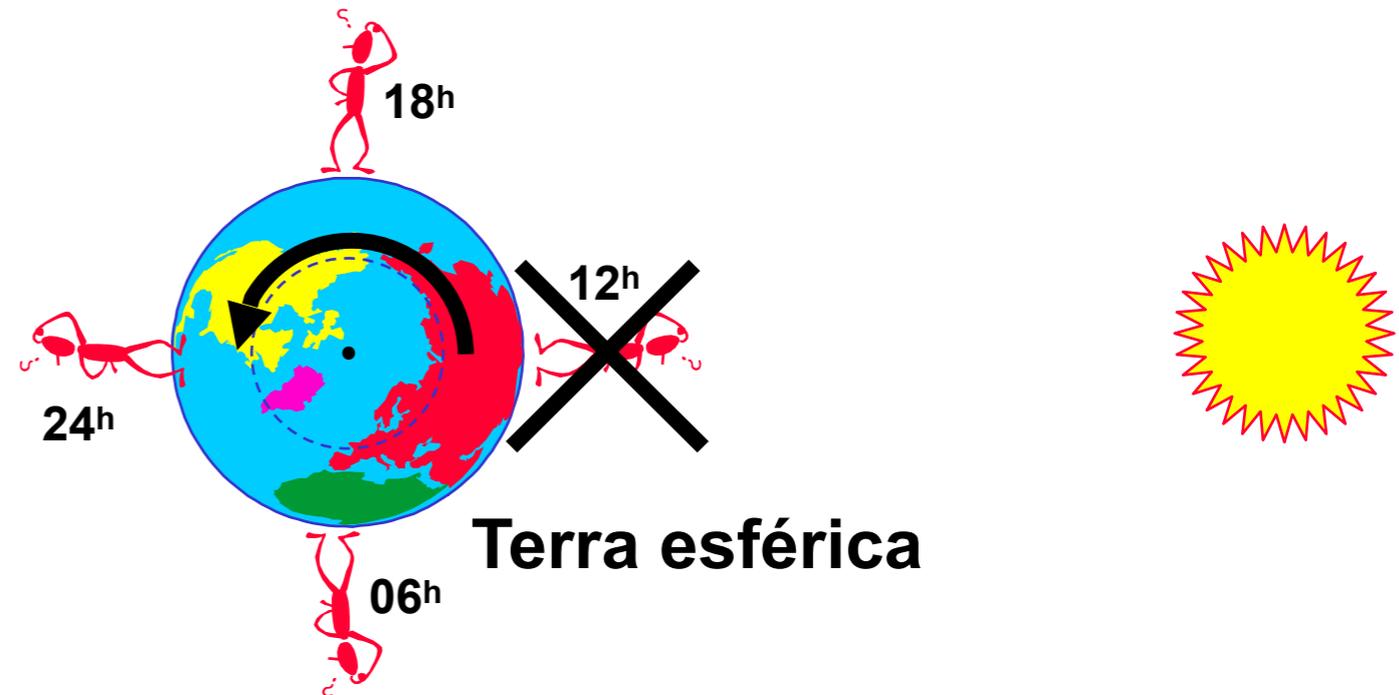
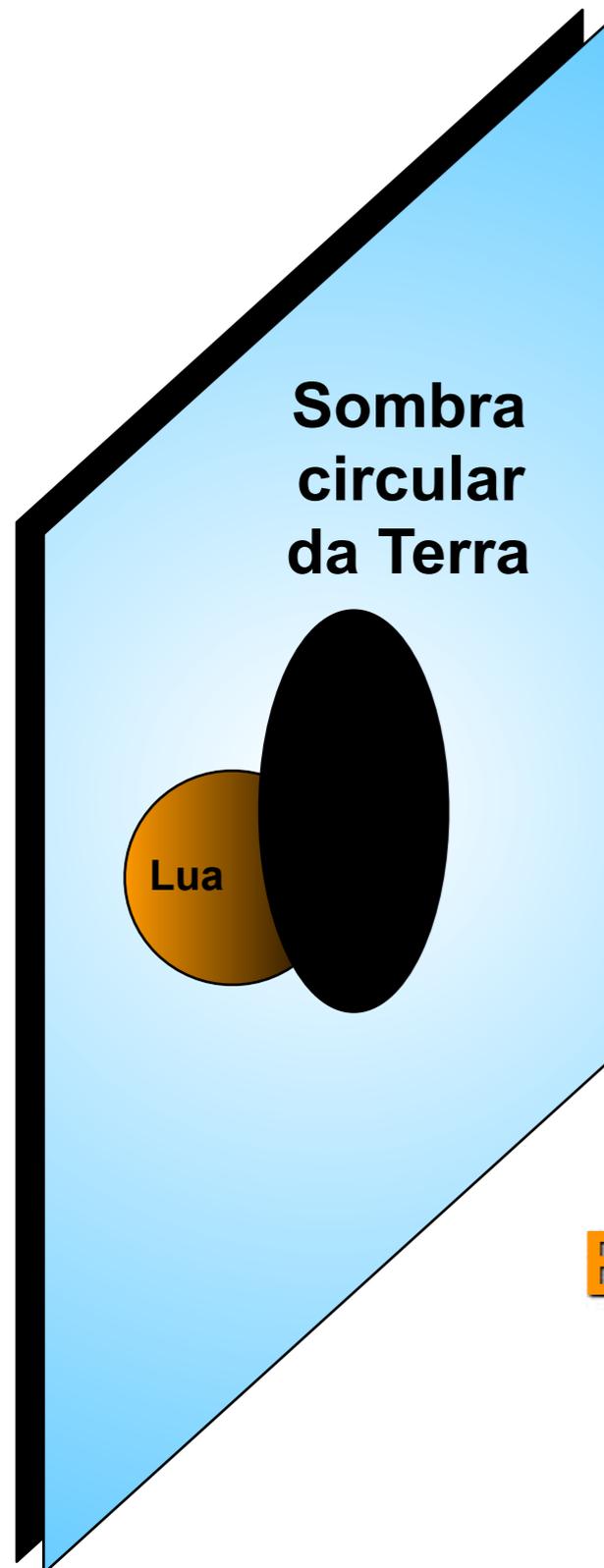
Terra plana



Eclipse lunar ao nascer ou ao ocaso do Sol

Não funciona!

Terra tem que ser esférica!

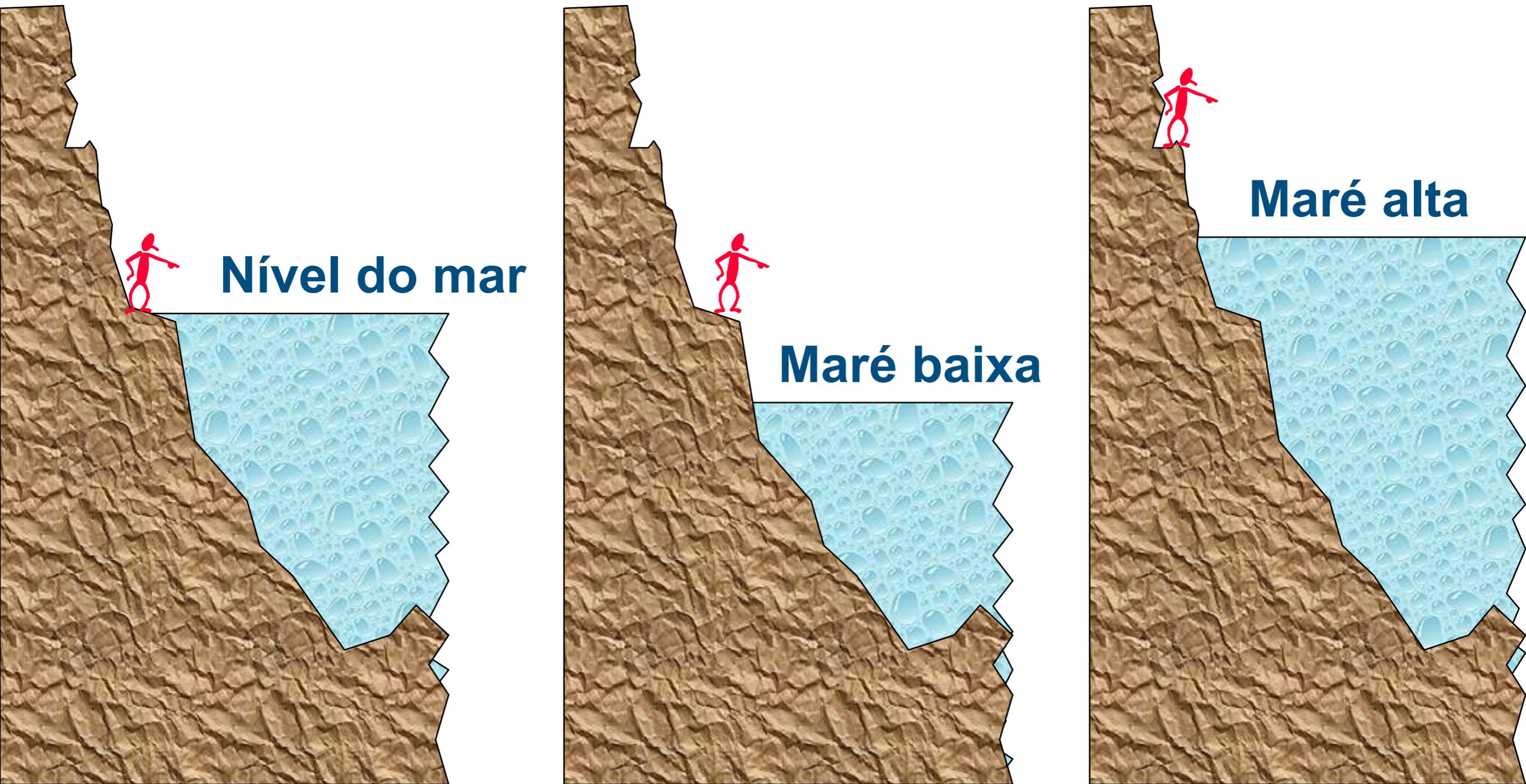


Eclipse lunar visível a quase qualquer hora

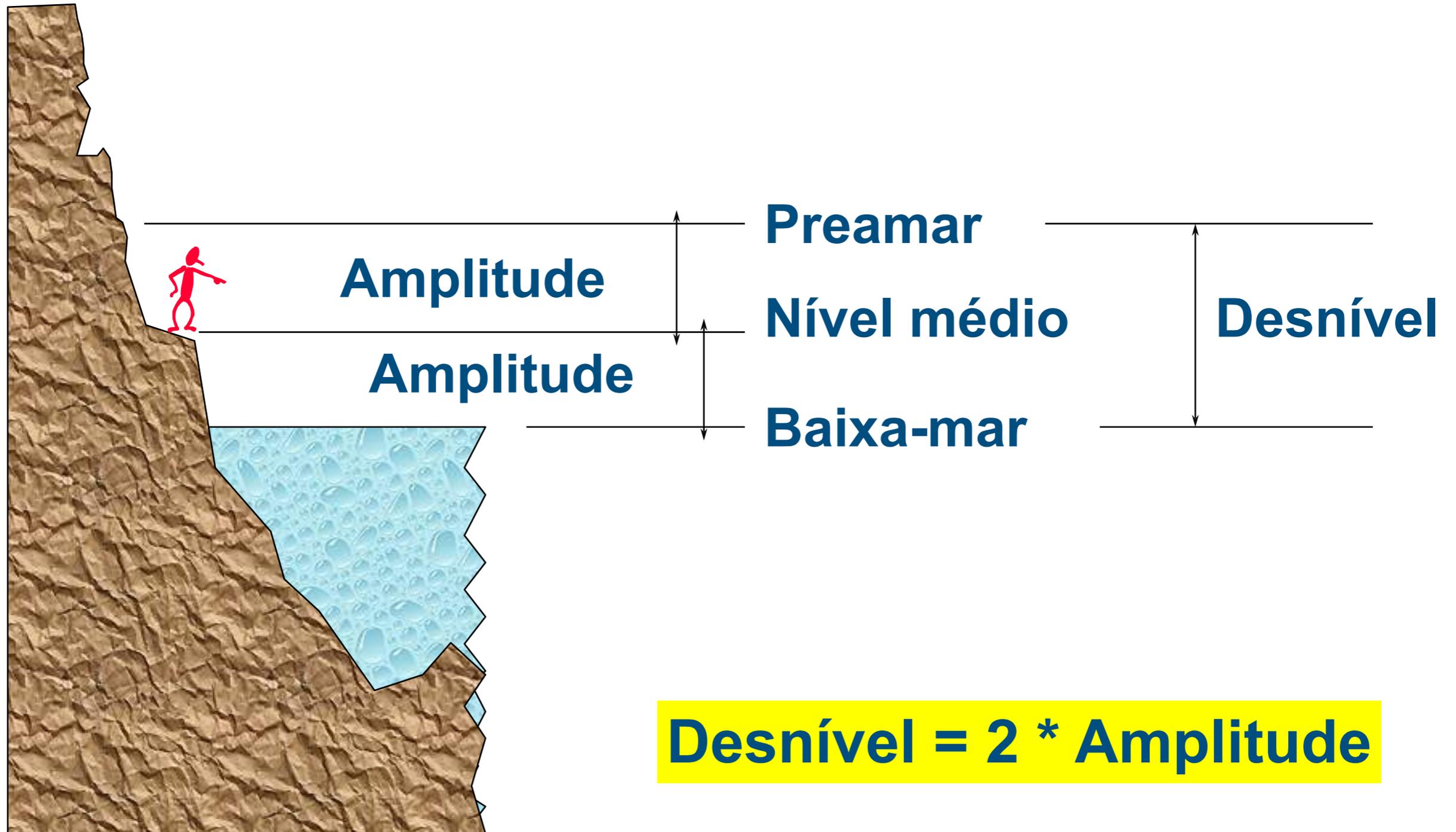
Funciona!

O fenômeno das marés

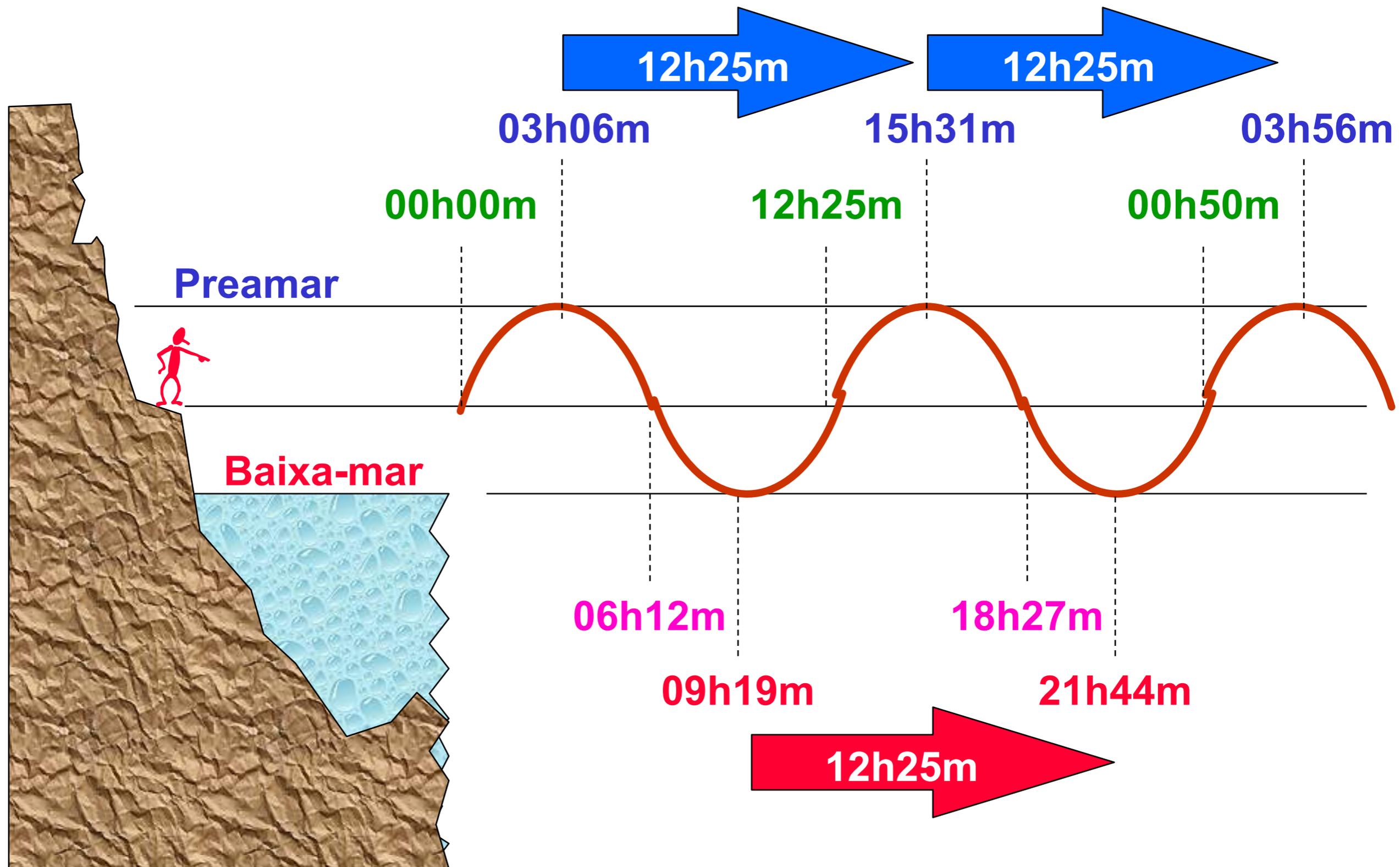
Observando o nível do mar



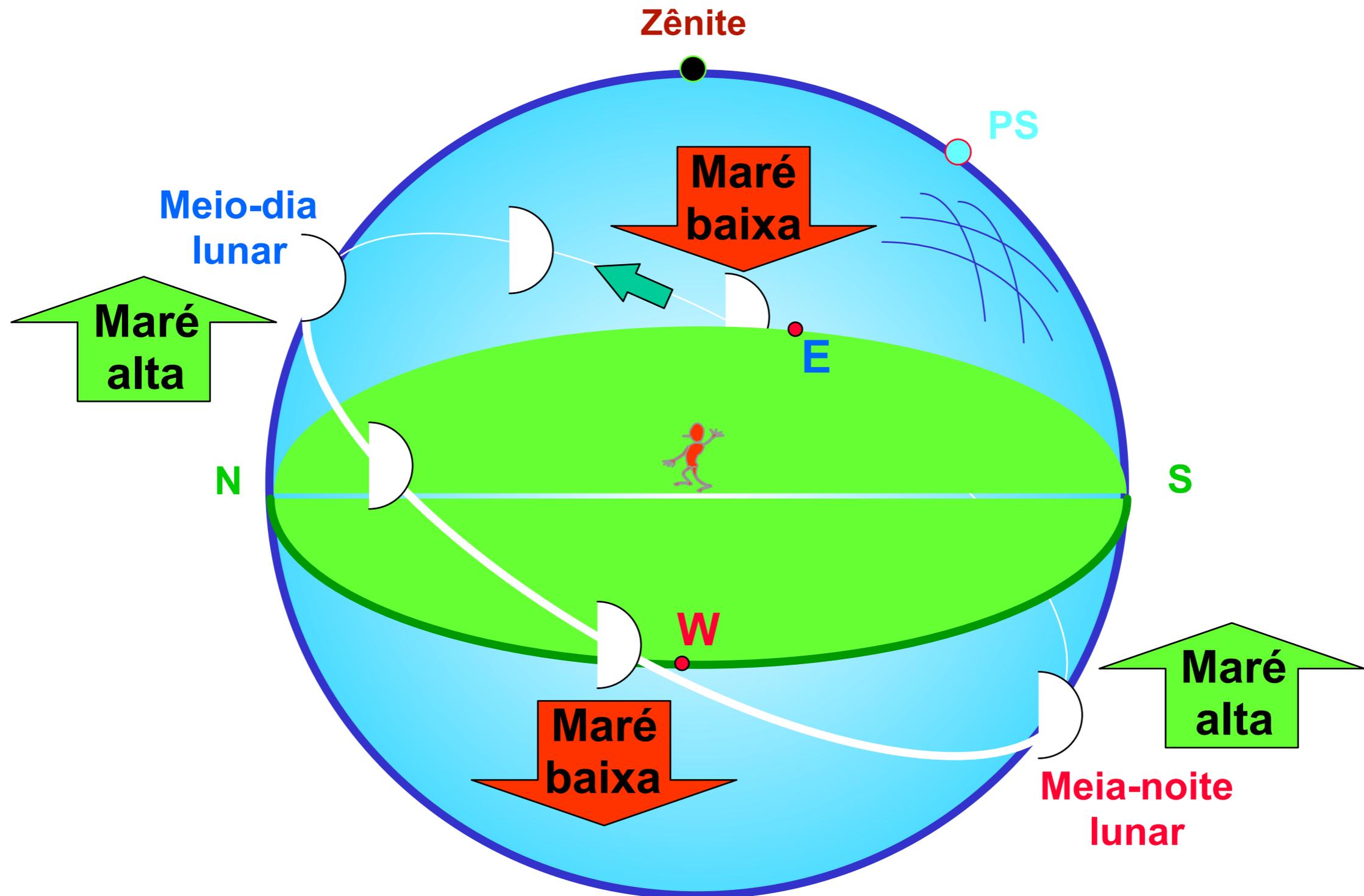
Desnível entre as marés alta e baixa



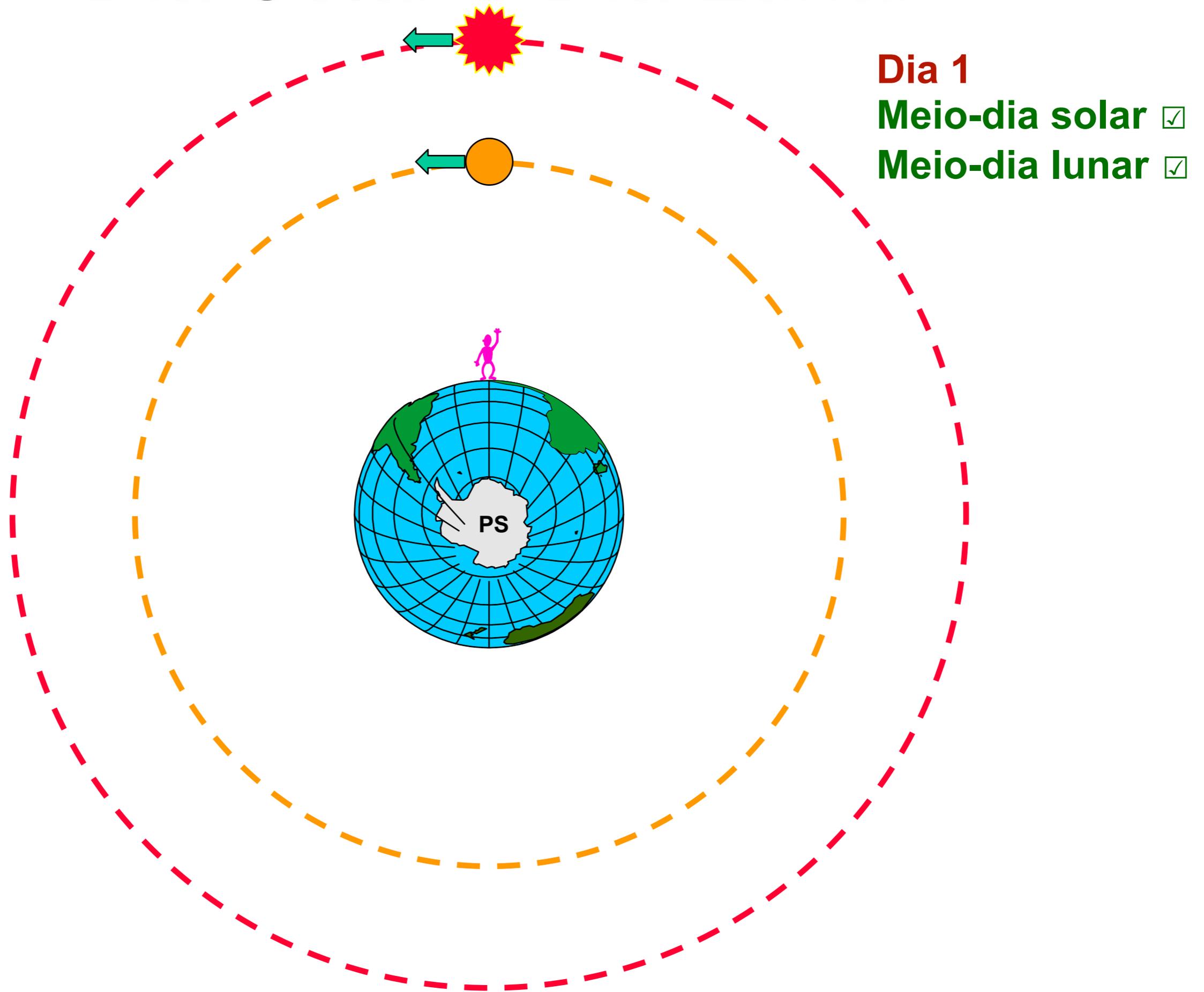
Intervalo de tempo entre marés



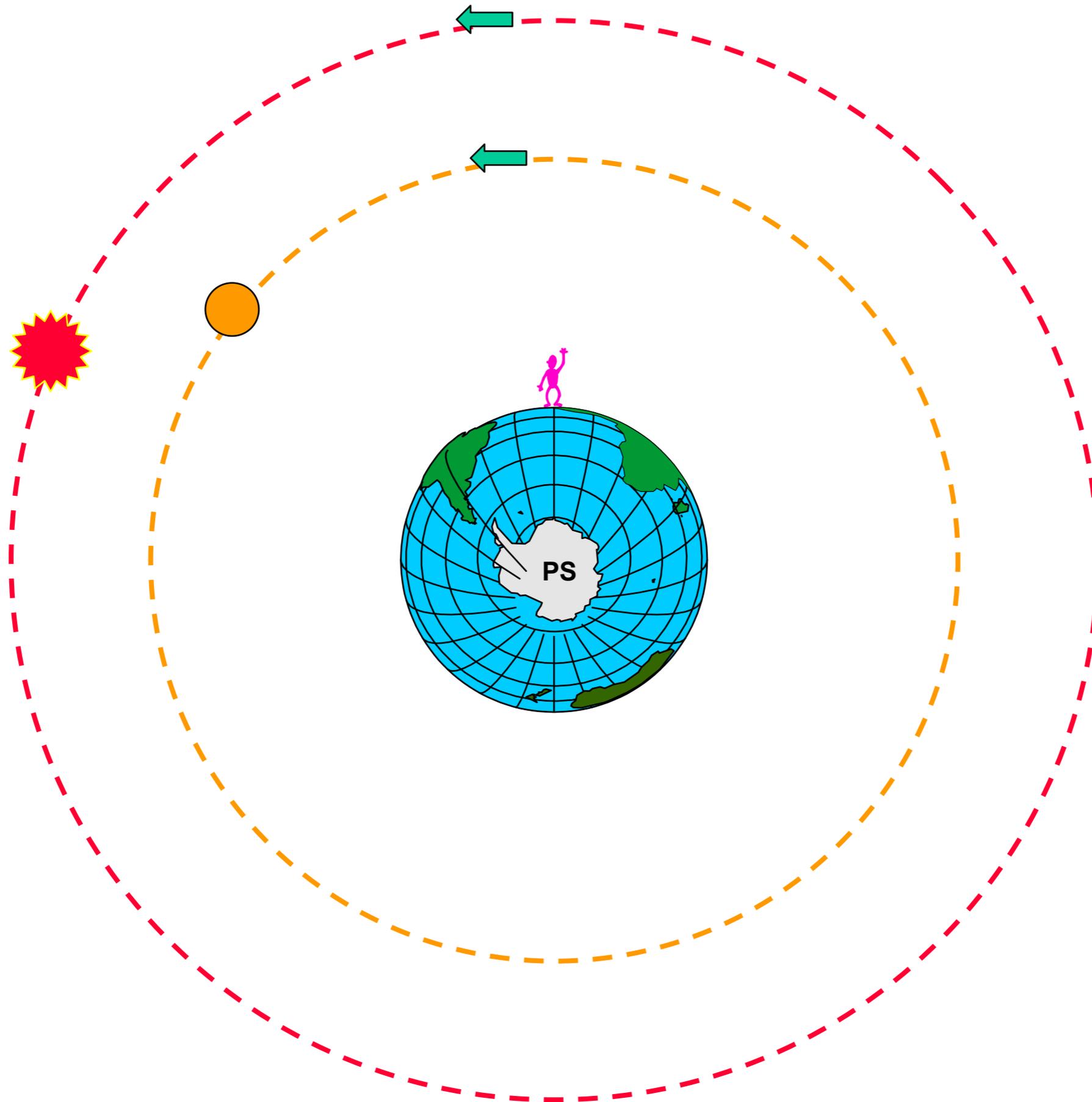
Relação entre marés e posição da Lua no céu



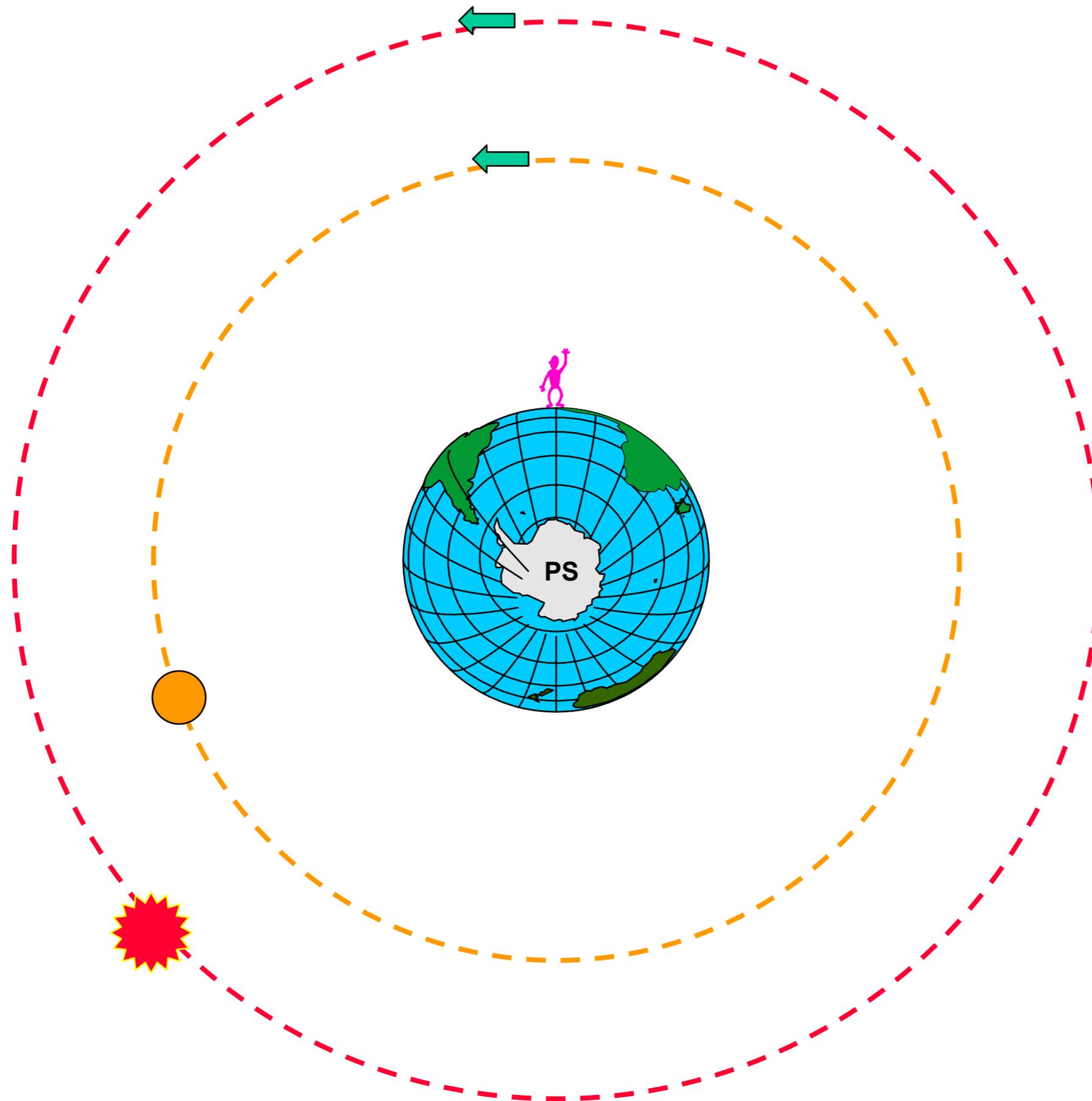
Dia Solar e Dia Lunar



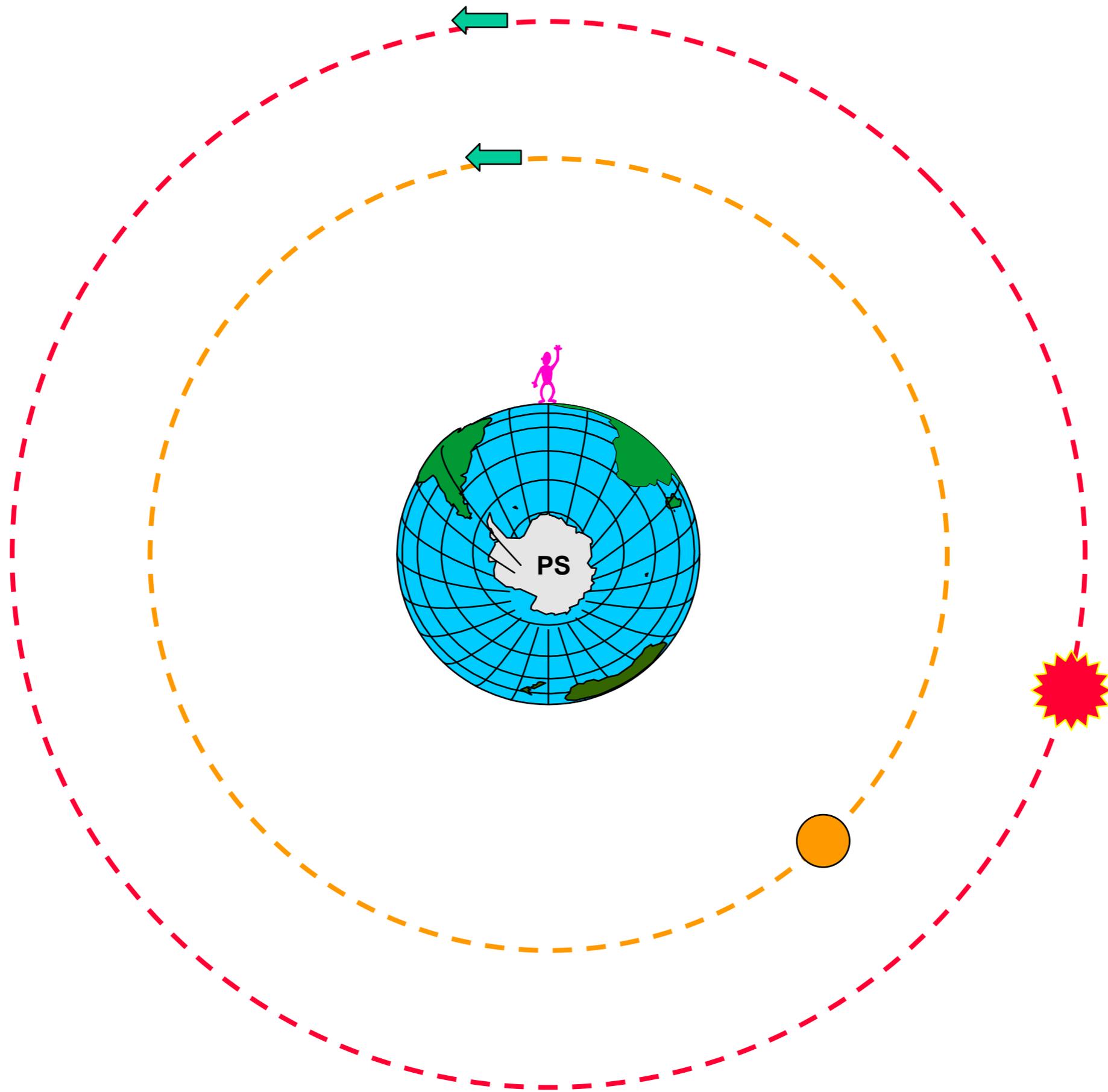
Dia Solar e Dia Lunar



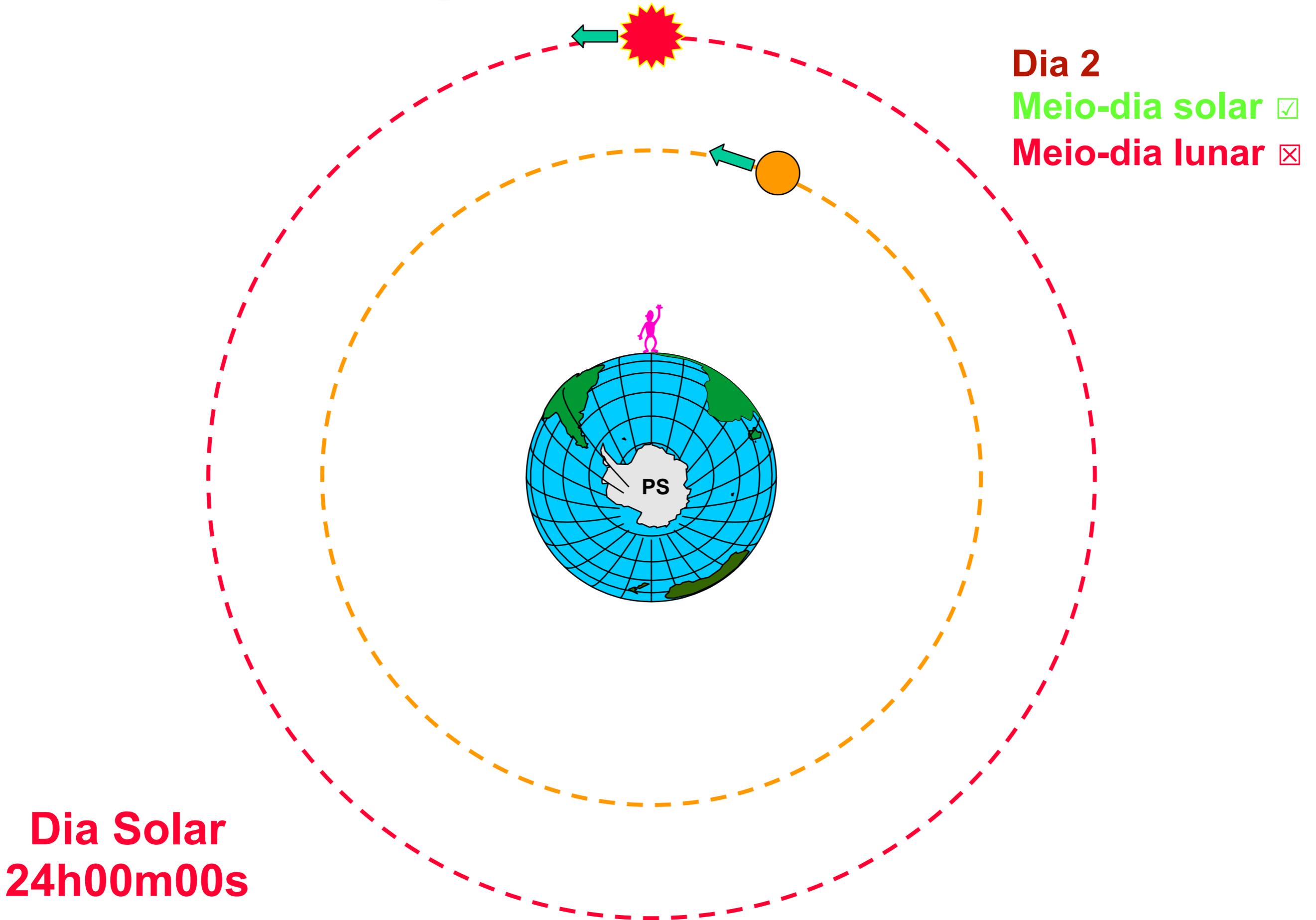
Dia Solar e Dia Lunar



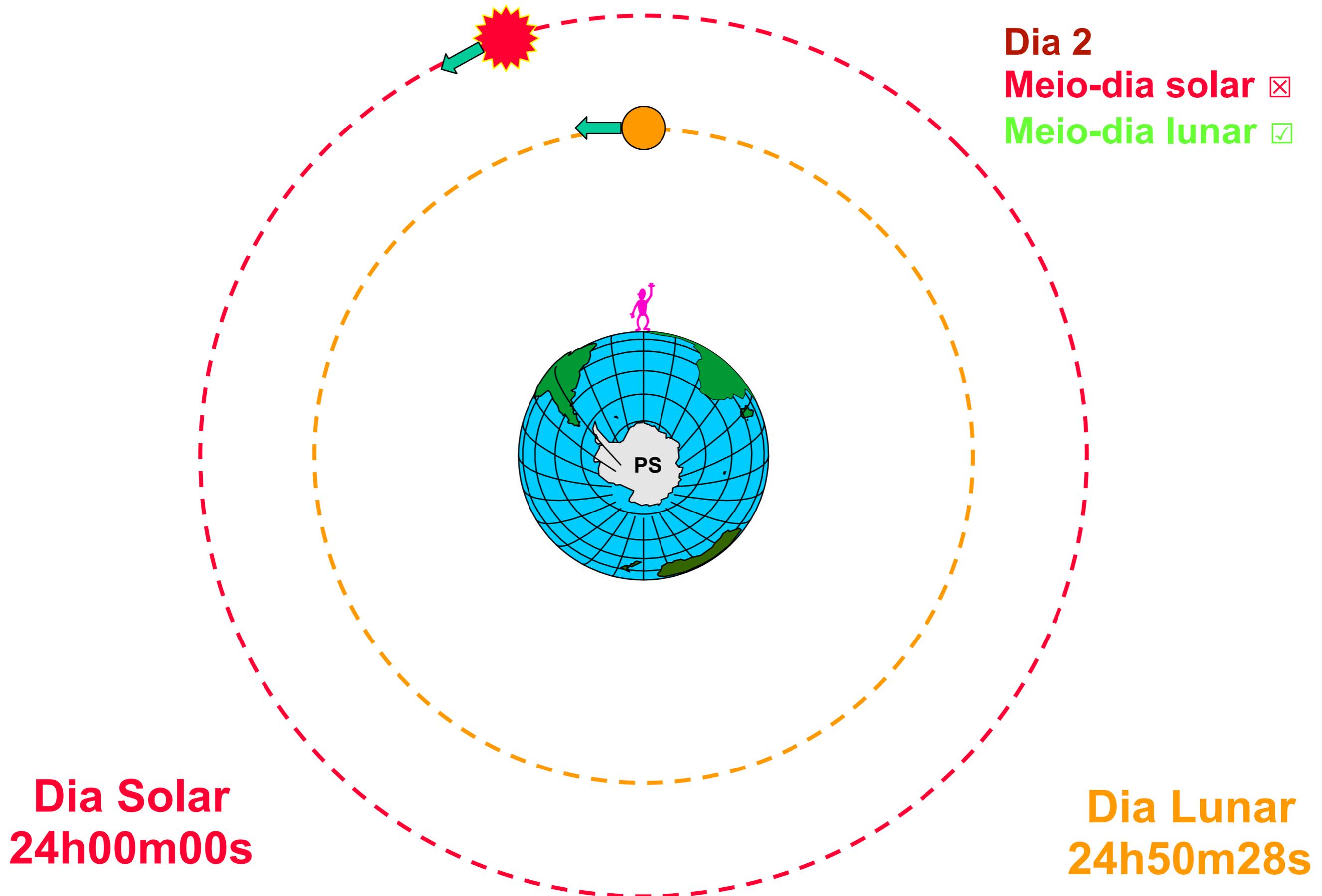
Dia Solar e Dia Lunar



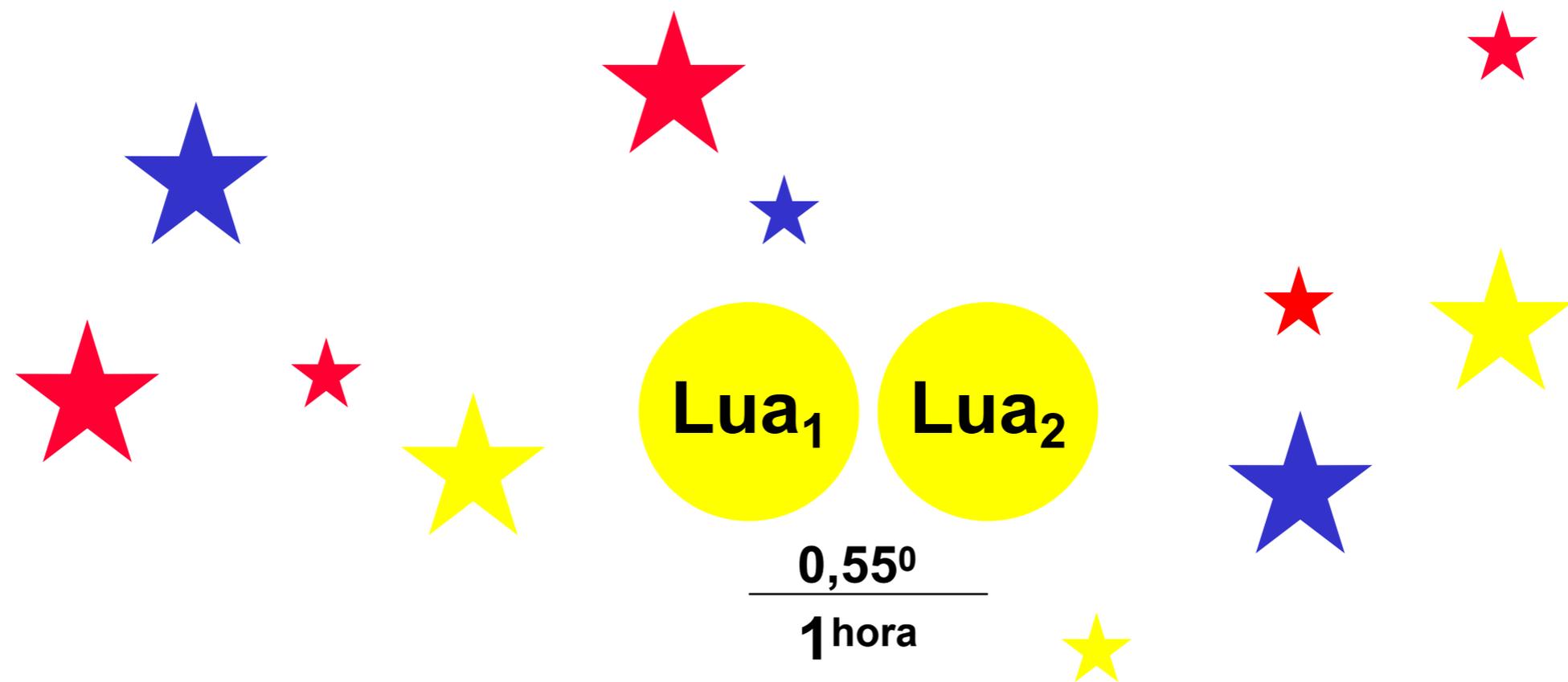
Dia Solar e Dia Lunar



Dia Solar e Dia Lunar



Movimento da Lua com relação às estrelas



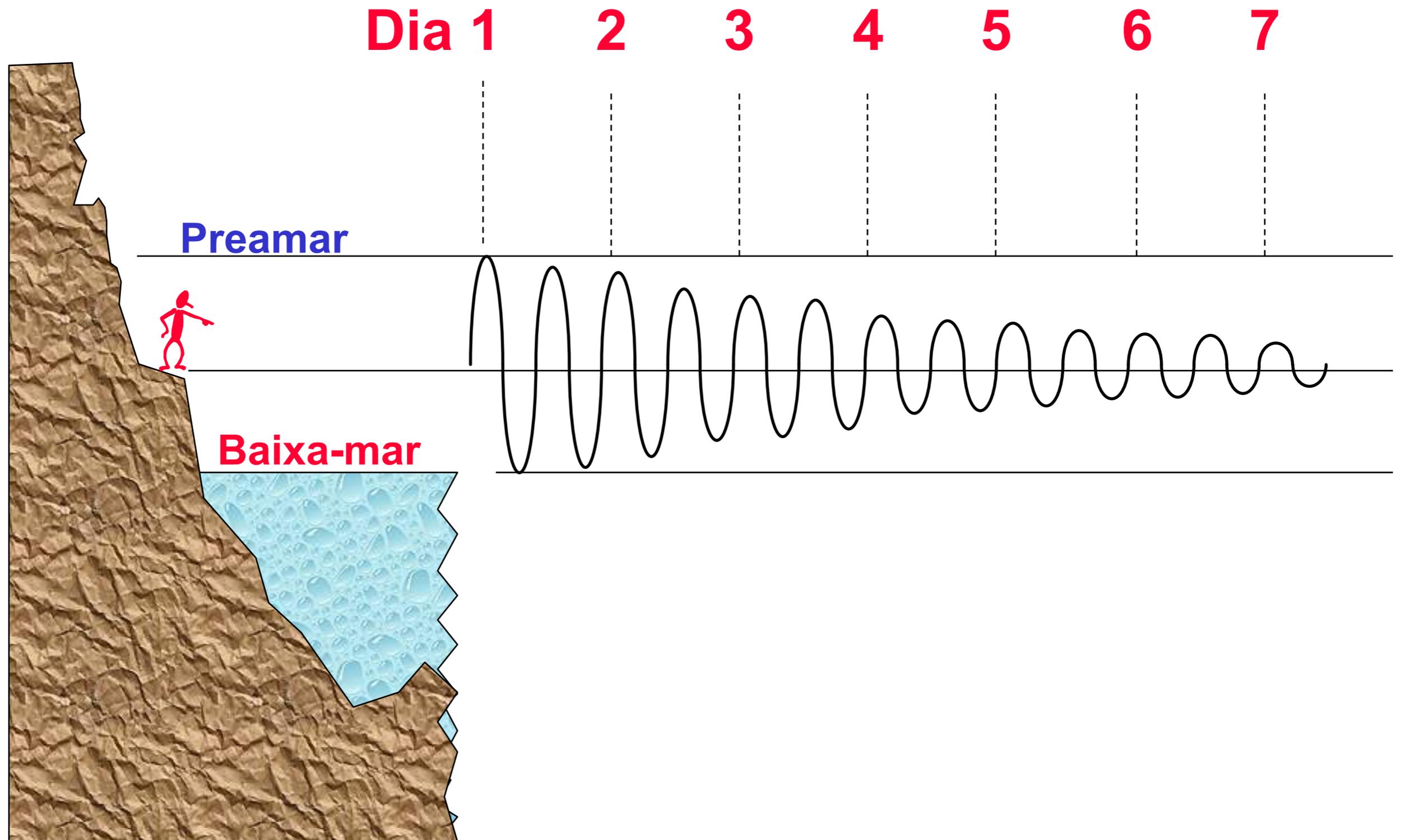
Oeste

Leste

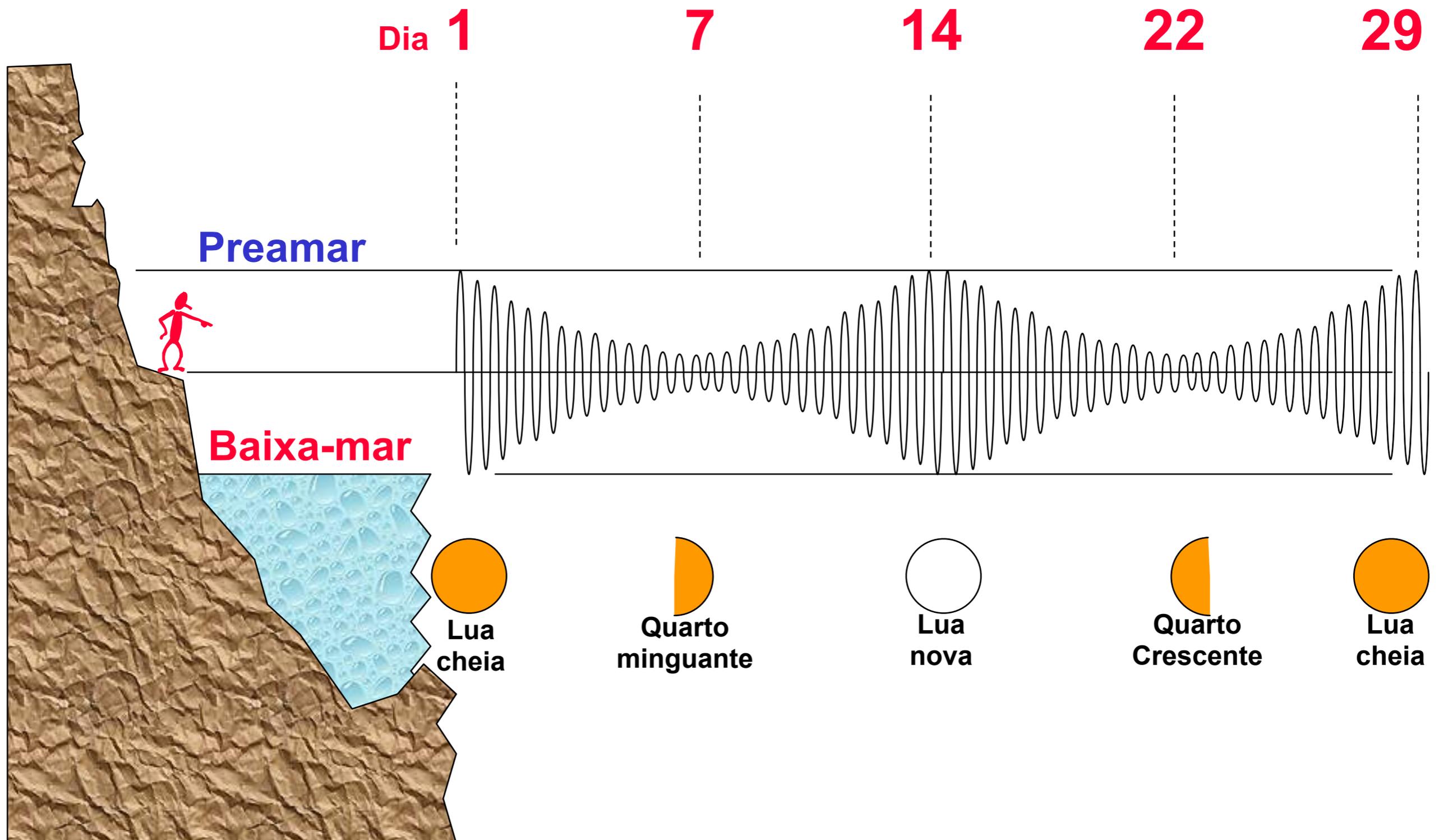
A Lua se desloca cerca de 1 Lua por hora com relação às estrelas.



Mudança diária no nível da maré



Influência da fase da Lua sobre a altura da maré

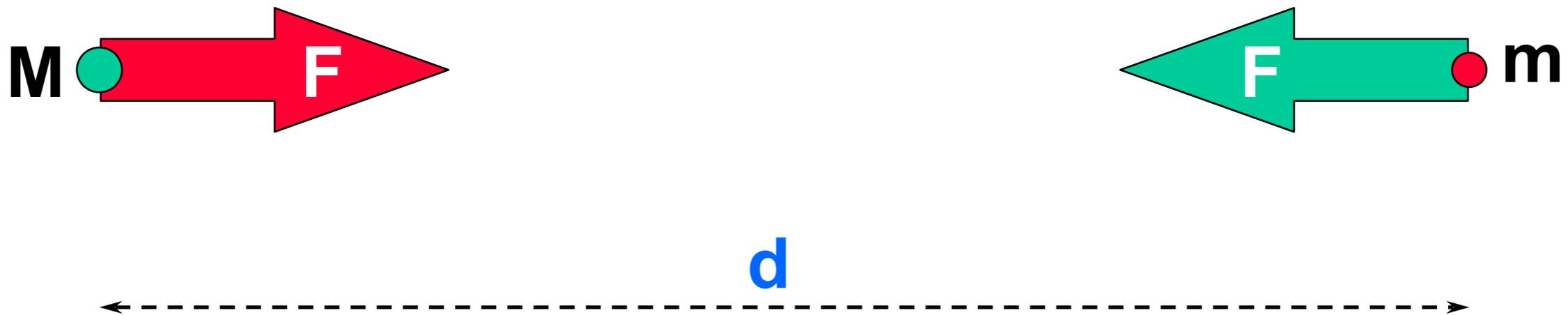


Qual a causa das marés?

Atração Gravitacional

(Newton)

Corpos puntiformes



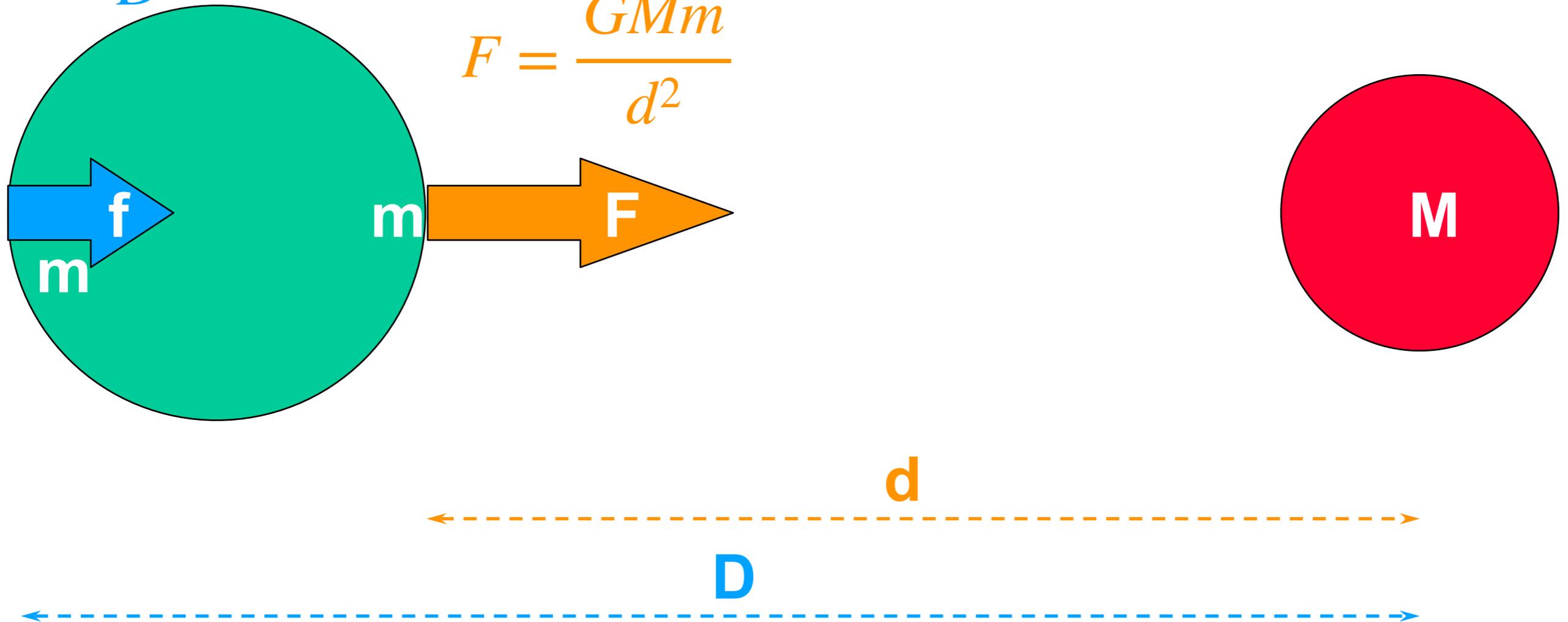
$$F = \frac{GMm}{d^2}$$

Atração gravitacional da Lua sobre a Terra

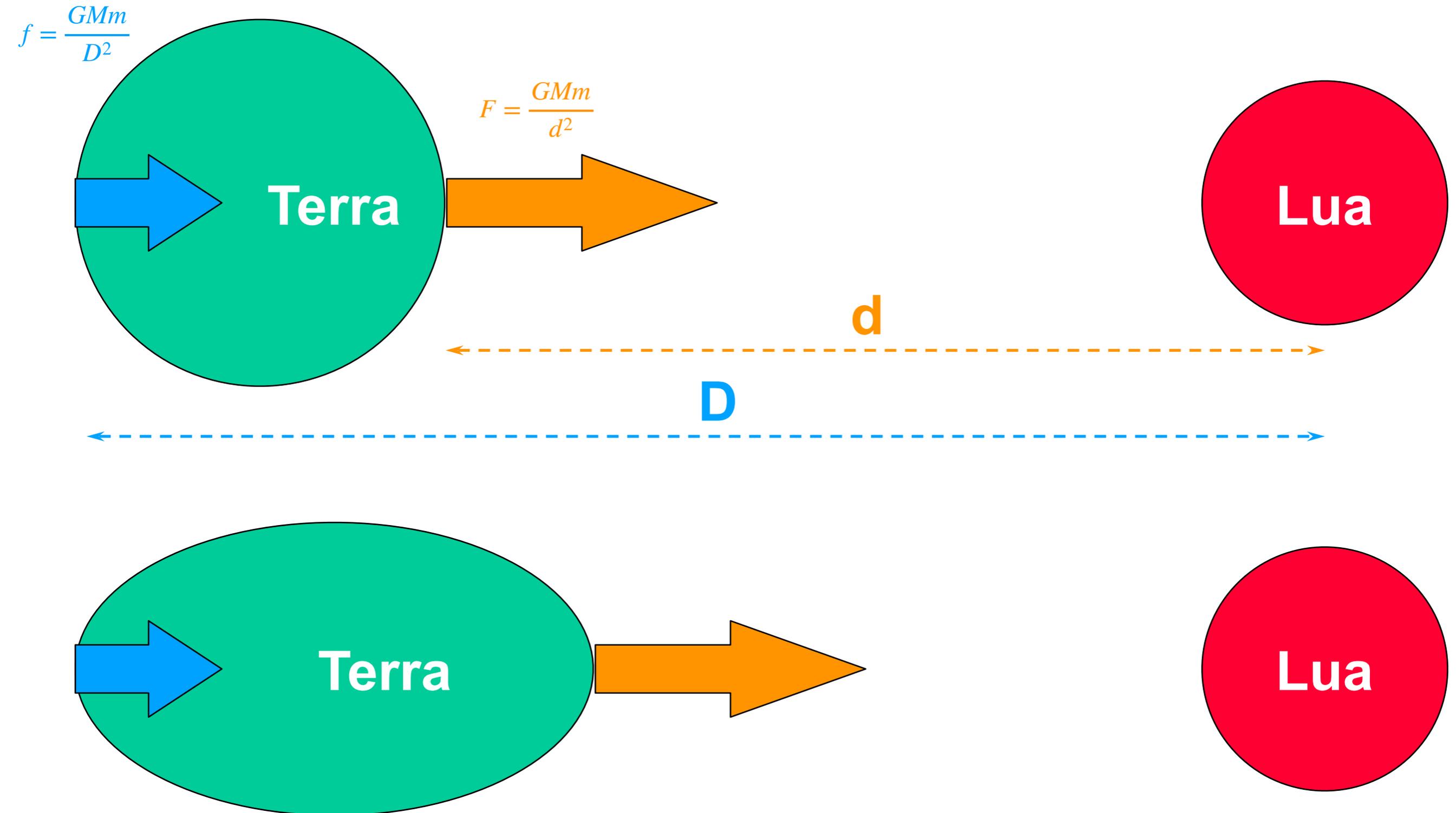
Corpos extensos

$$f = \frac{GMm}{D^2}$$

$$F = \frac{GMm}{d^2}$$



Atração gravitacional da Lua sobre a Terra elástica

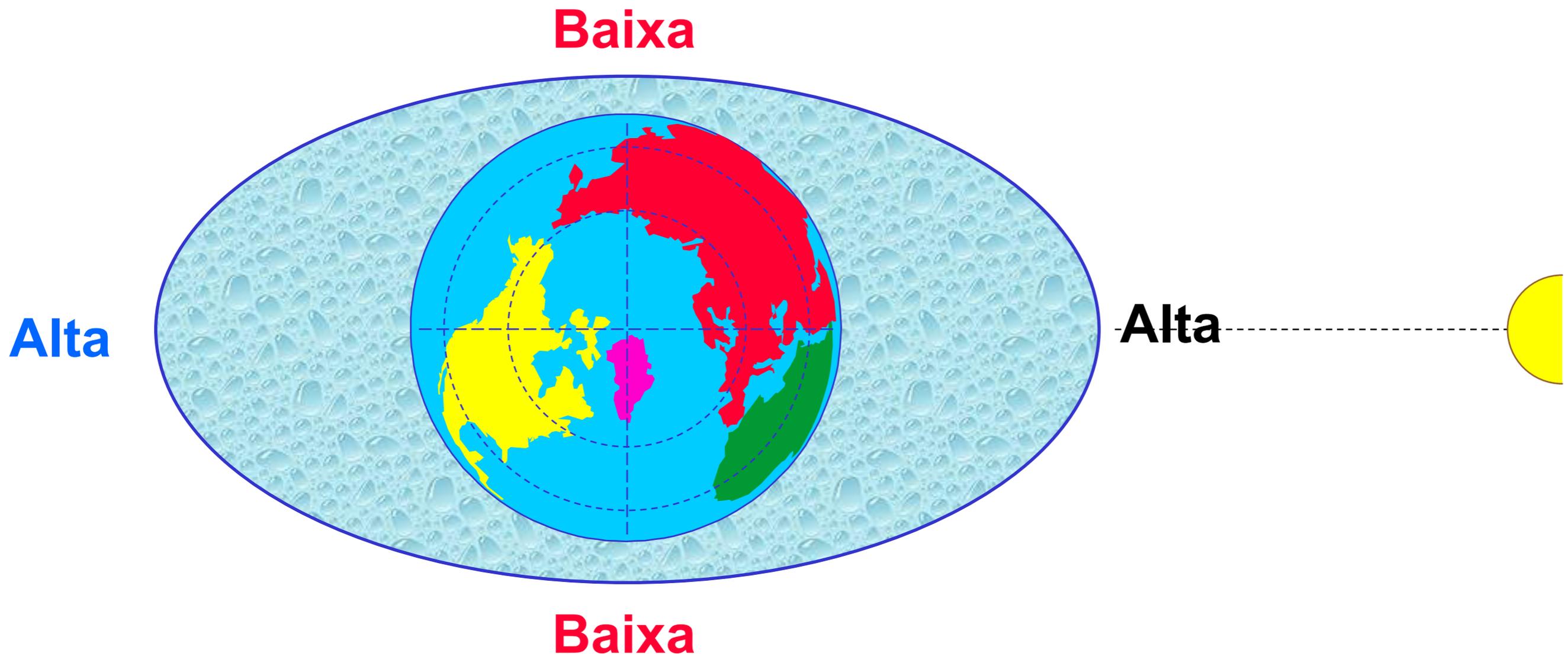


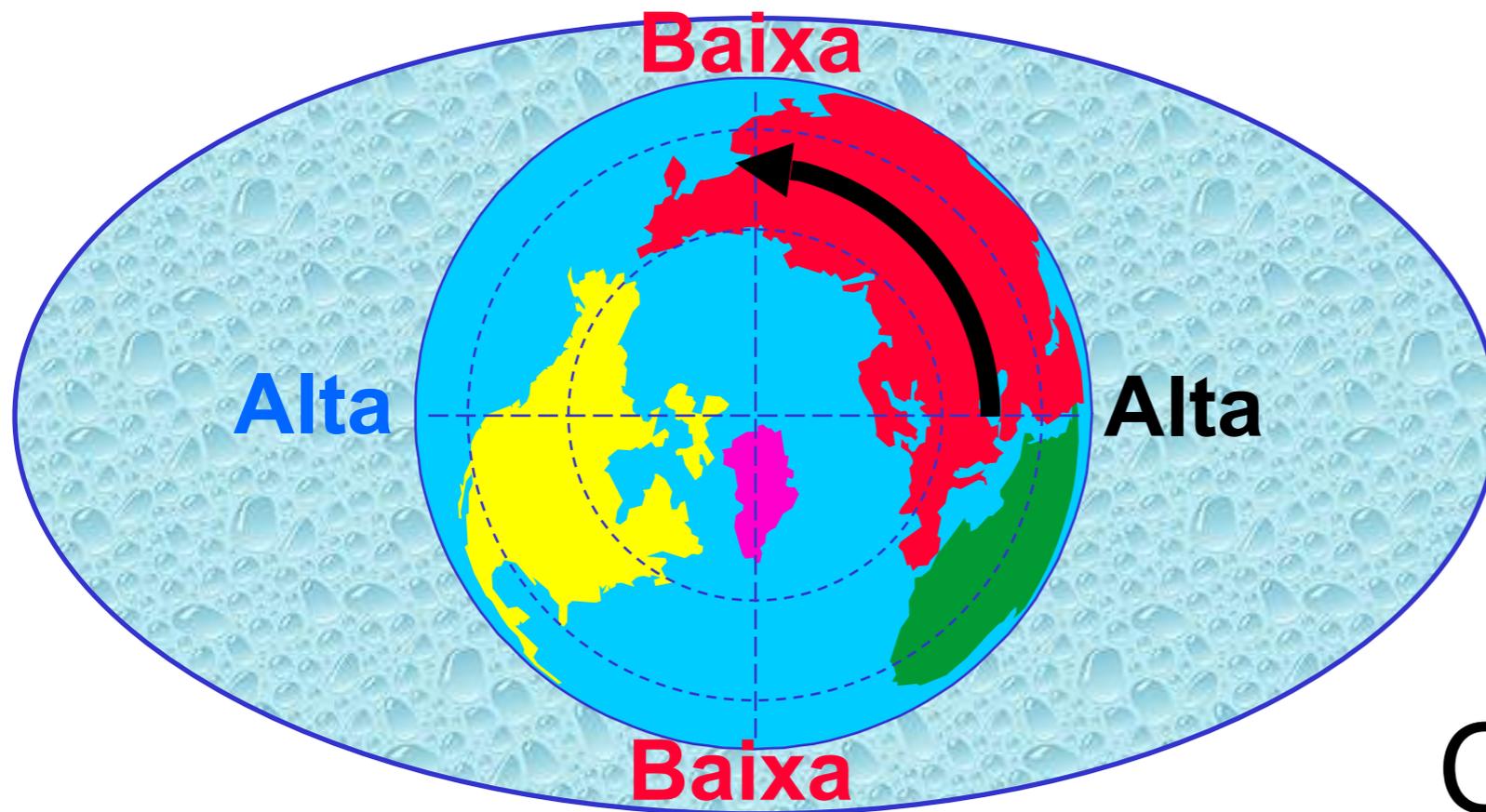
Forças gravitacionais diferenciais

$$F = -\frac{GMm}{r^2}$$

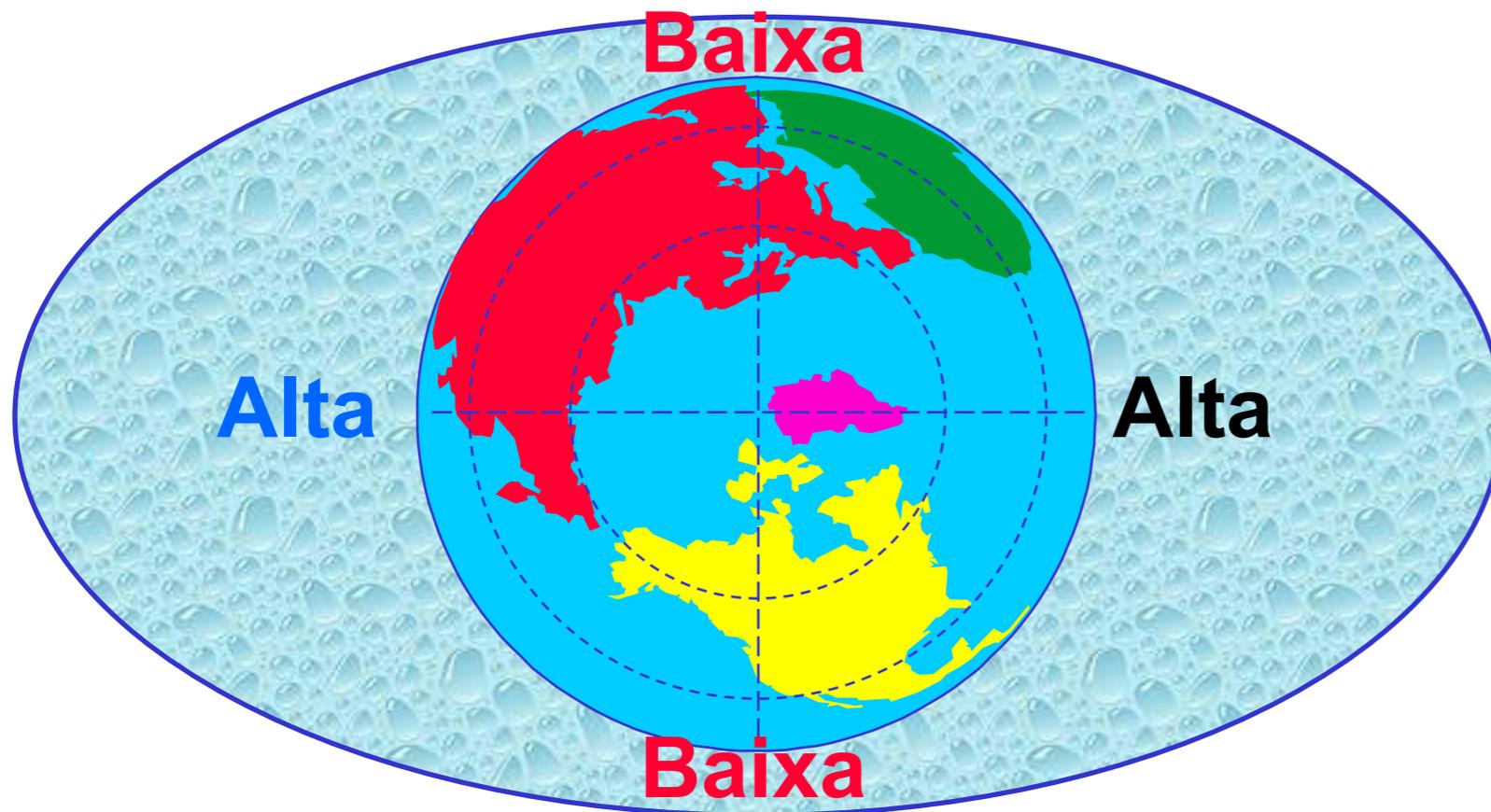
$$\frac{dF}{dr} = \frac{2GMm}{r^3}$$

Configuração instantânea das marés na superfície da Terra





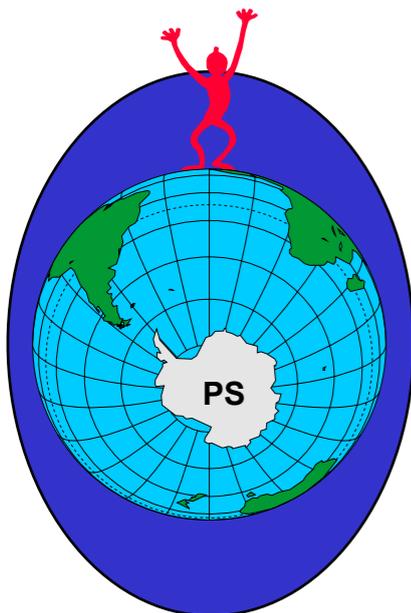
Configurações locais depois de cerca de 6 h



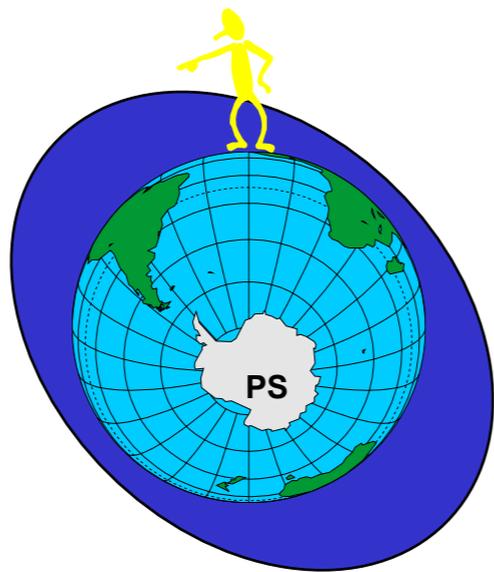
Movimento diurno aparente da Lua



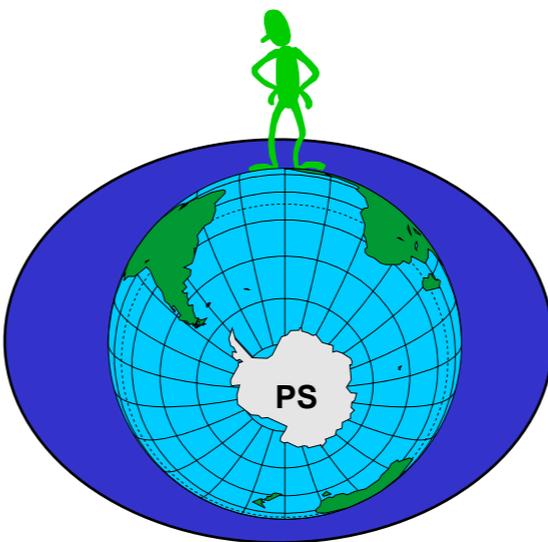
Glub-glub...



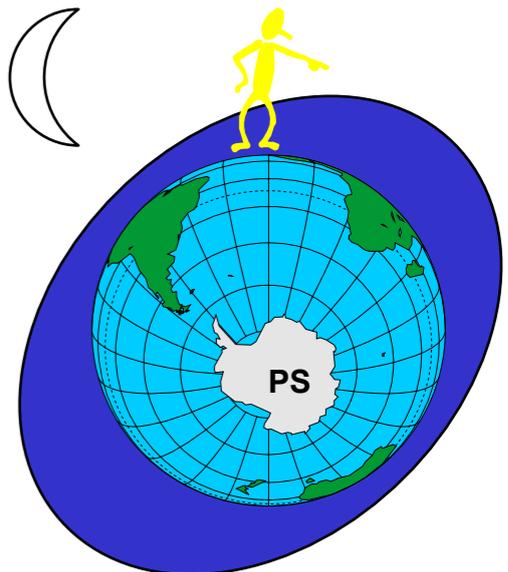
7



8



1

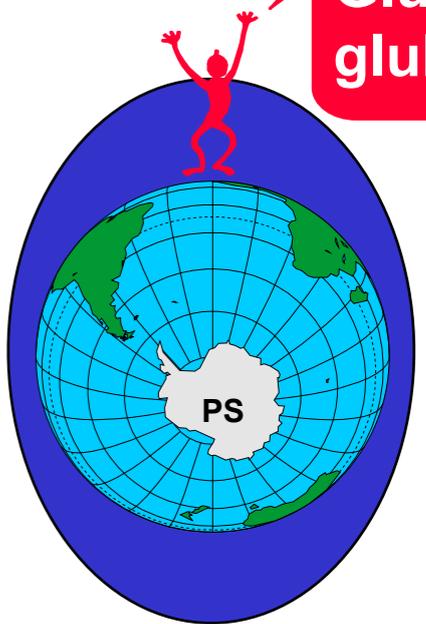


2

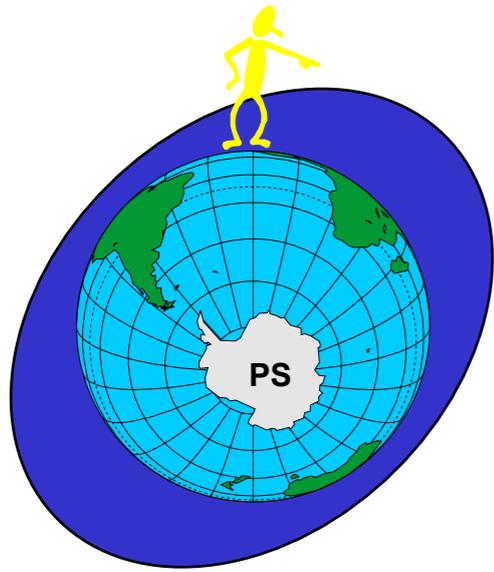
Seqüência da Maré

3

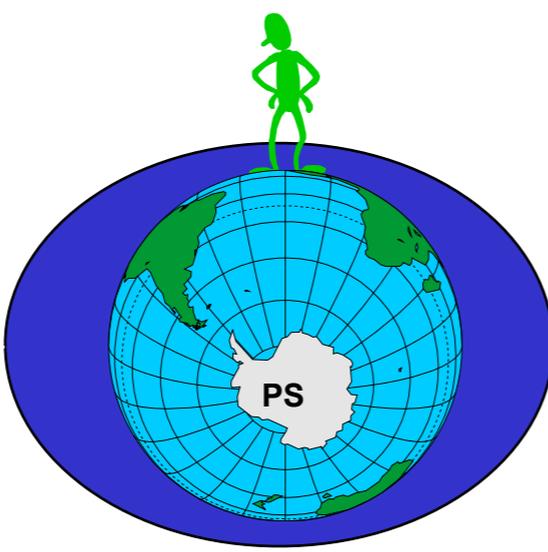
Glub-glub...



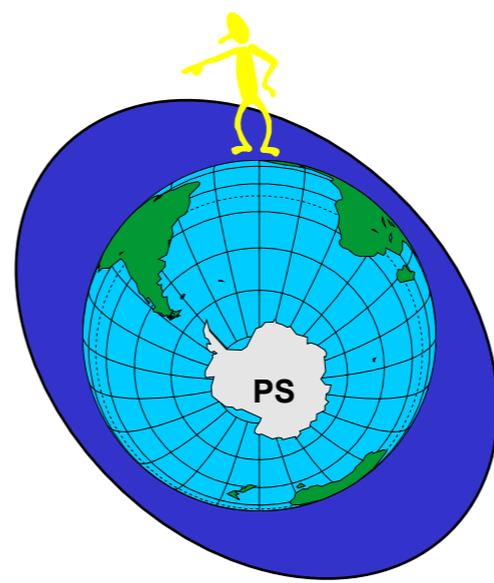
6



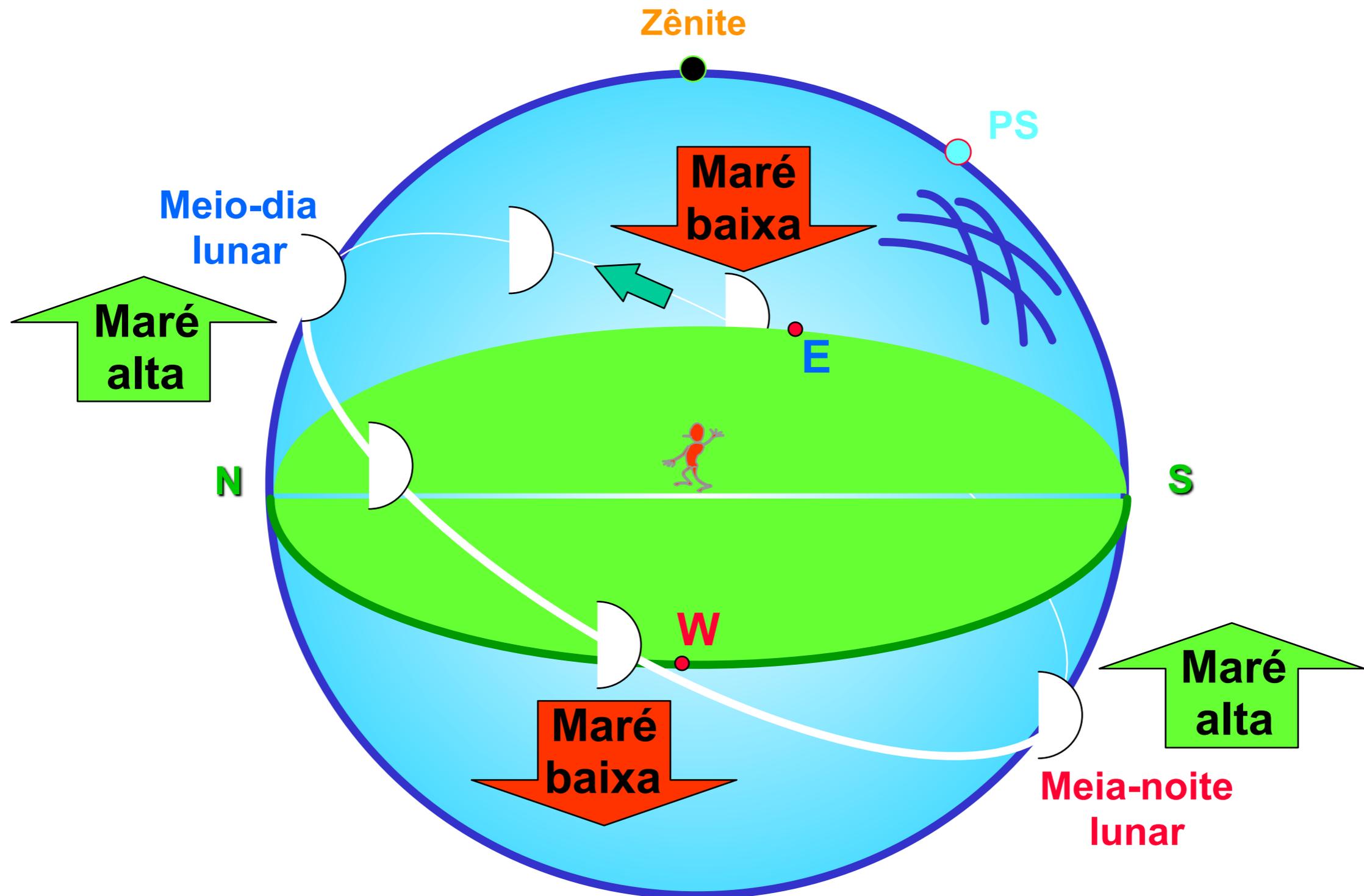
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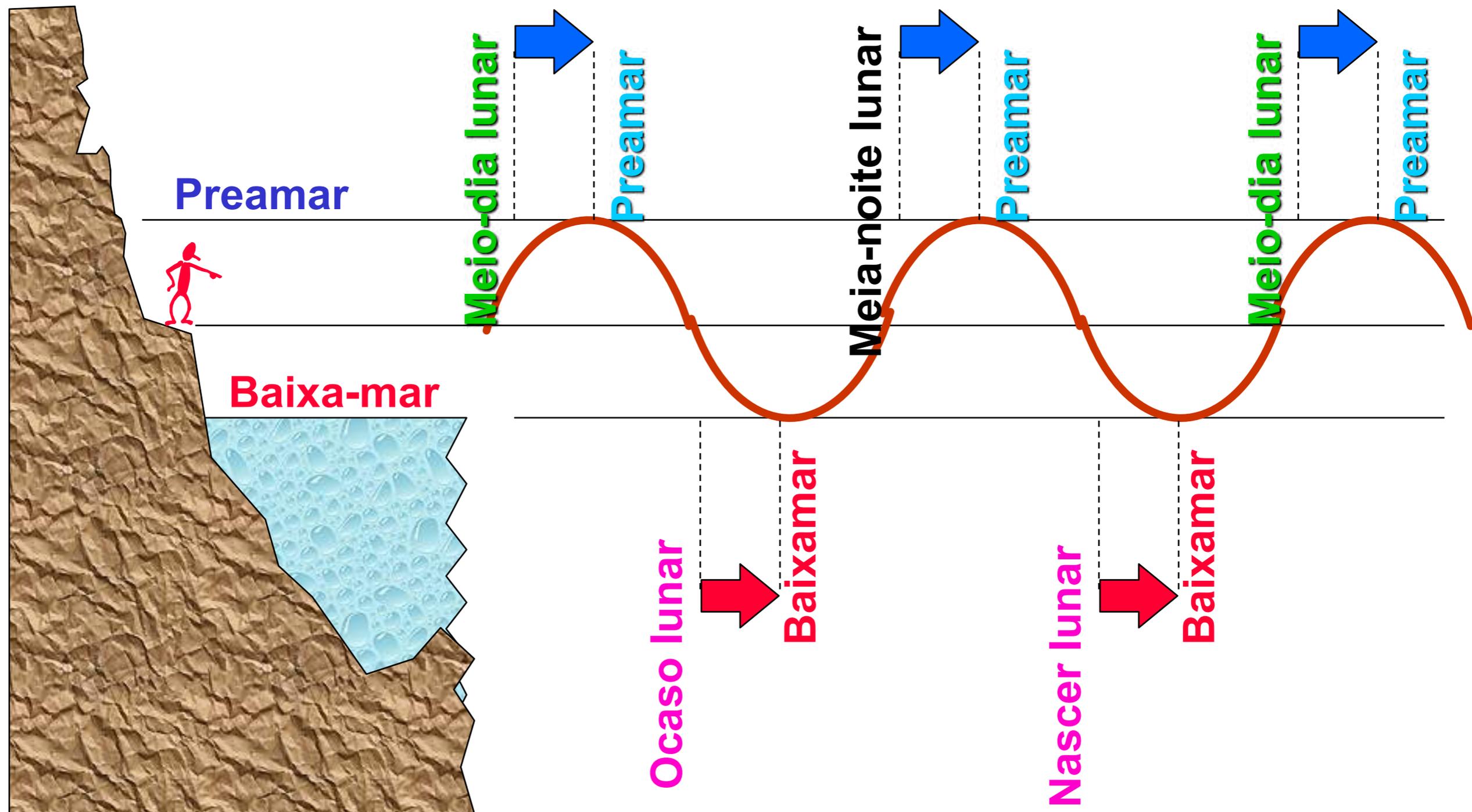
4



Relação entre marés e posição da Lua no céu

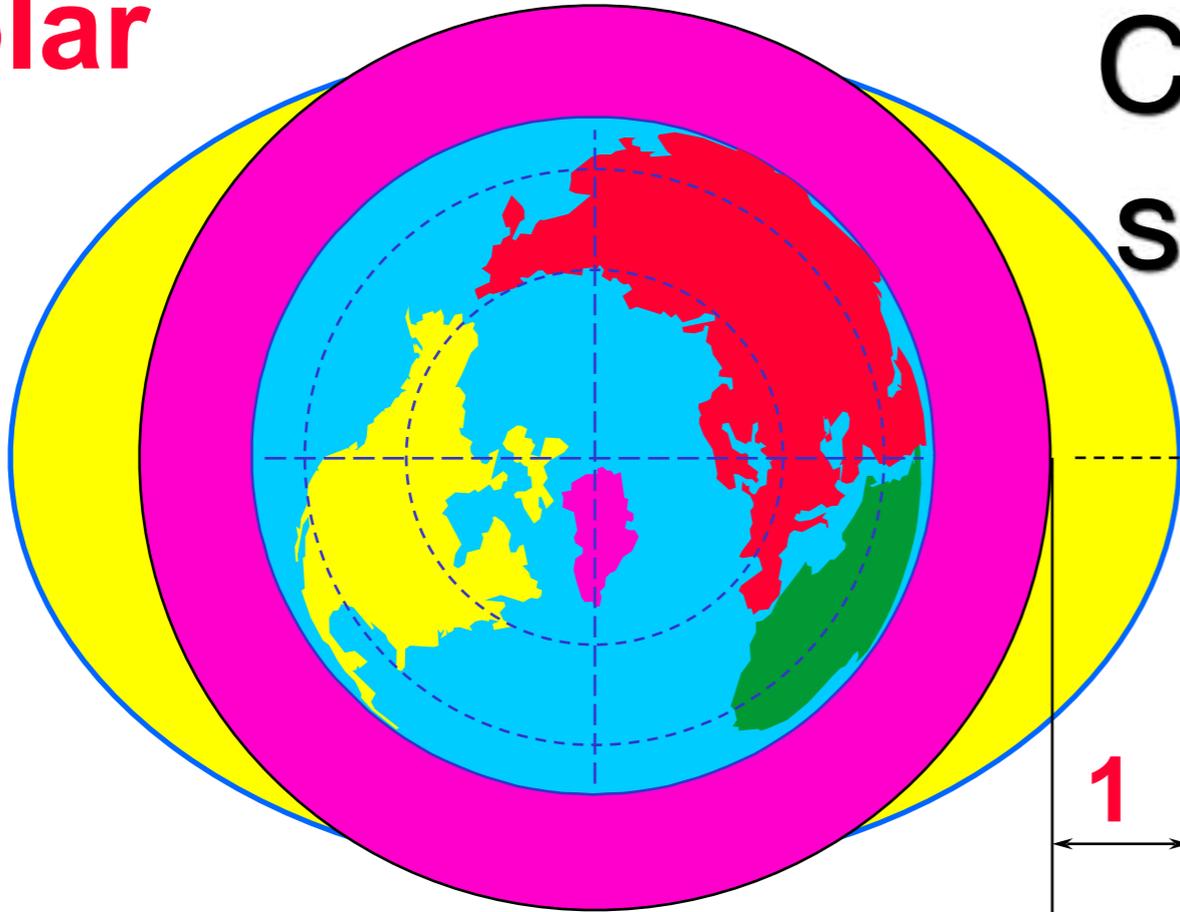
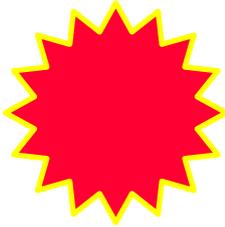


Defasagem entre maré alta ou baixa e meio-dia lunar

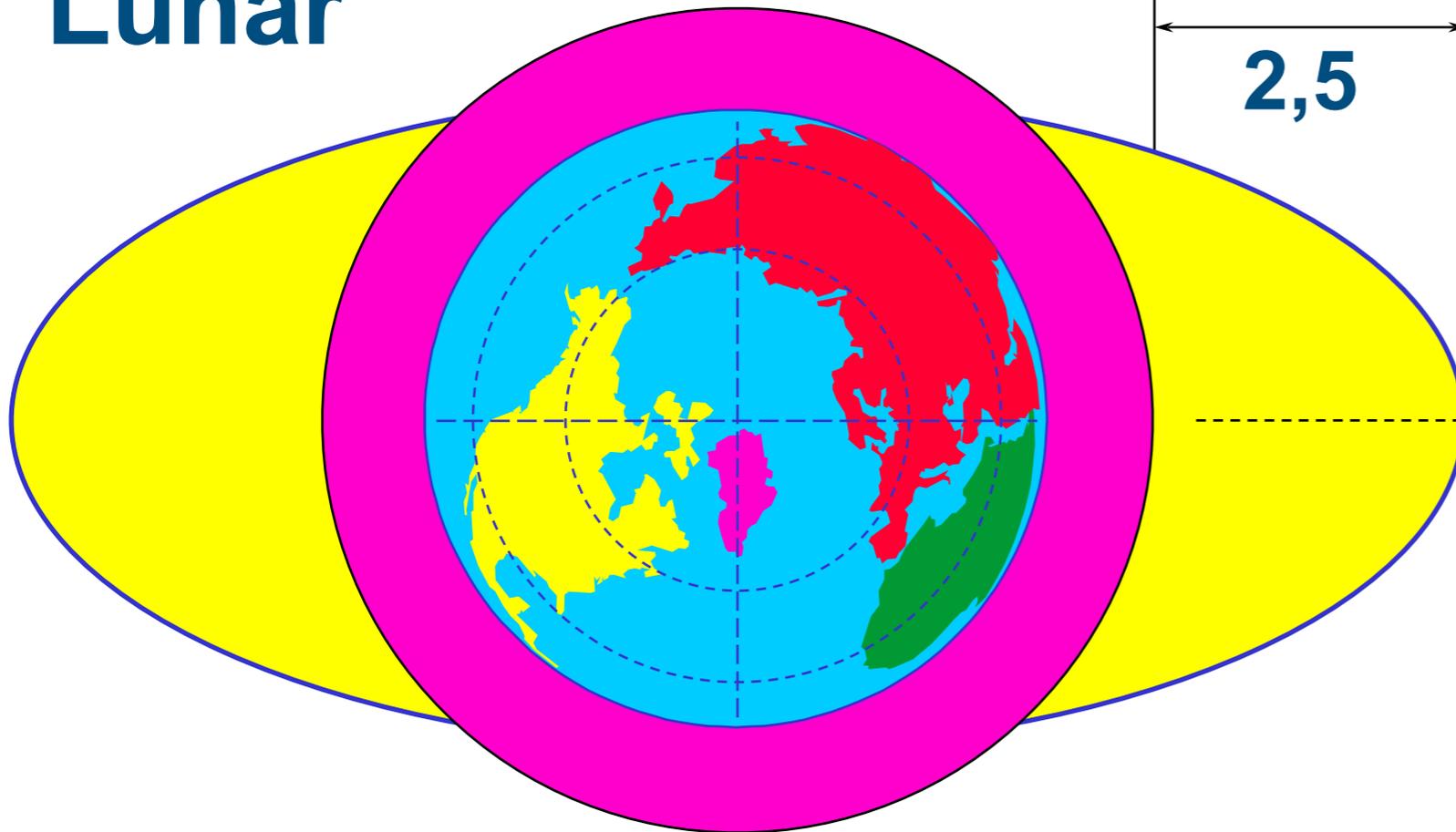


Solar

Contribuição da maré solar e da maré lunar



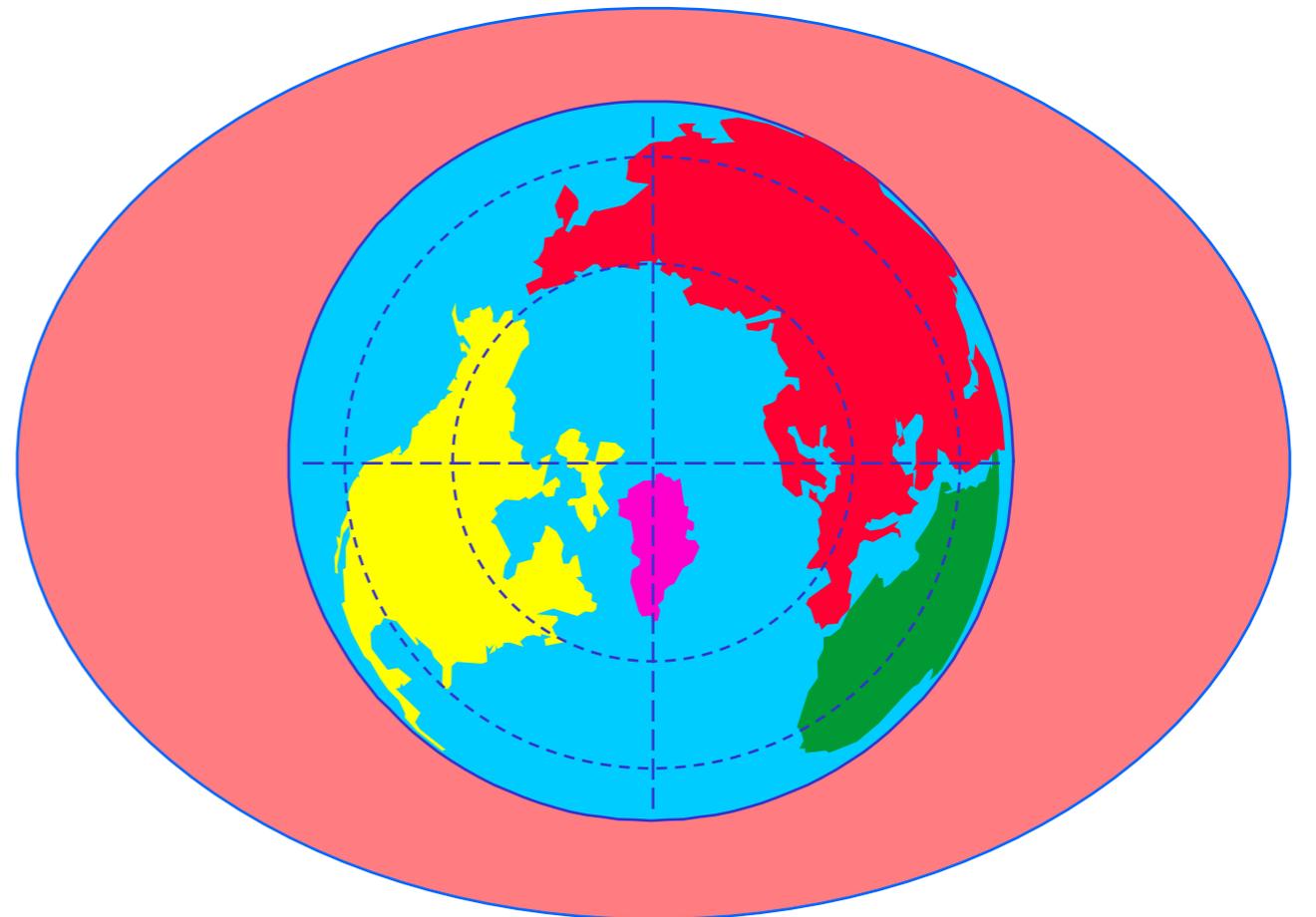
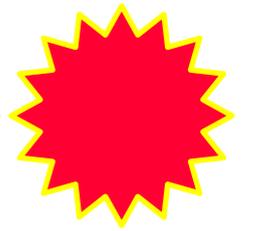
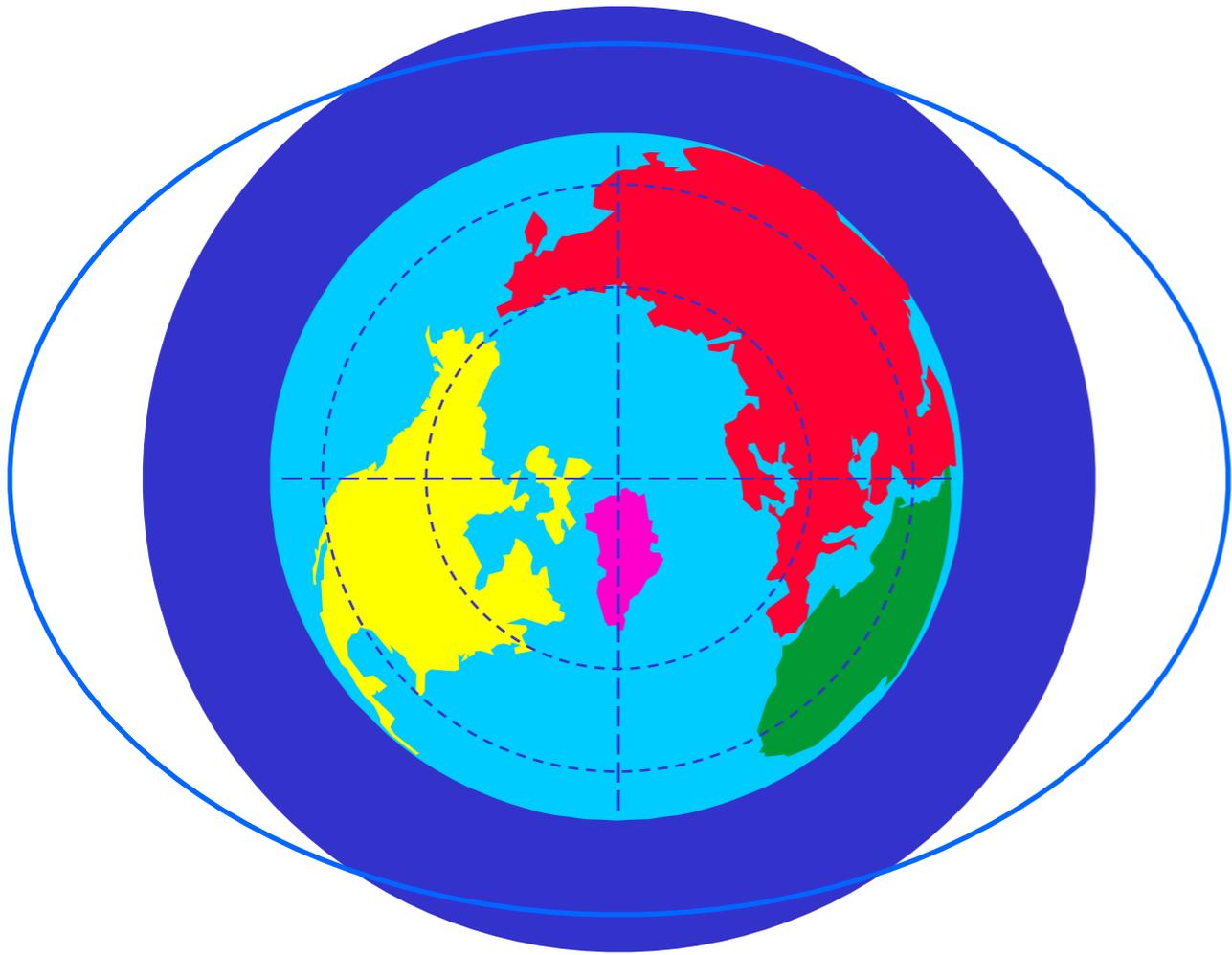
Lunar



1

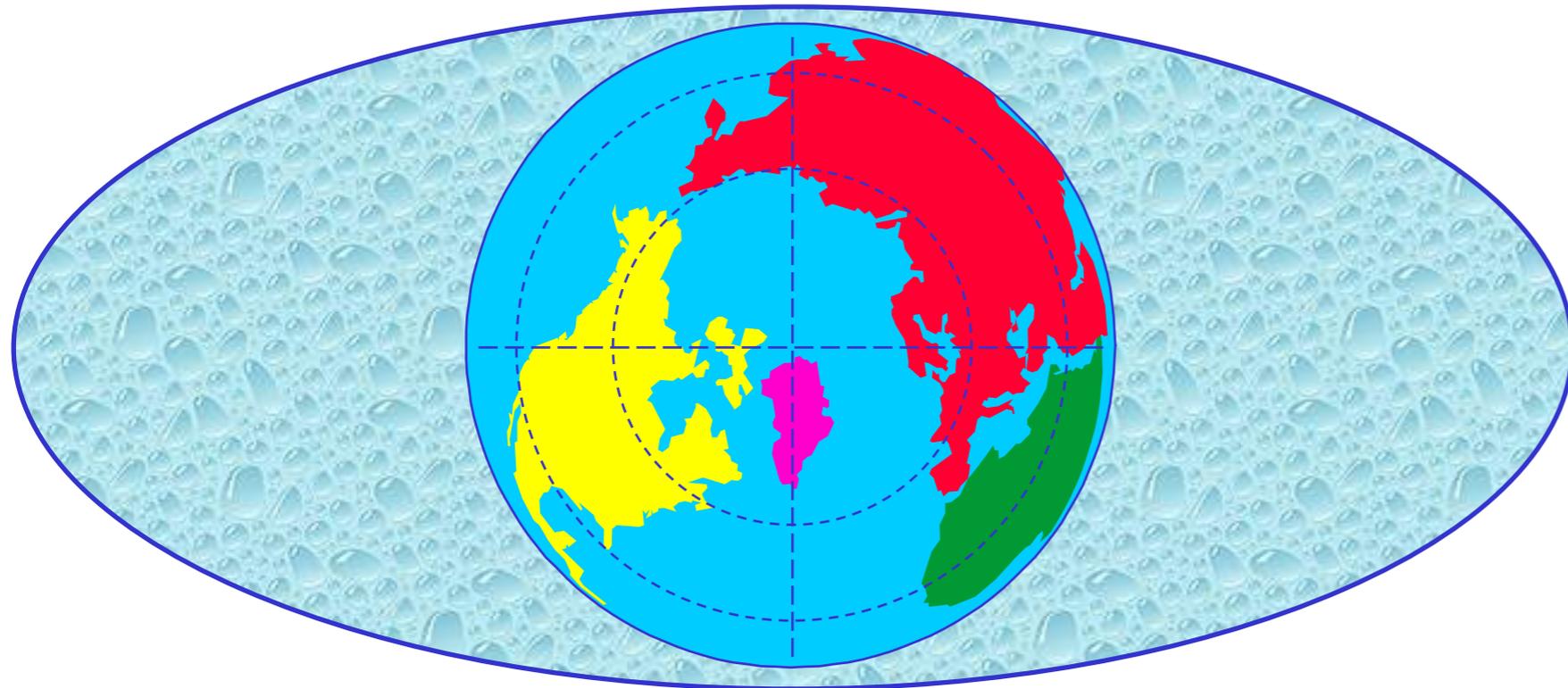
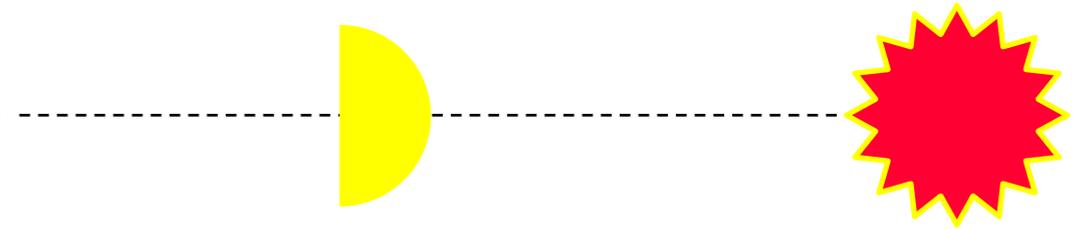
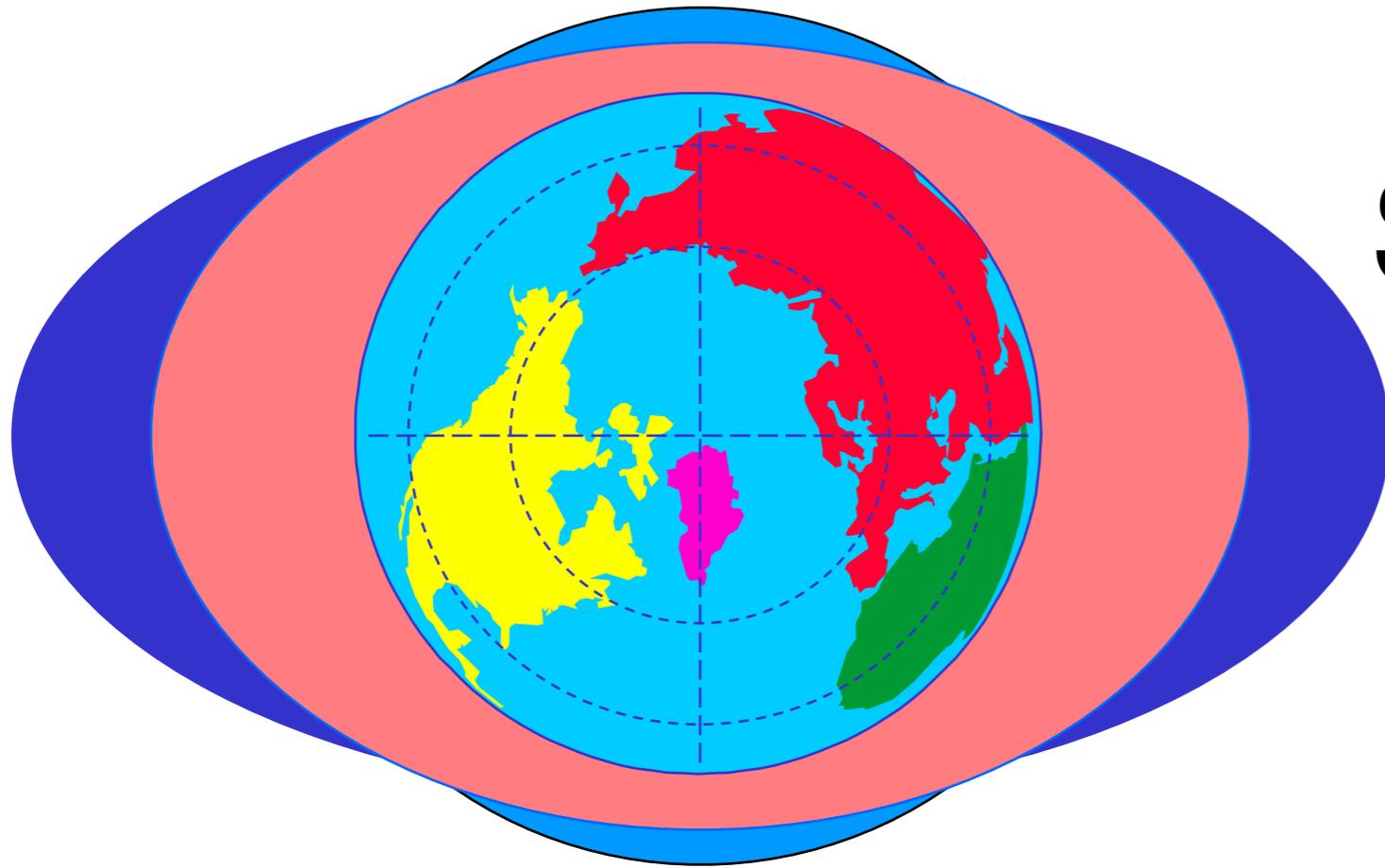
2,5

Maré Solar

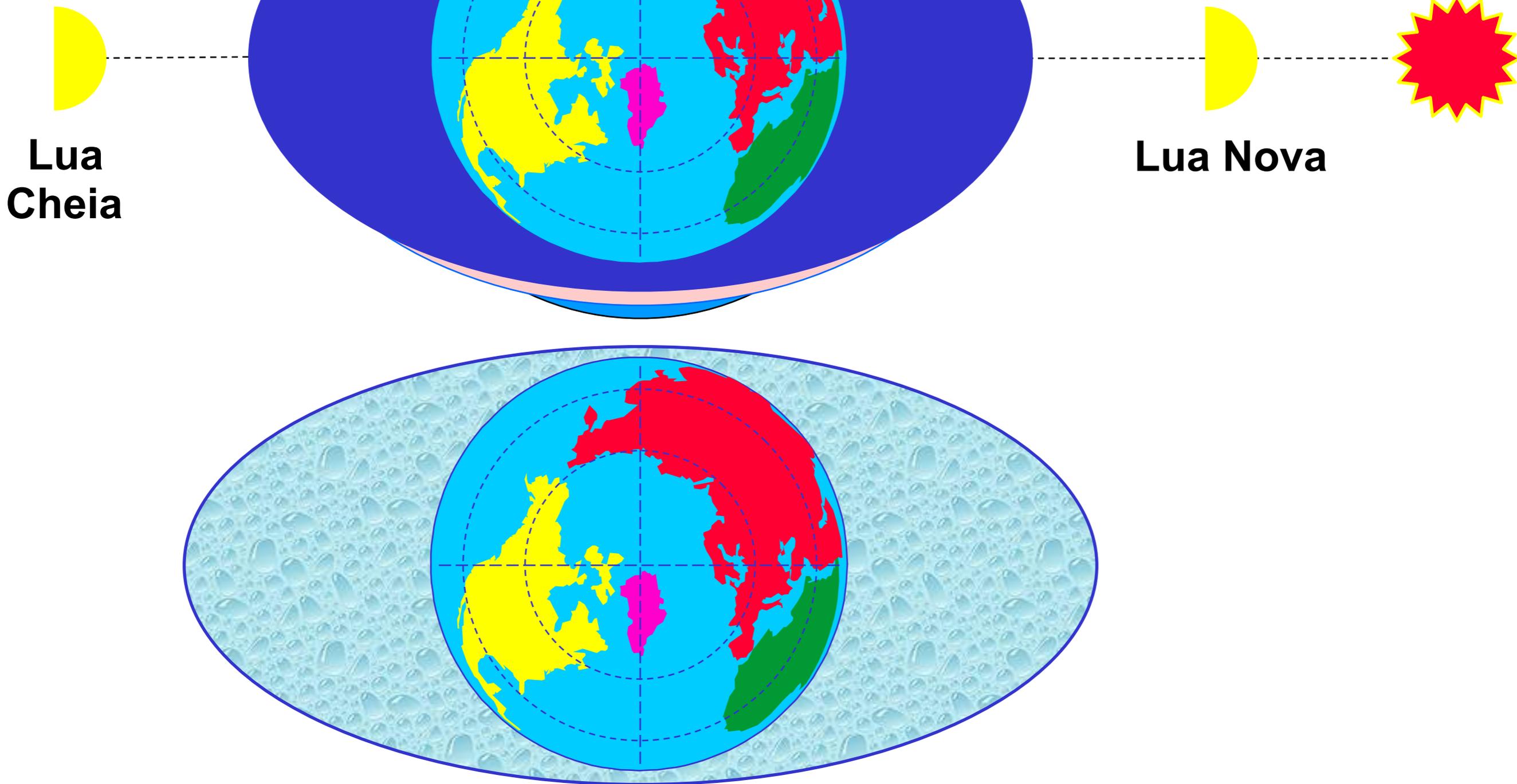


Maré

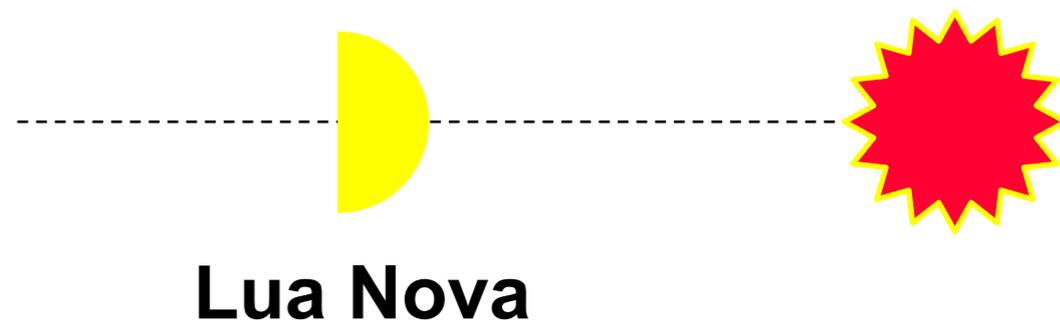
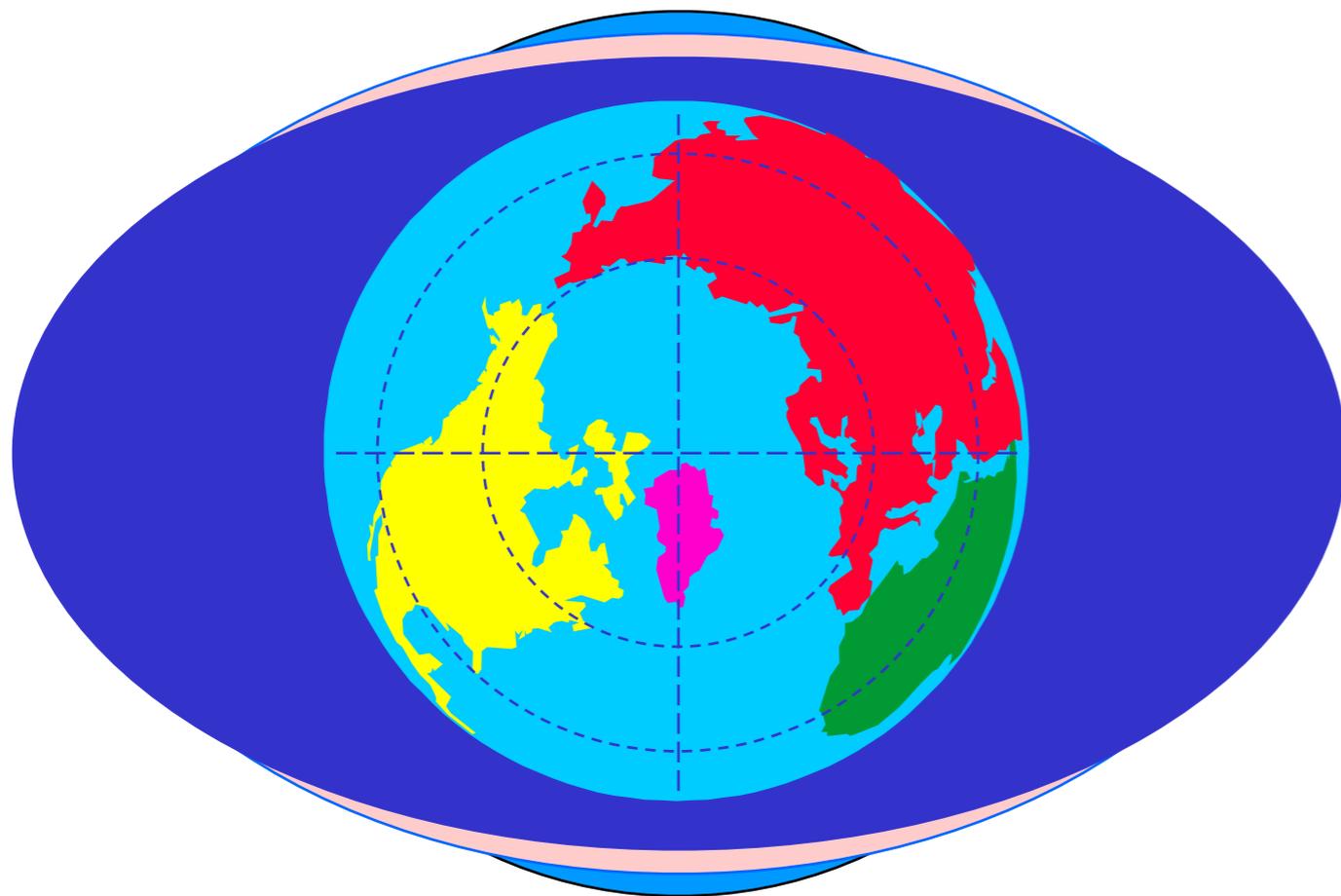
Solar + Lunar



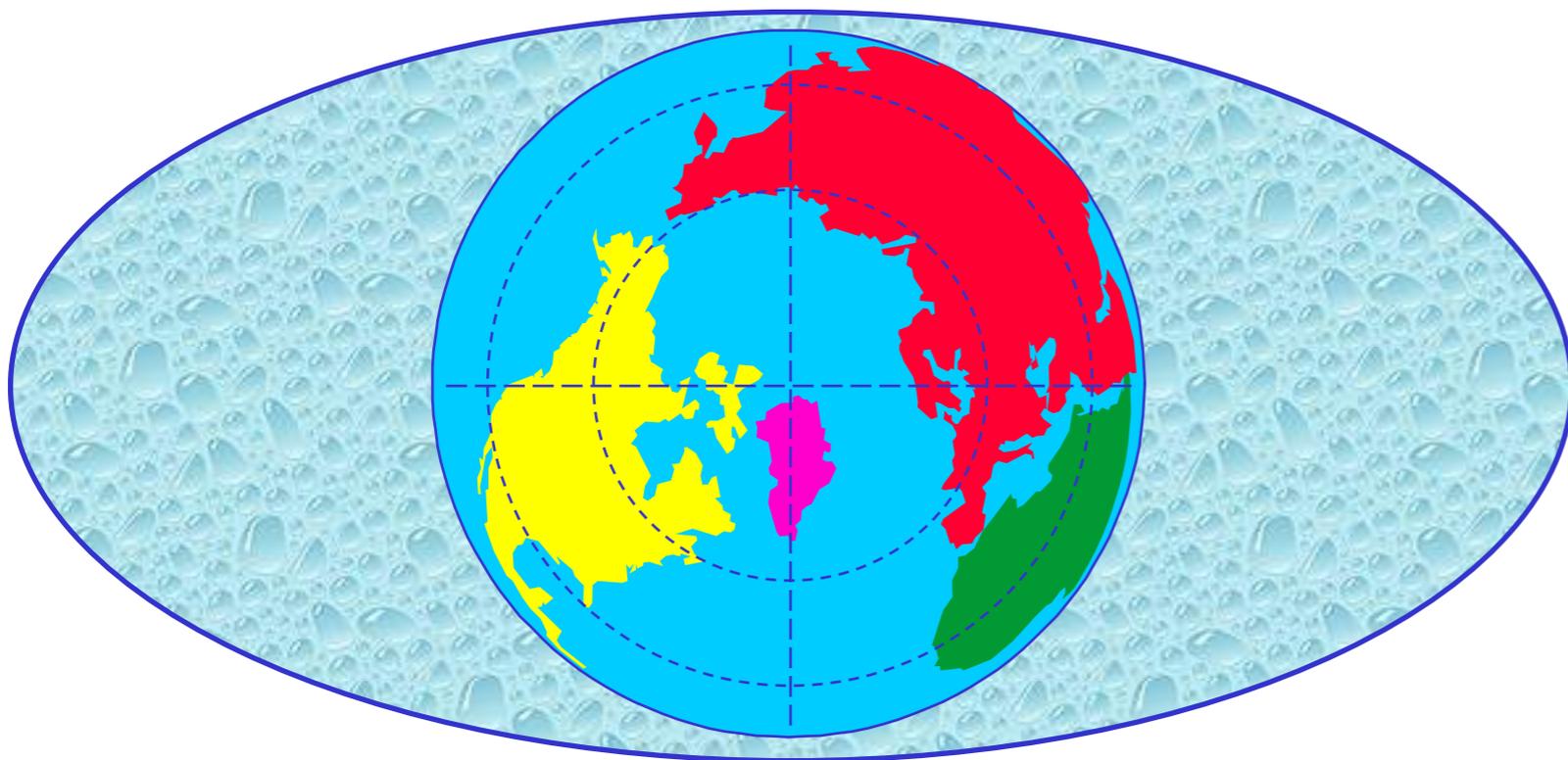
Marés de Sizígea



Maré de Sizígea



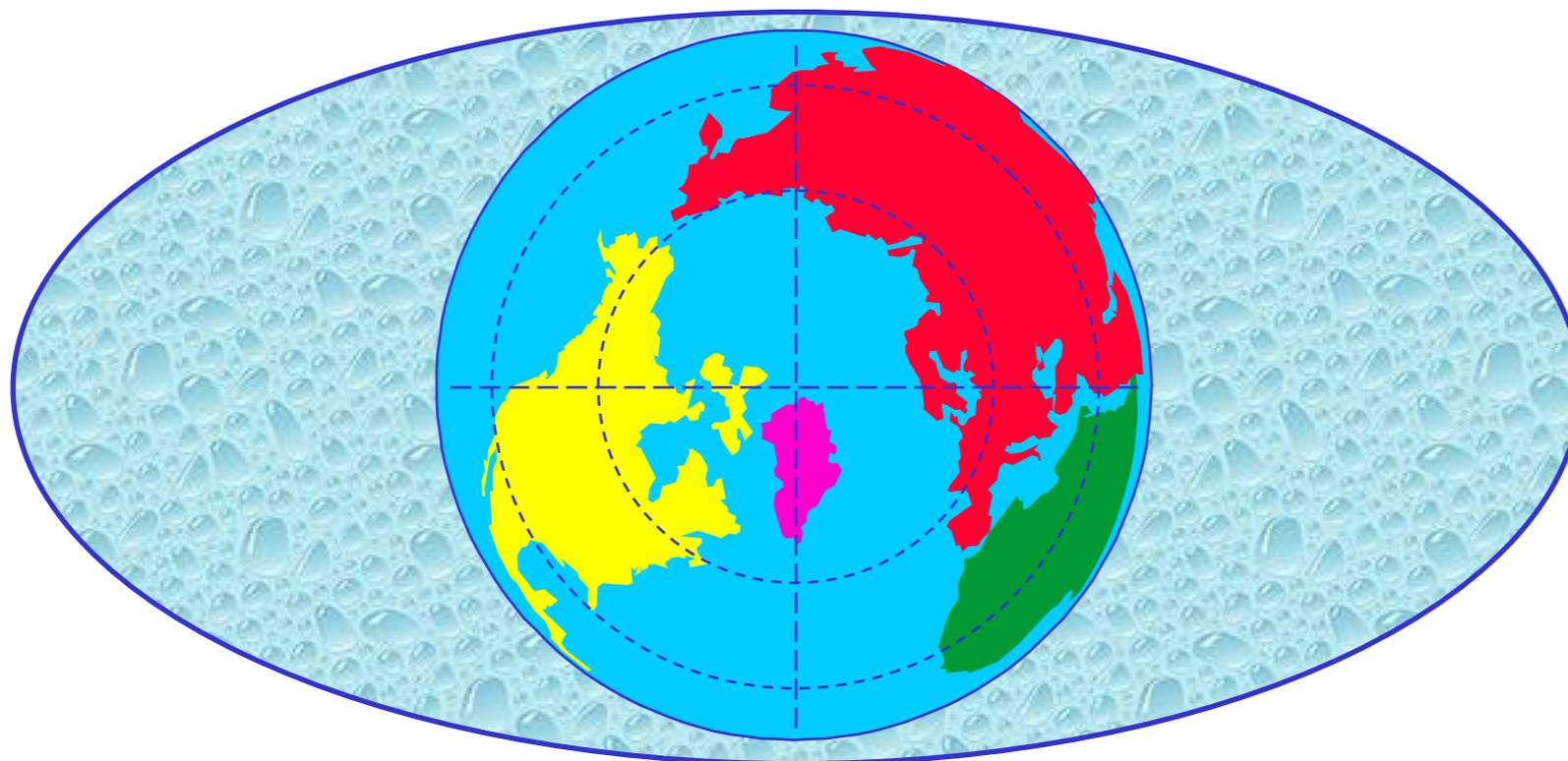
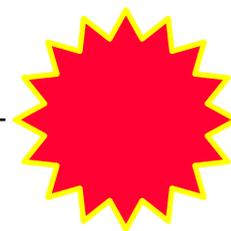
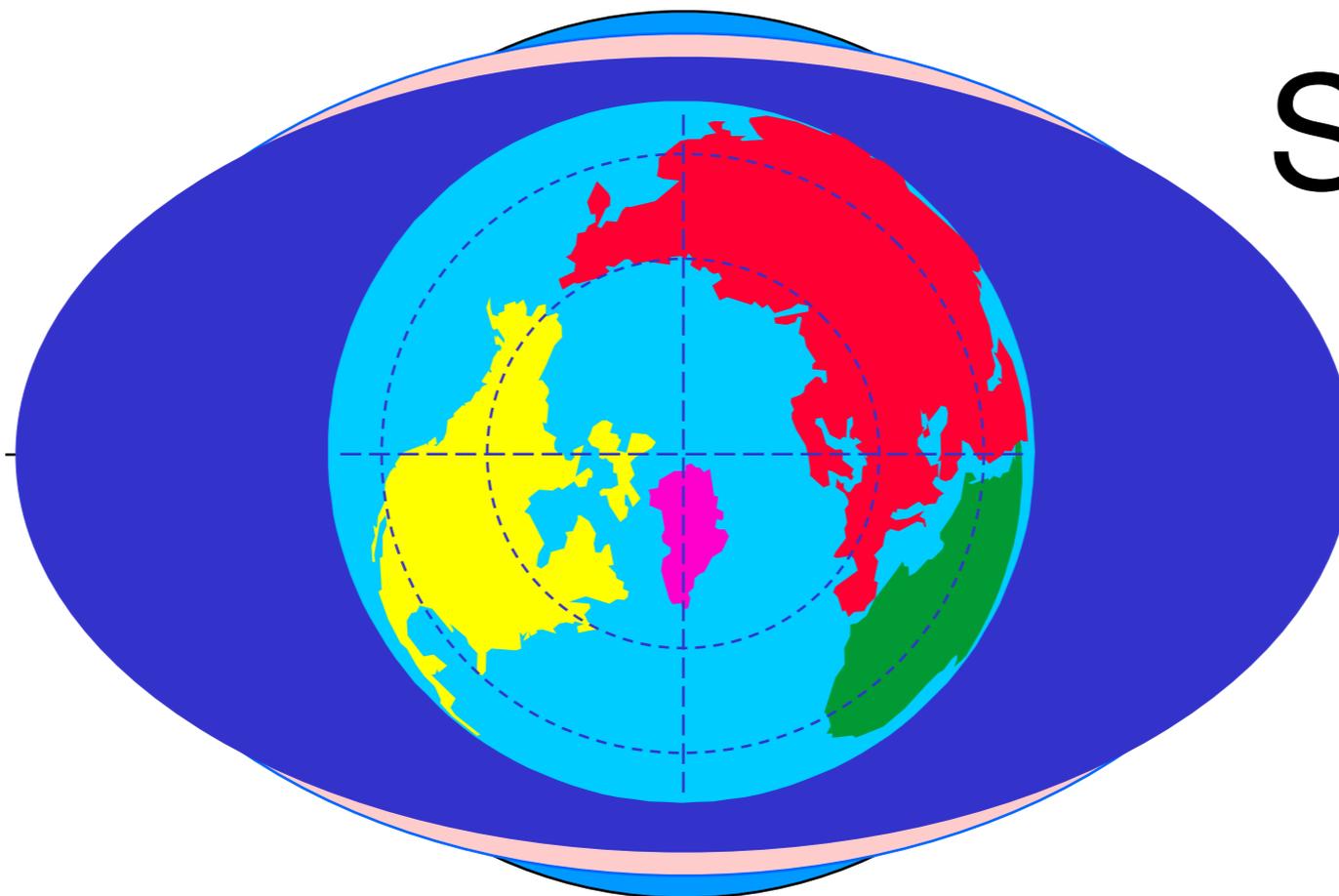
Lua Nova

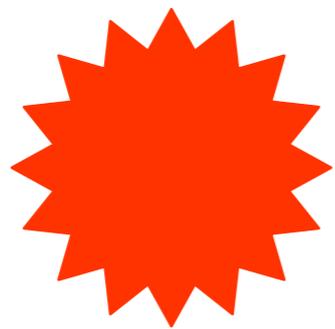


Maré de Sizígea

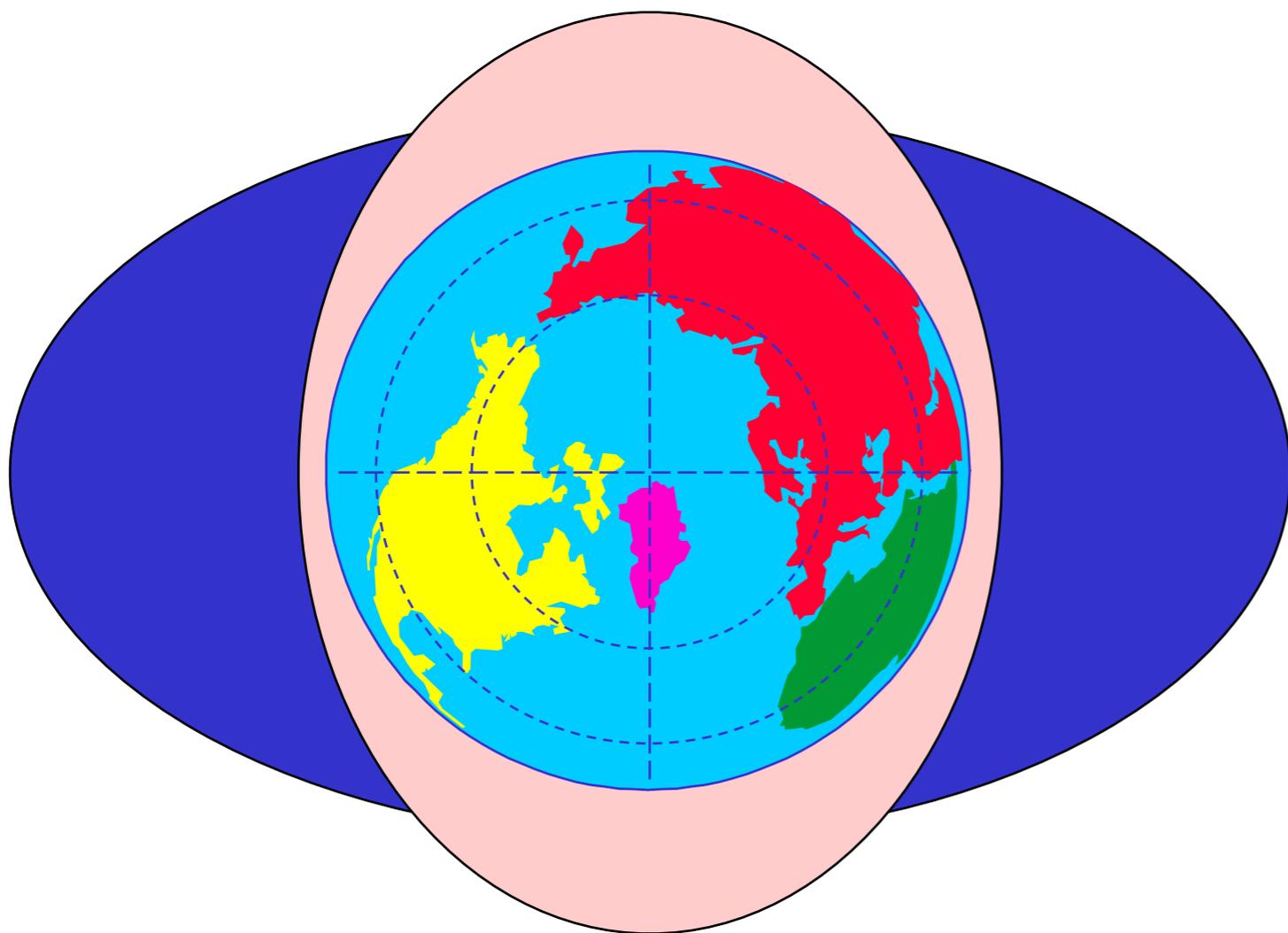
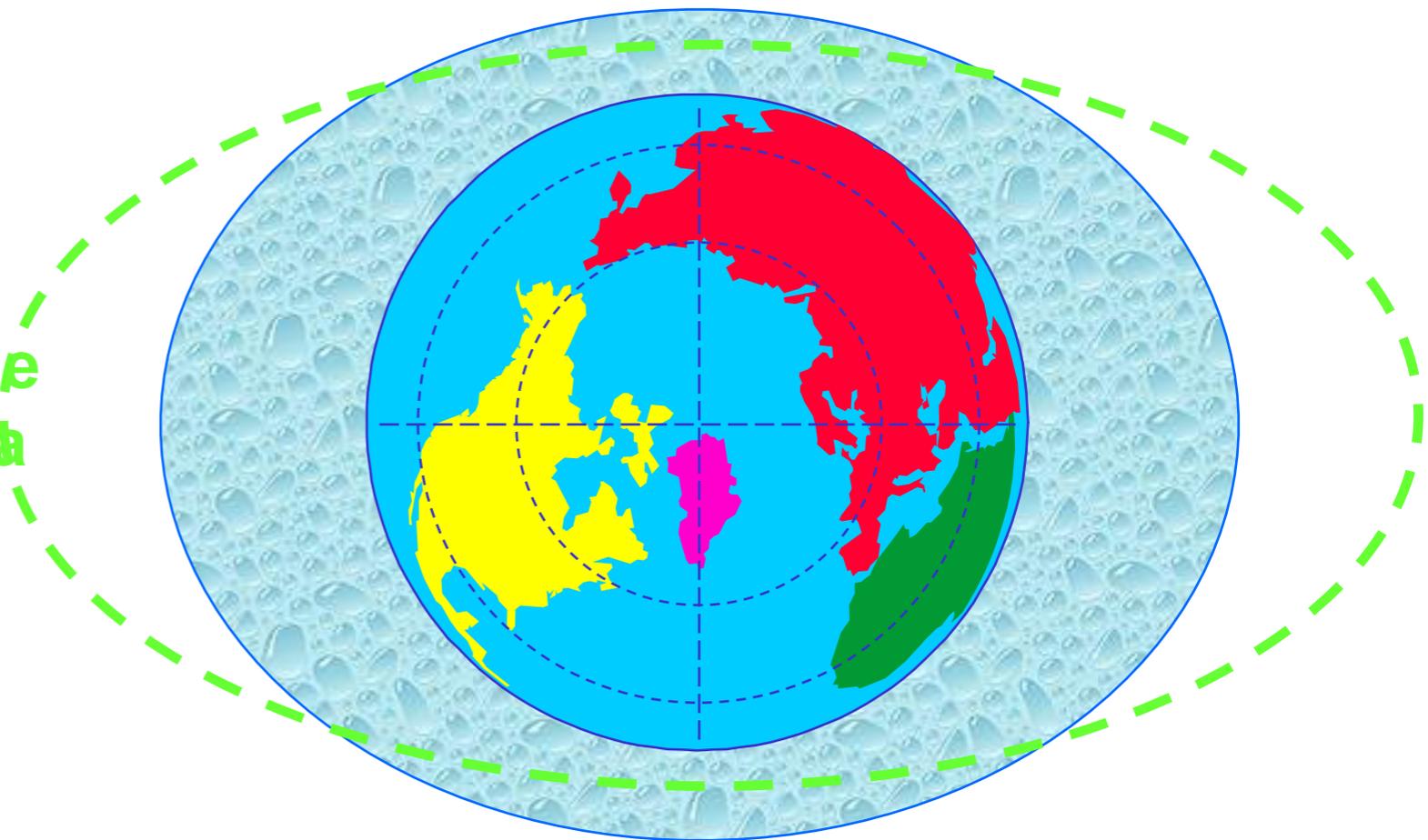


Lua
Cheia

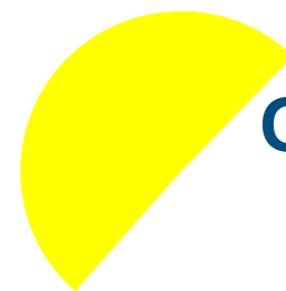




Maré de
sizígea



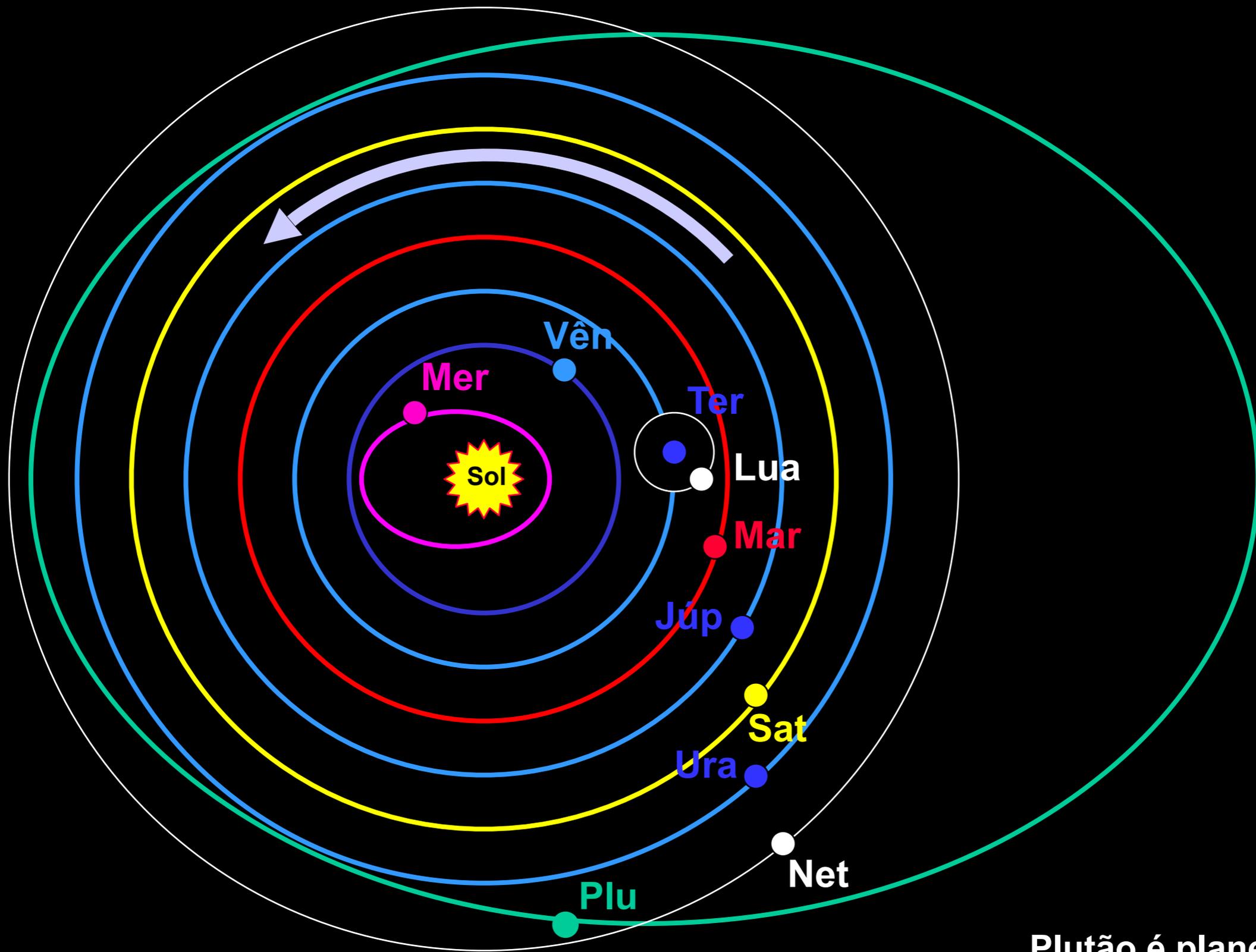
Lua
Quarto Minguante
ou
Quarto Crescente



Marés de
Quadratura

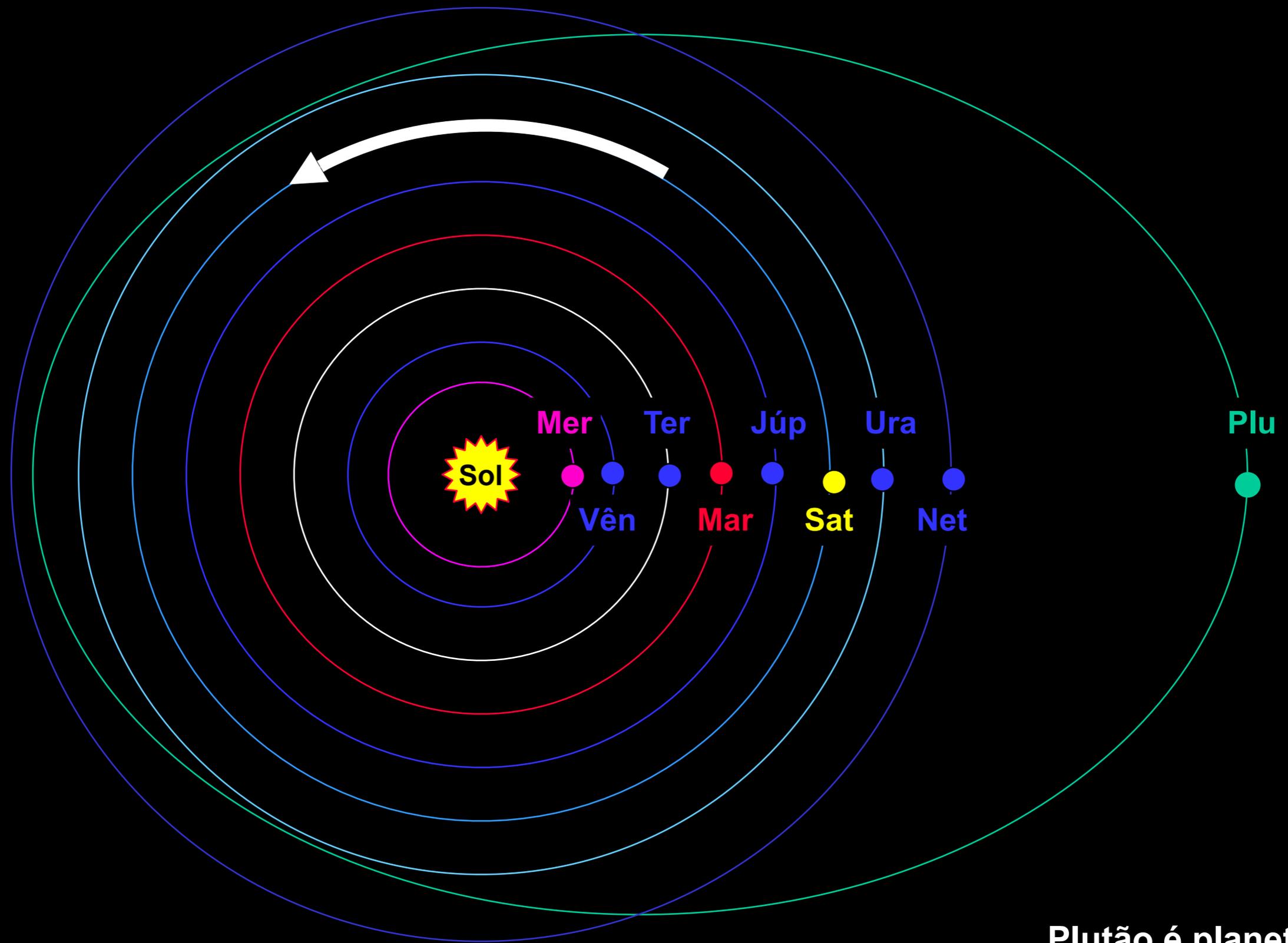
Maré criada pelo
“alinhamento” dos planetas

Sistema Heliocêntrico



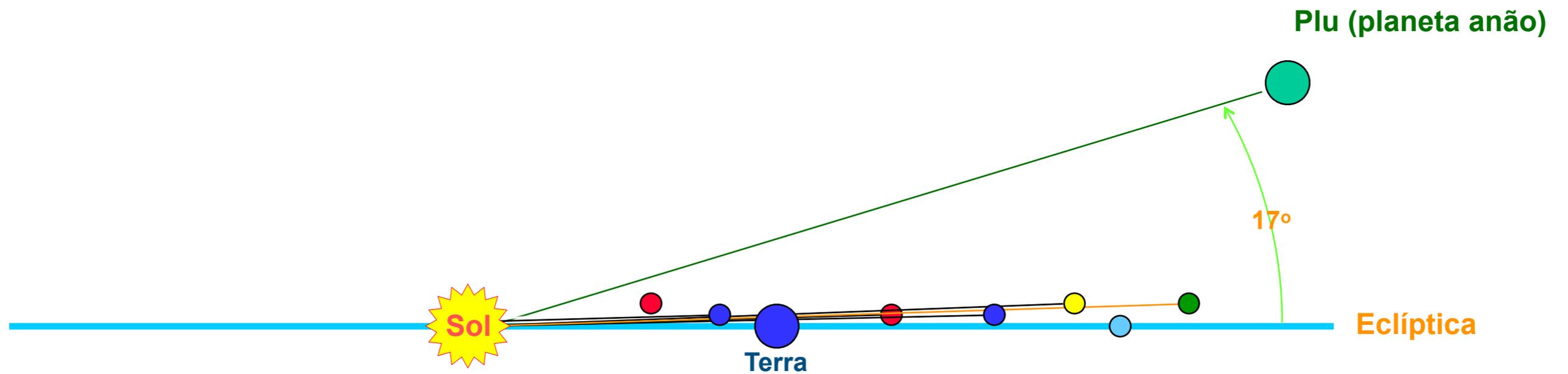
Plutão é planeta anão!

'Alinhamento' dos planetas

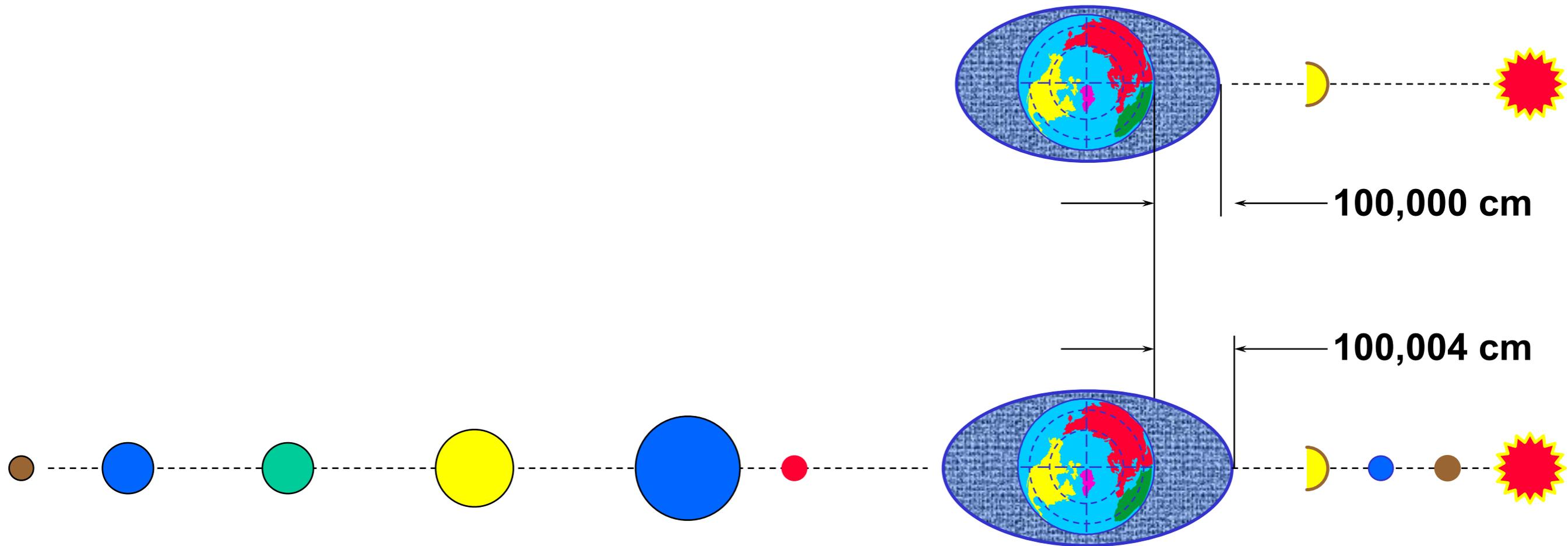


Plutão é planeta anão!

Órbitas não coplanares



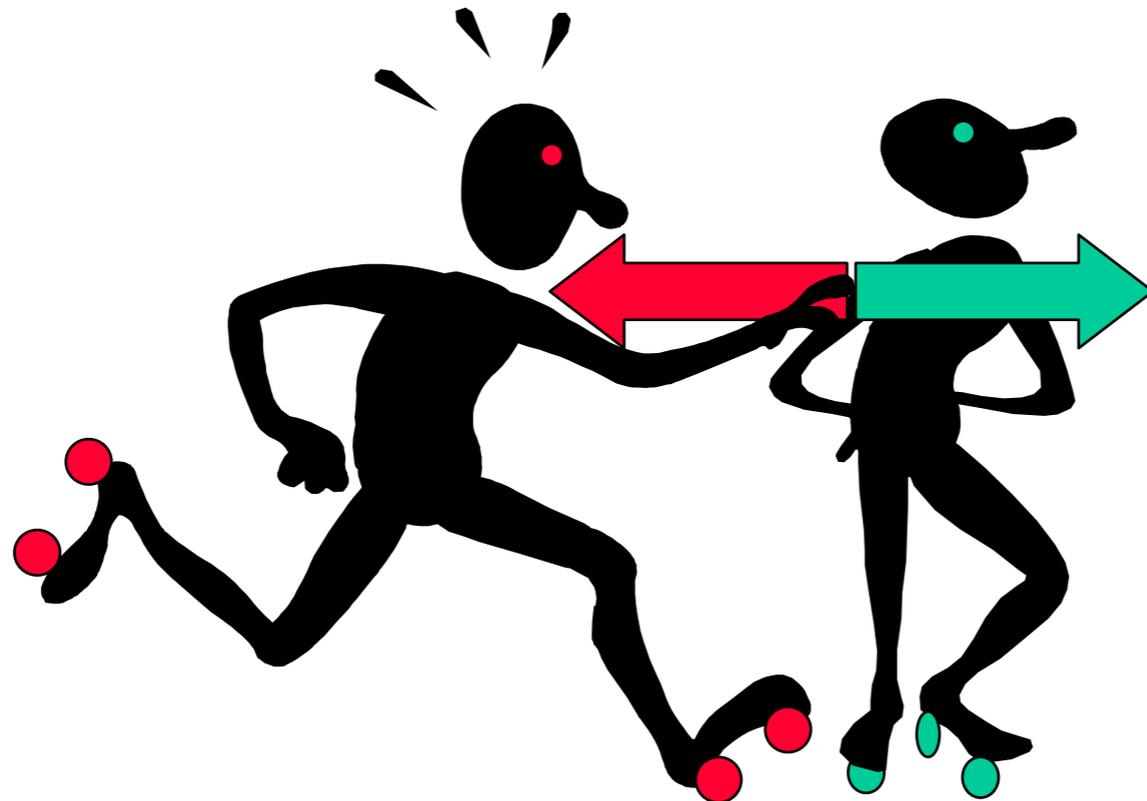
Marés adicionais cauda pelo alinhamento dos planetas

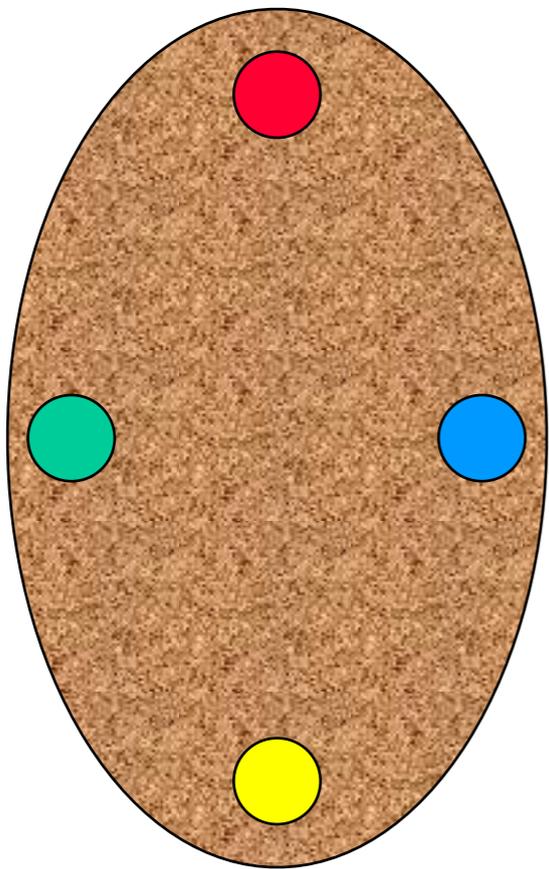


Efeitos das marés sobre a Lua

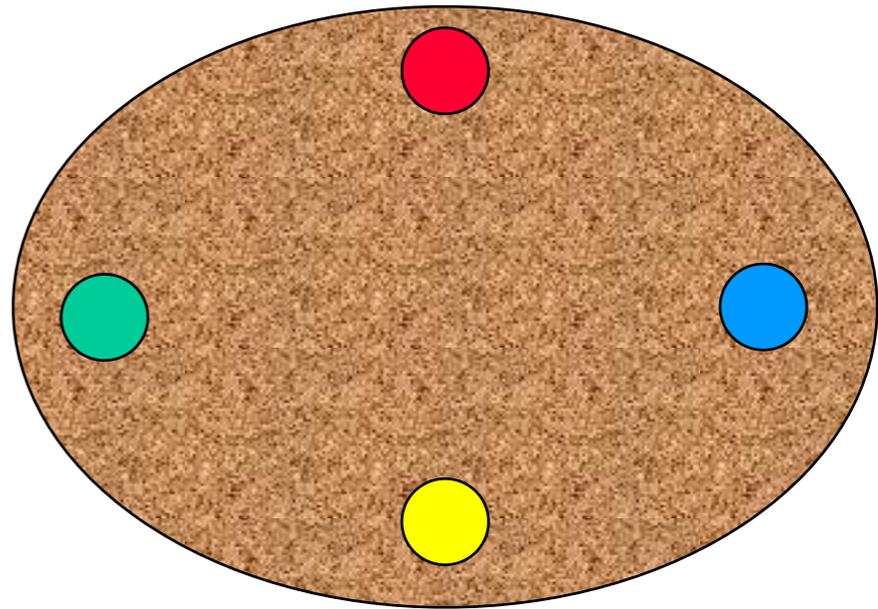
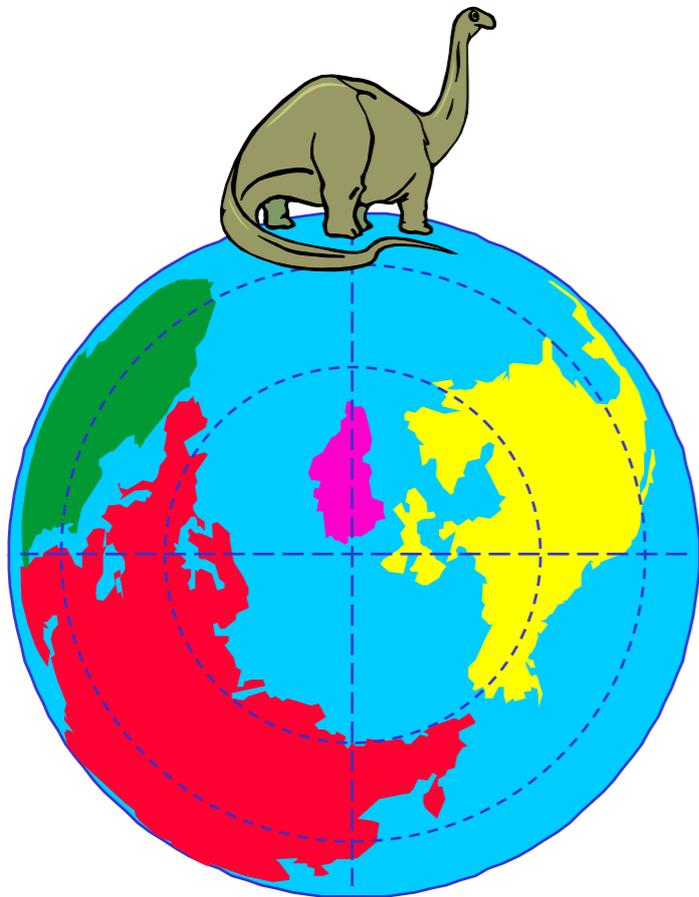
Princípio da ação e da reação

A cada ação corresponde uma reação de mesma intensidade e de sentido oposto.

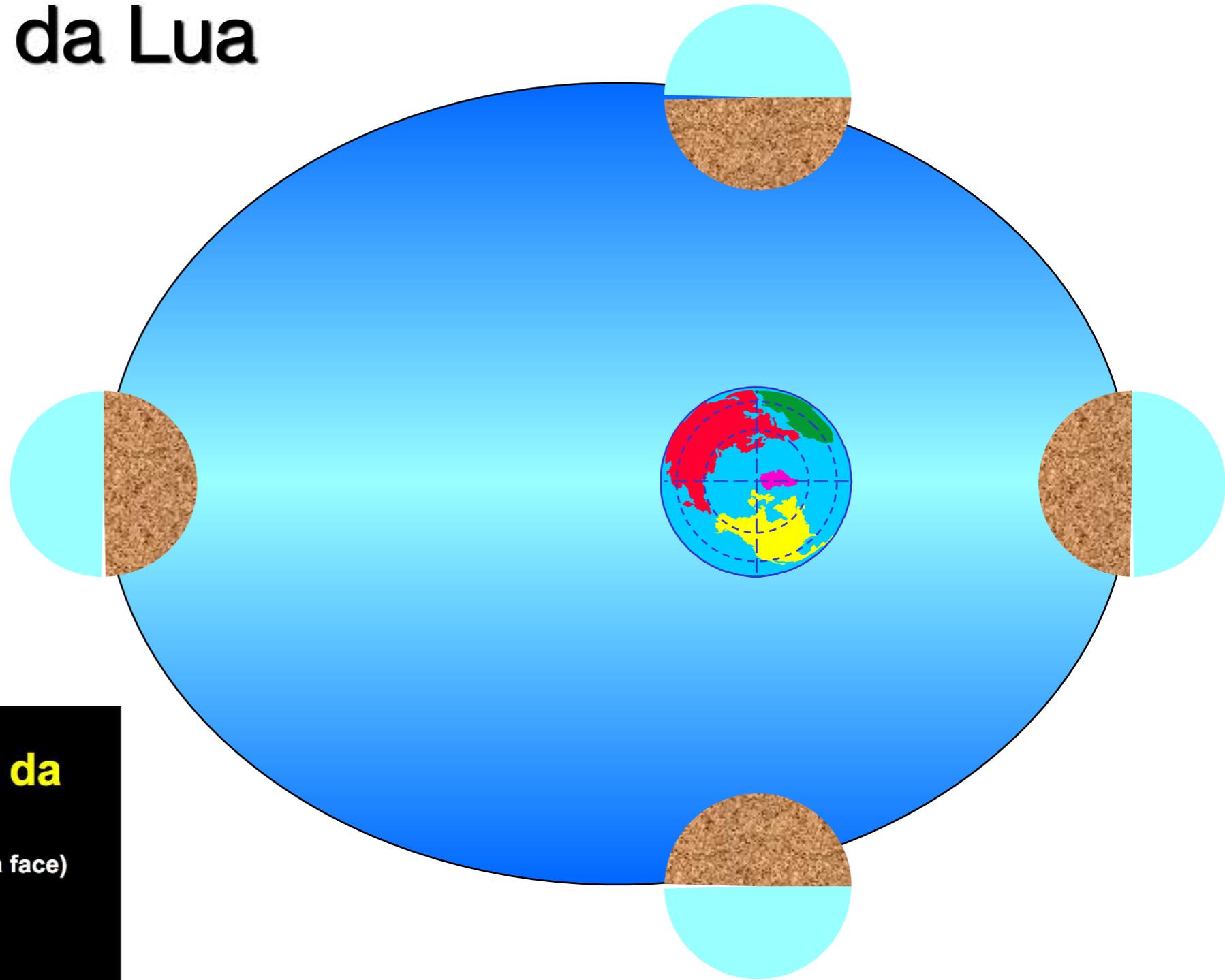




Marés outrora criadas pela Terra sobre a Lua



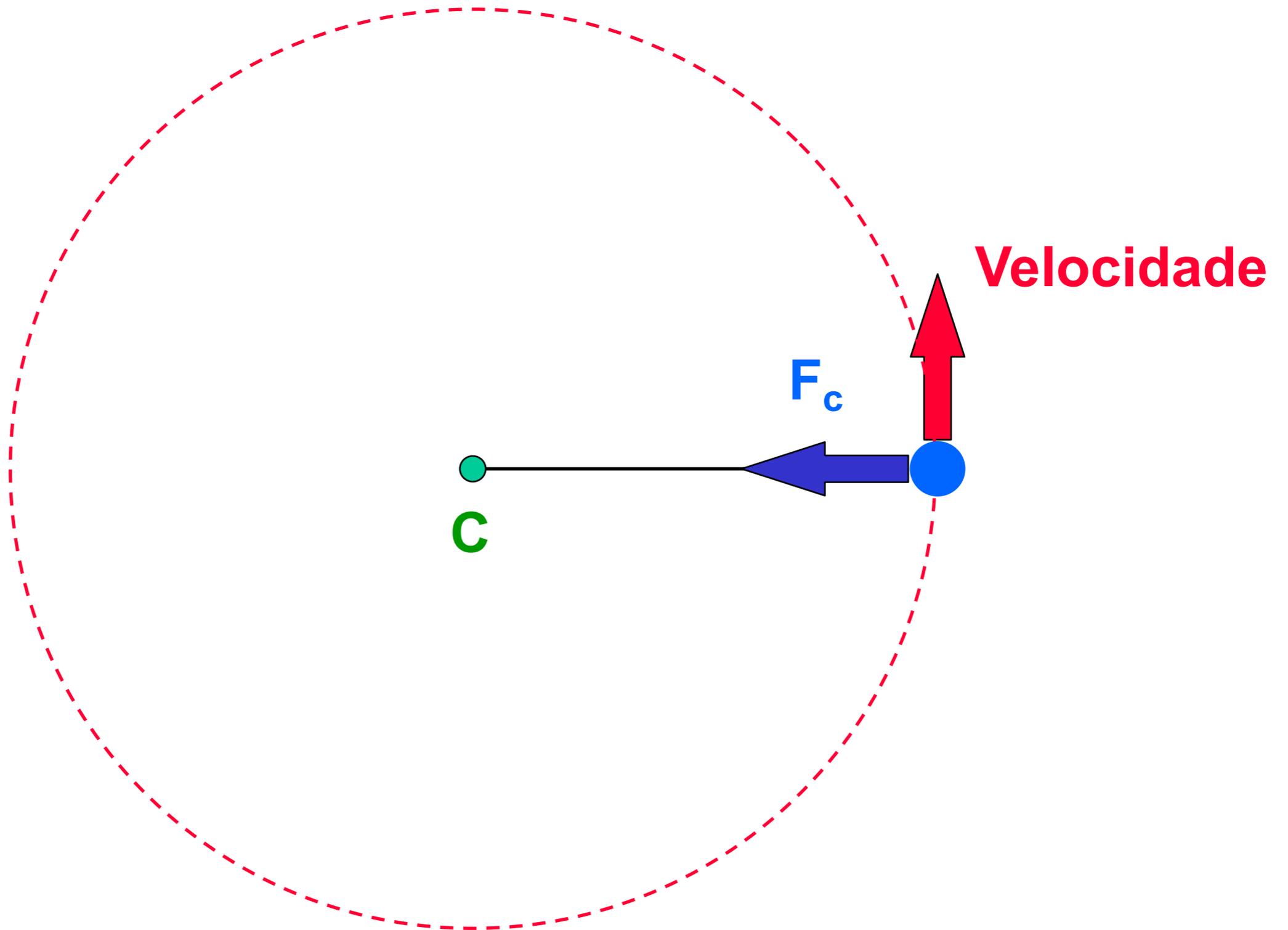
Translação atual da Lua



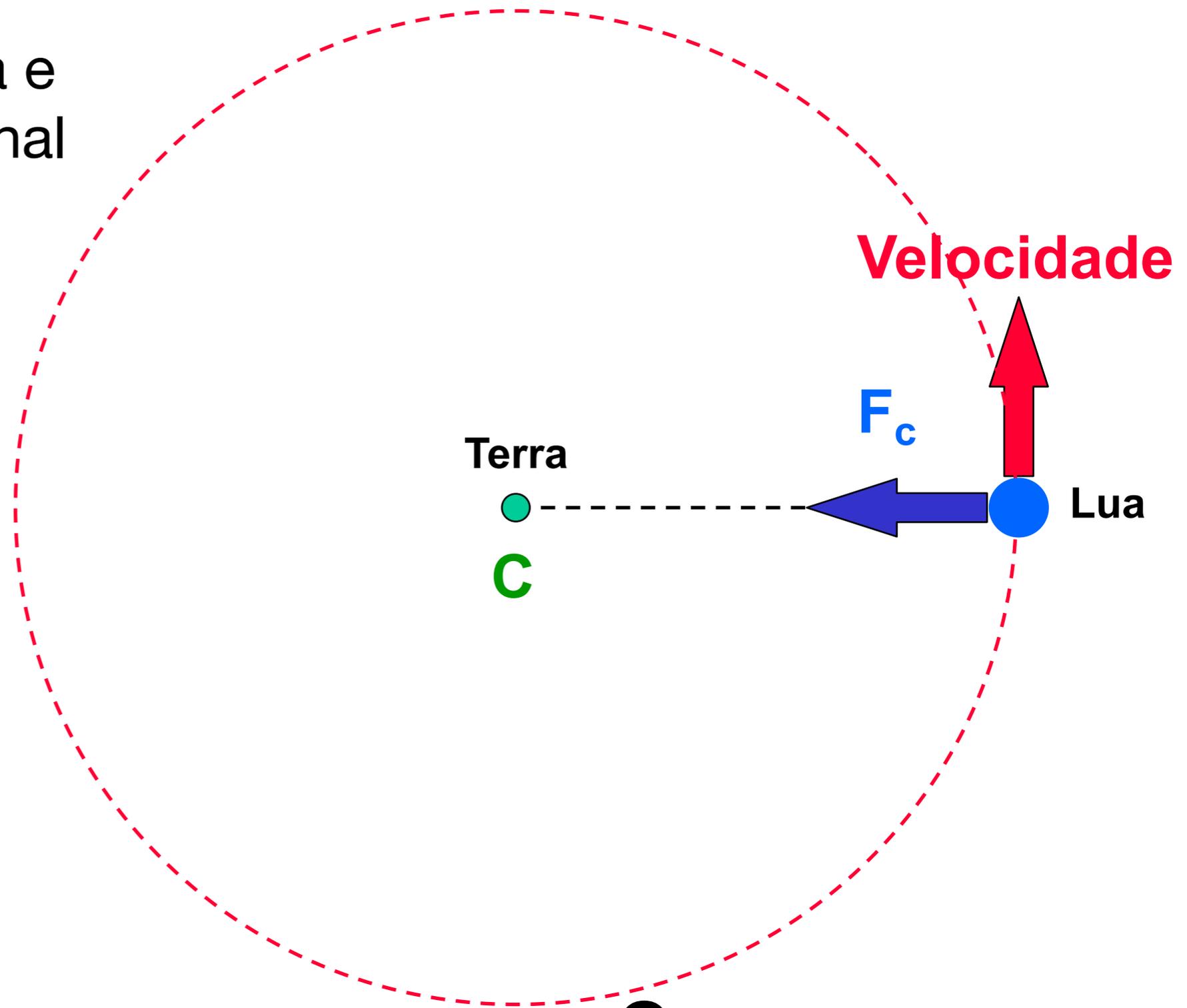
Lua vista da Terra
(sempre a mesma face)

Destruição de corpos
celestes por efeito de maré

Força Centrípeta



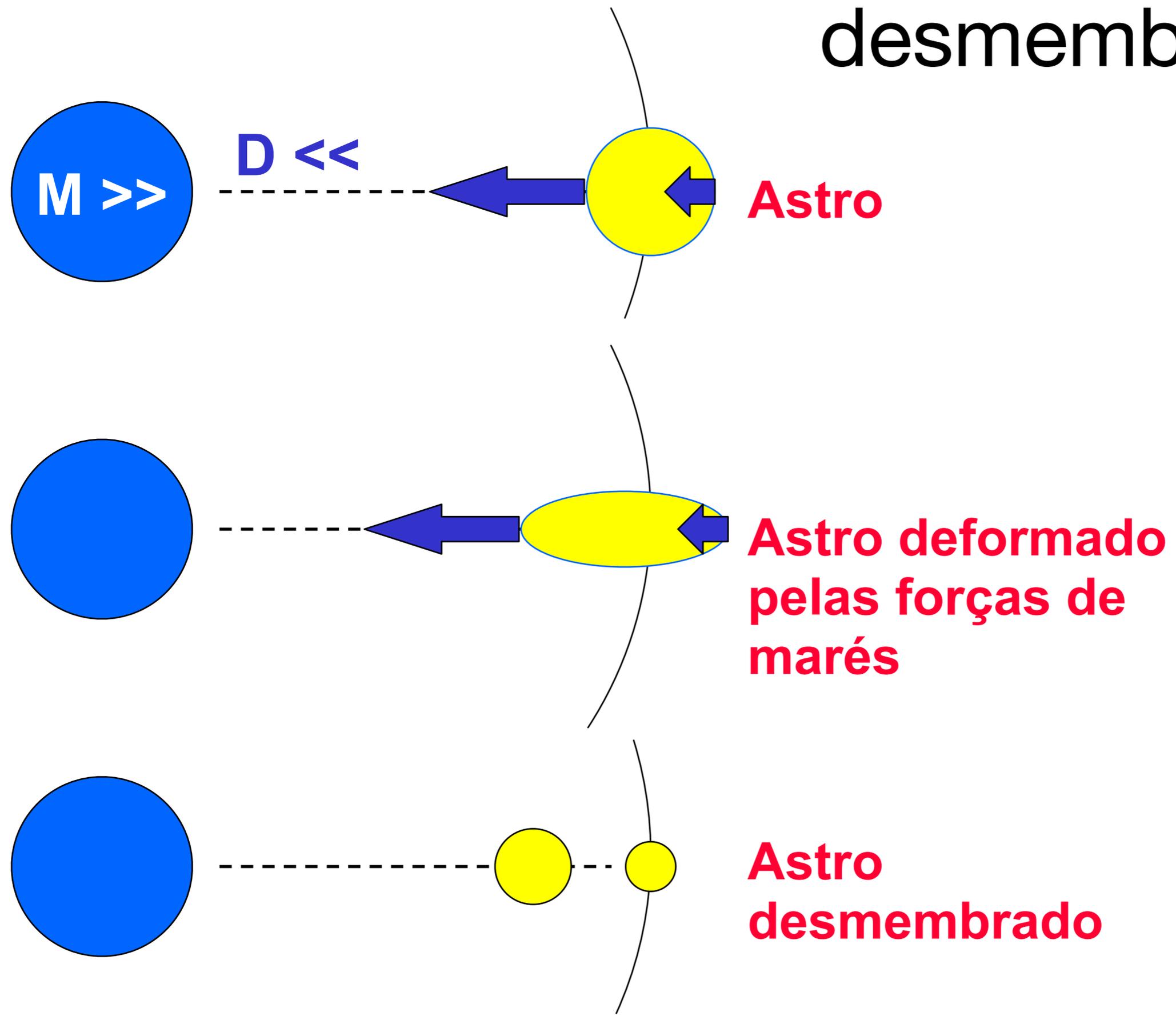
Força Centrípeta e Força Gravitacional sobre a Lua



Quem exerce a força centrípeta?

A atração gravitacional!

Deformação e/ou desmembramento de astro

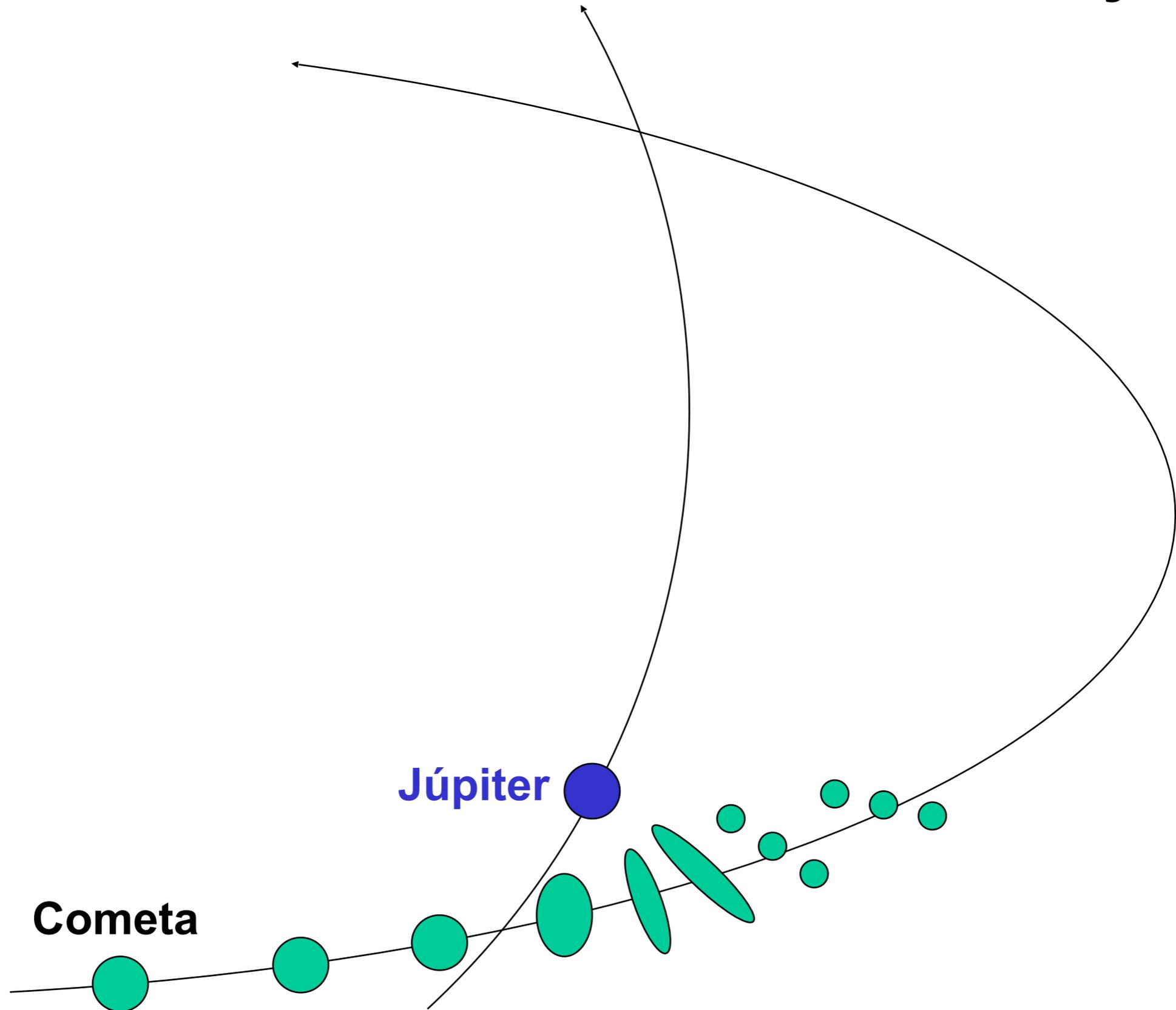


Astro

Astro deformado pelas forças de marés

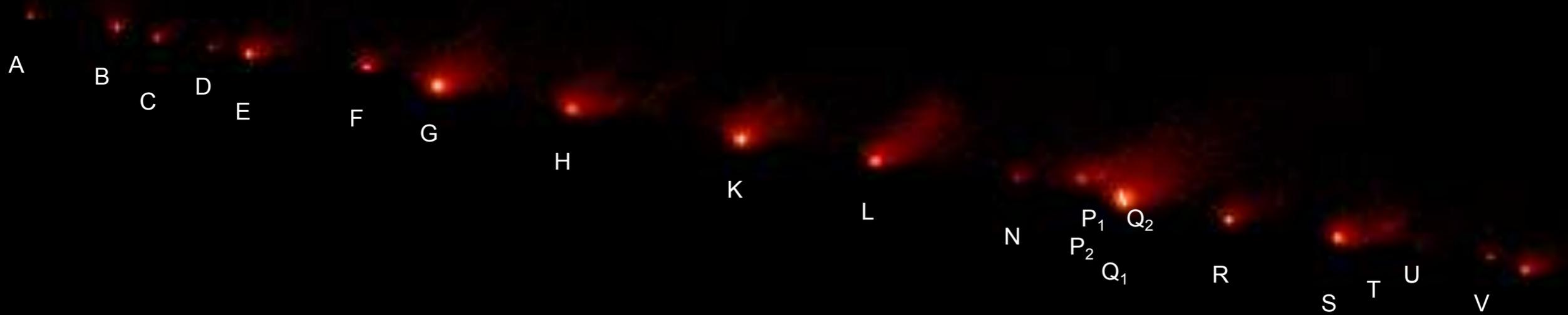
Astro desmembrado

Cometa Shoemaker-Levy



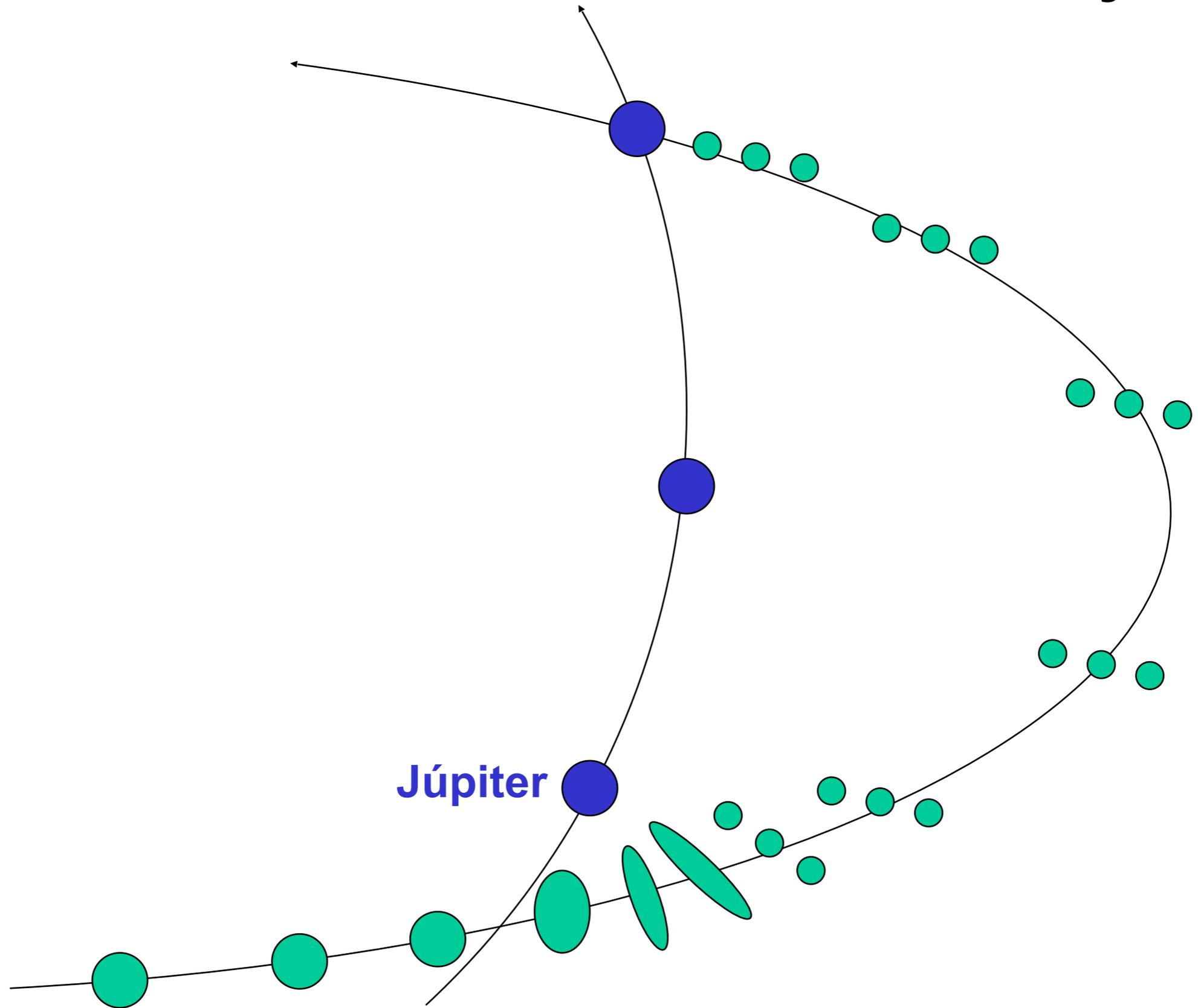
Cometa Shoemaker-Levy 9

(1994 maio)



**Número de
grandes
fragmentos: 21**

Cometa Shoemaker-Levy



Impacto do fragmento Q do Shoemaker-Levy 9 em Júpiter



