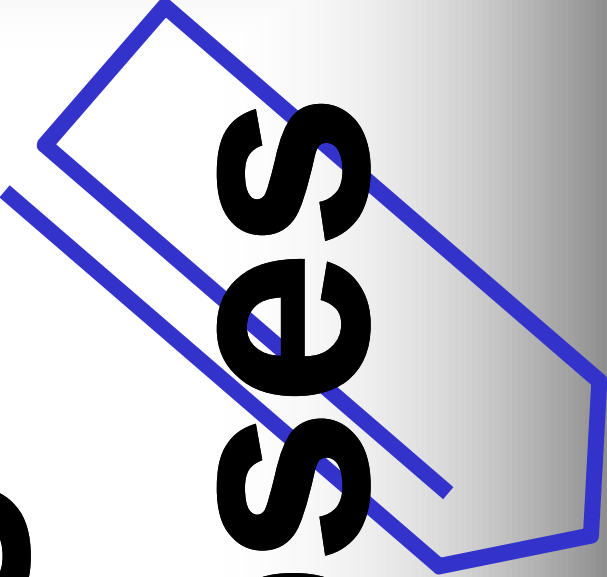


OS Eclipses

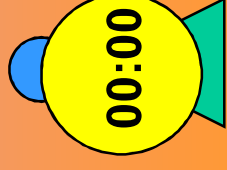
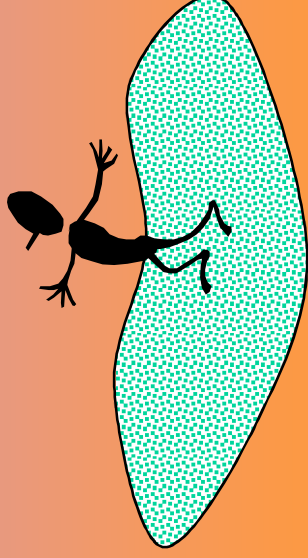
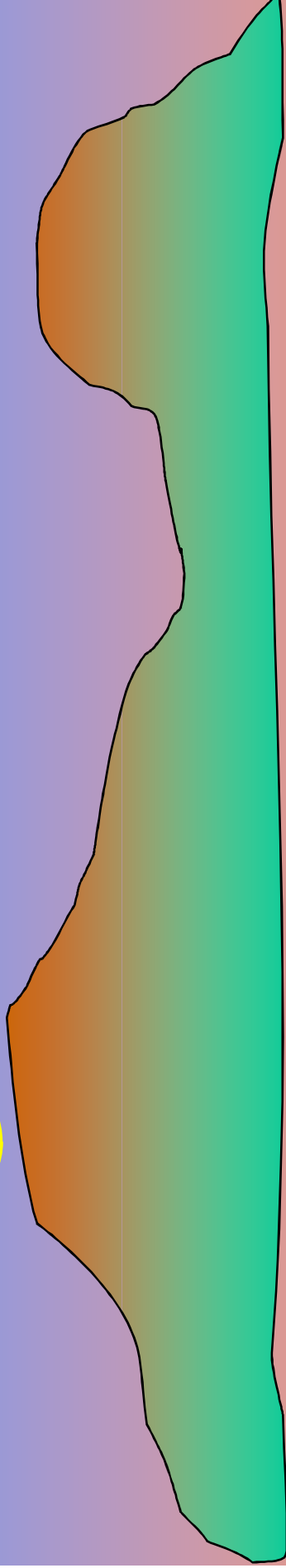


08
01
03

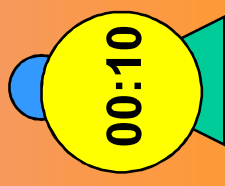
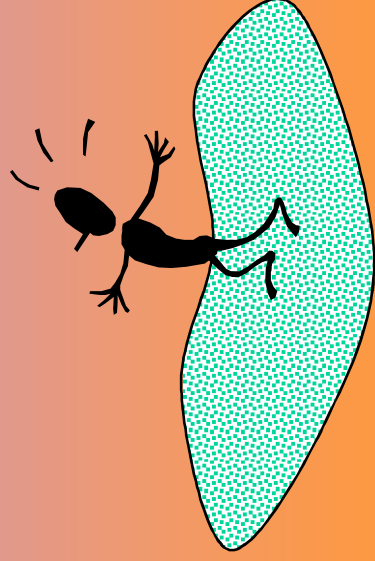
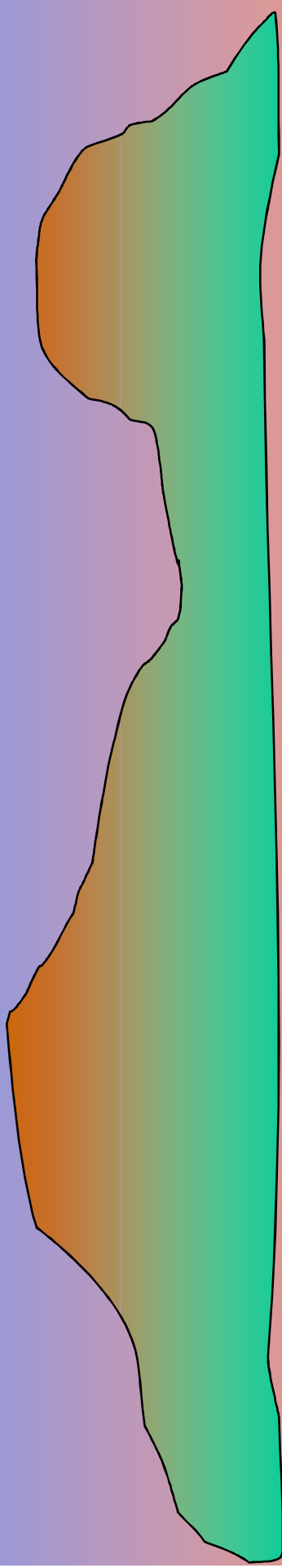
R. Boczko
IAG-USP

Seqüência de um Eclipse Solar

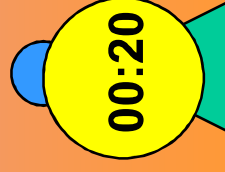
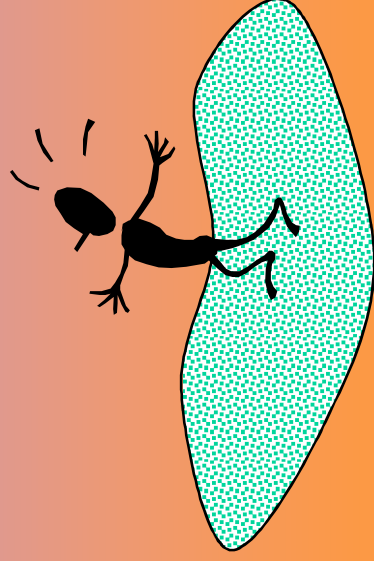
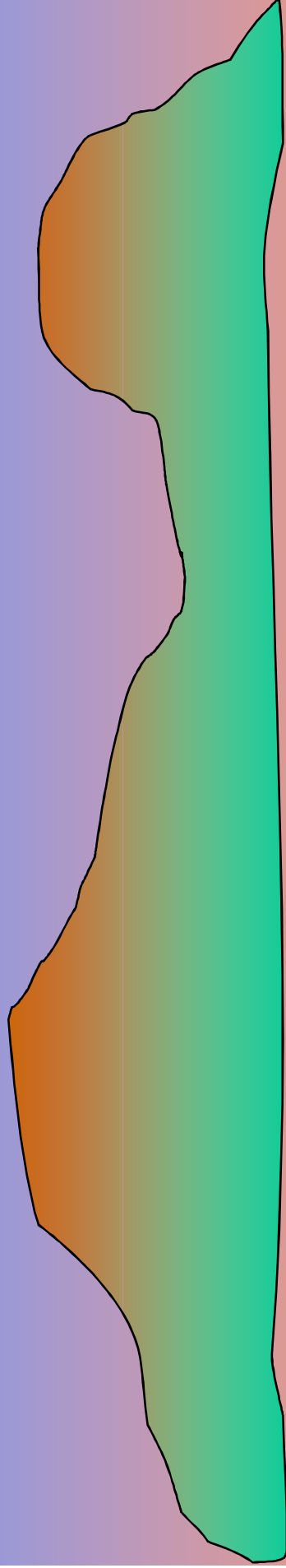
Sol visto no céu



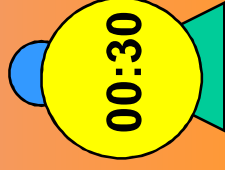
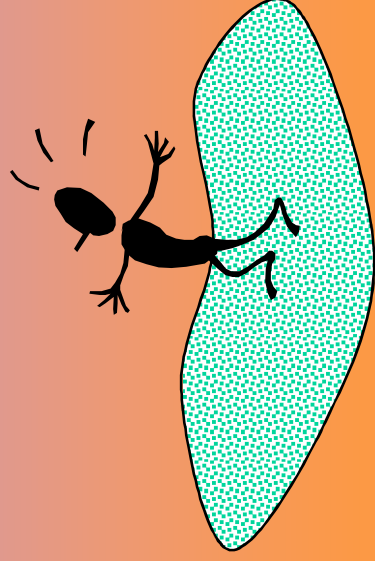
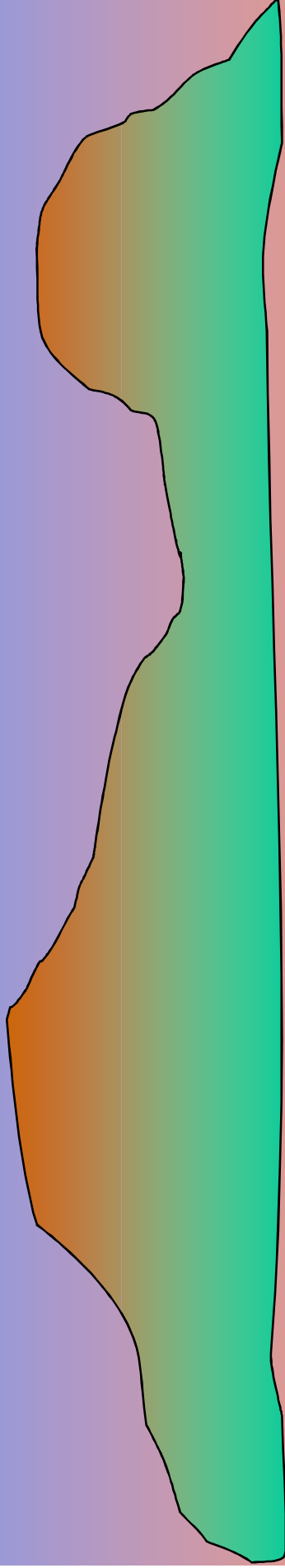
Início do Eclipse Solar Parcial



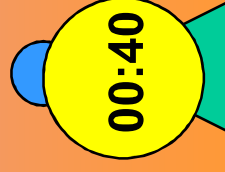
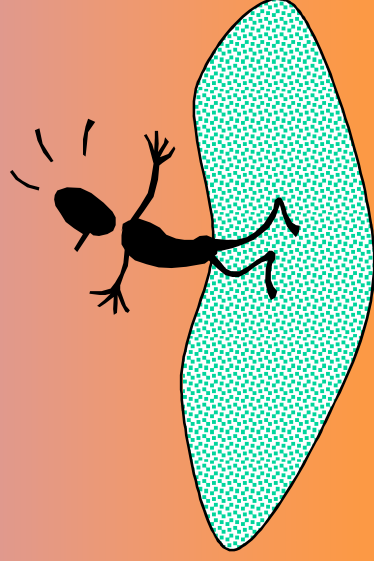
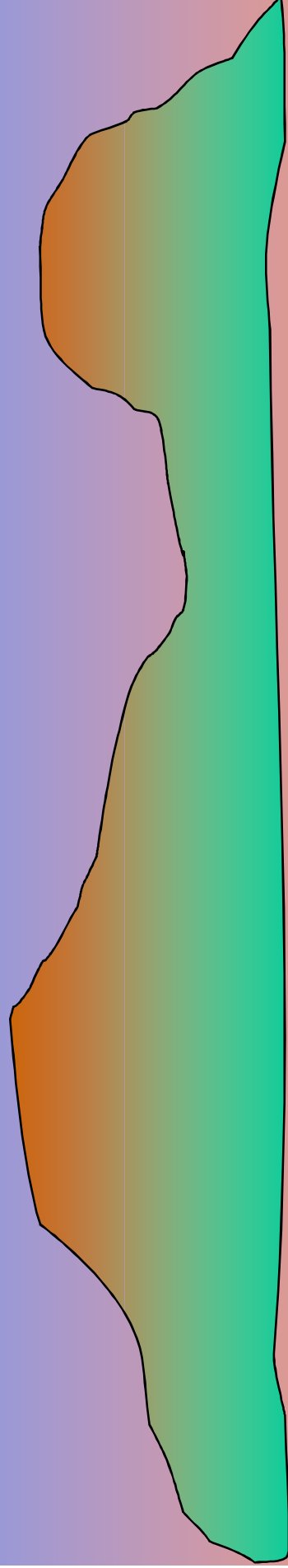
Eclipse Solar Parcial



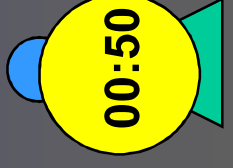
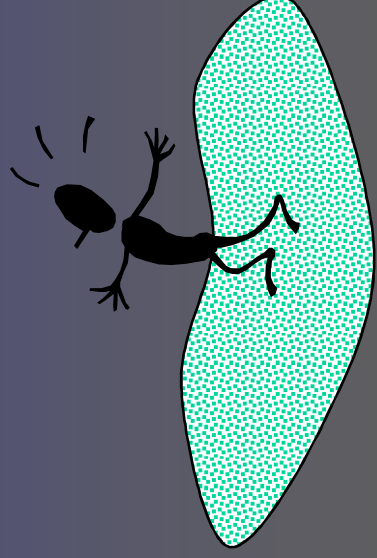
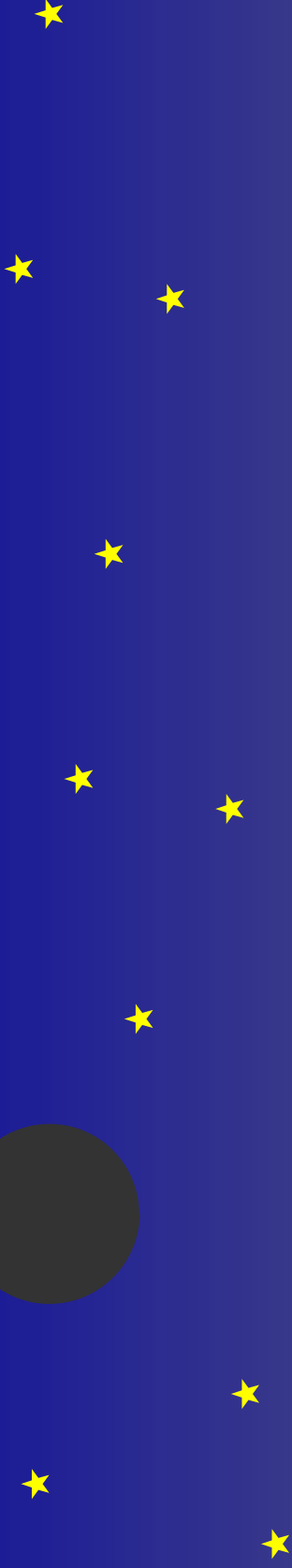
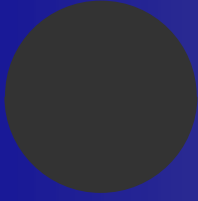
Eclipse Solar Parcial



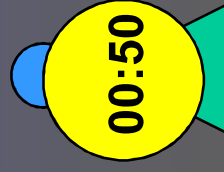
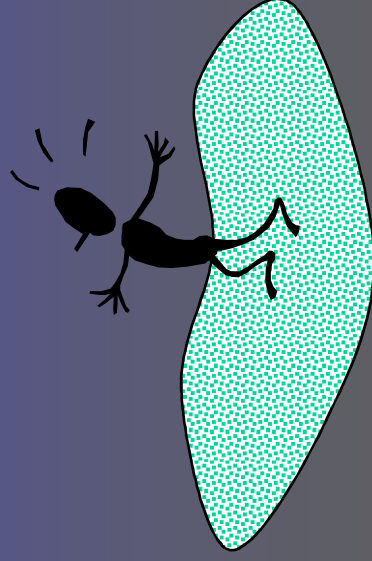
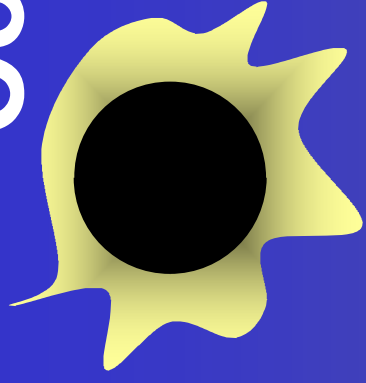
Eclipse Solar Parcial



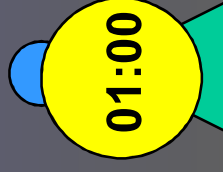
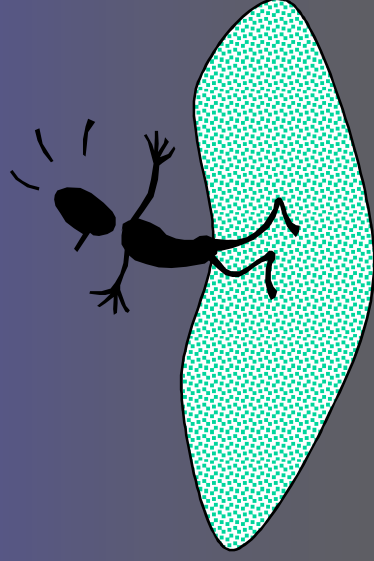
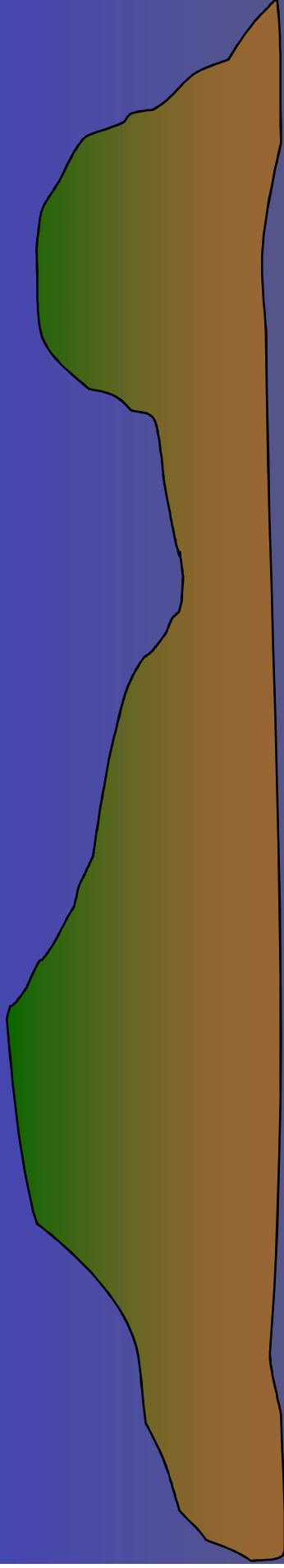
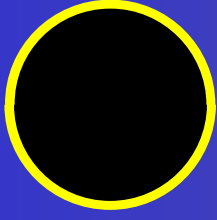
Eclipse Solar Total



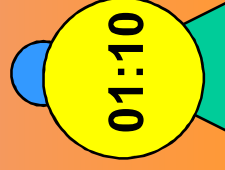
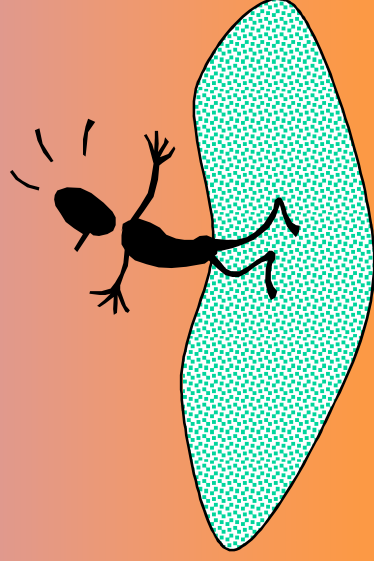
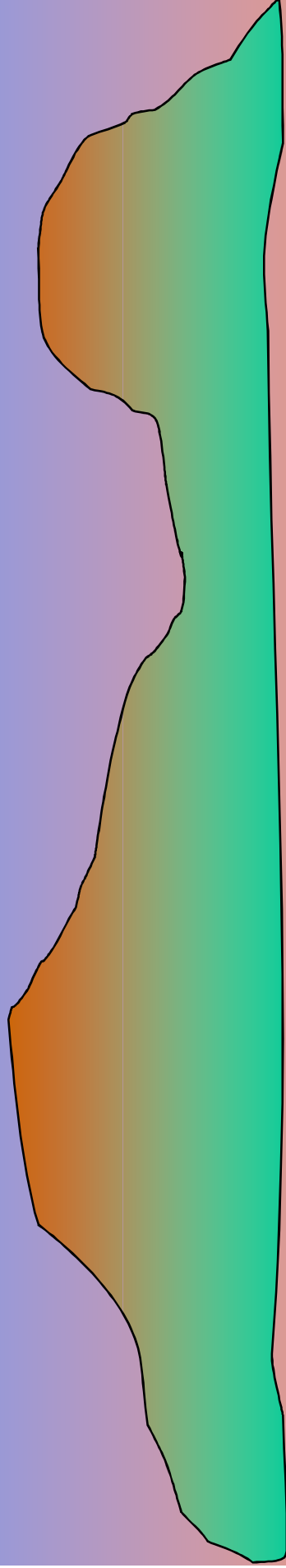
Coroa Solar vista durante o Eclipse Solar Total



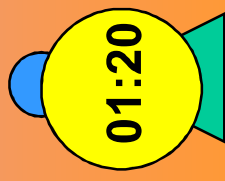
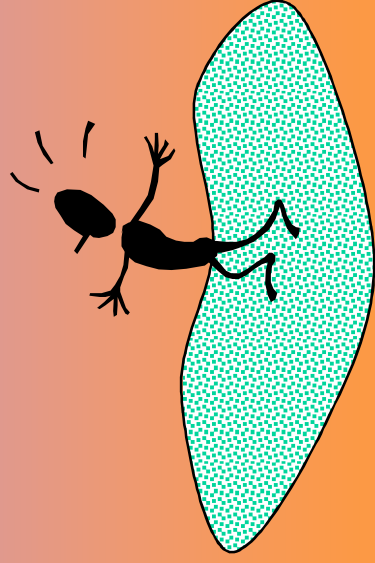
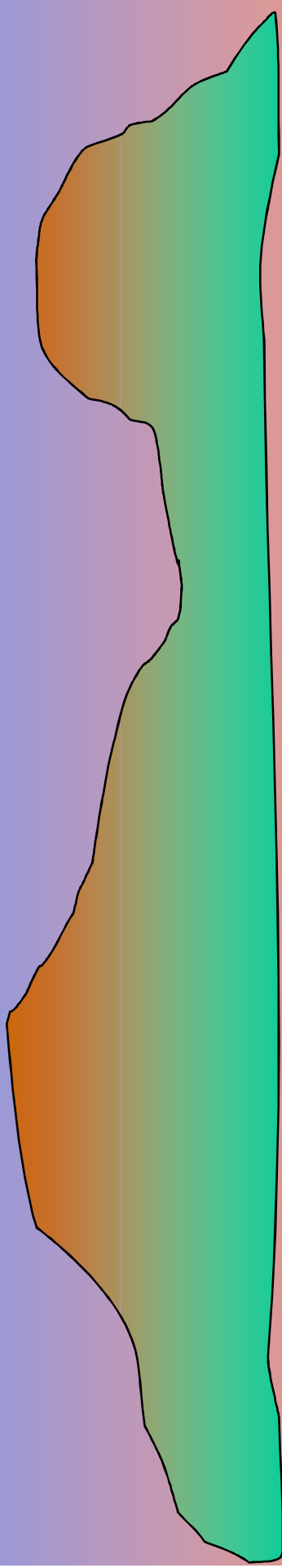
Eclipse Solar Anular



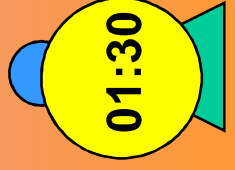
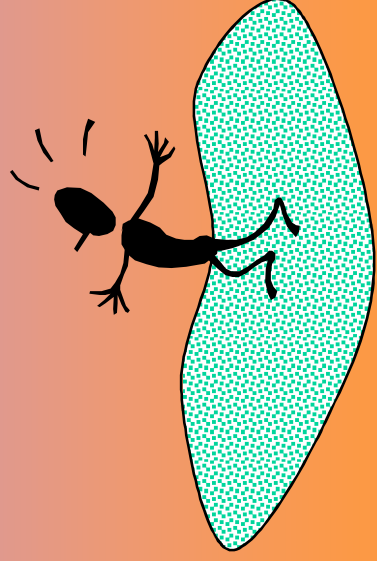
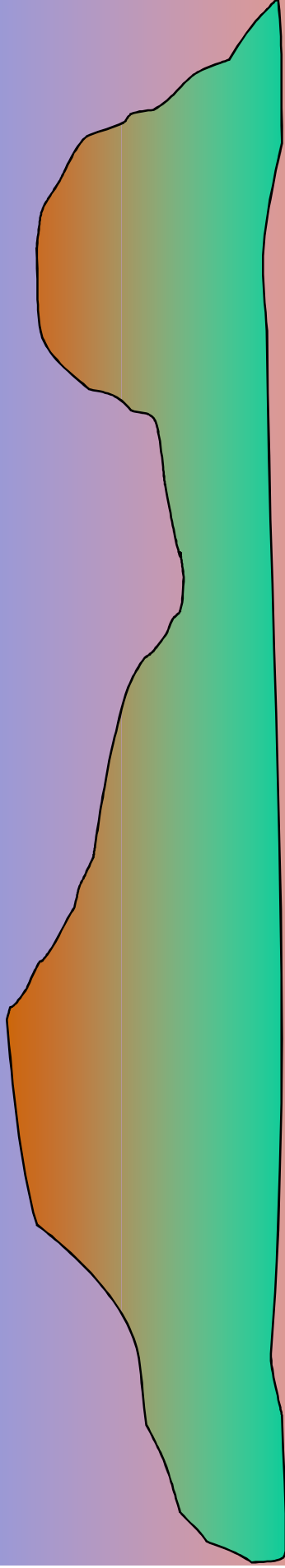
Fim do Eclipse Solar Total



Eclipse Solar Parcial

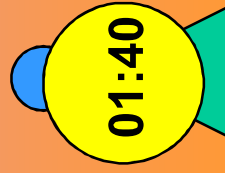
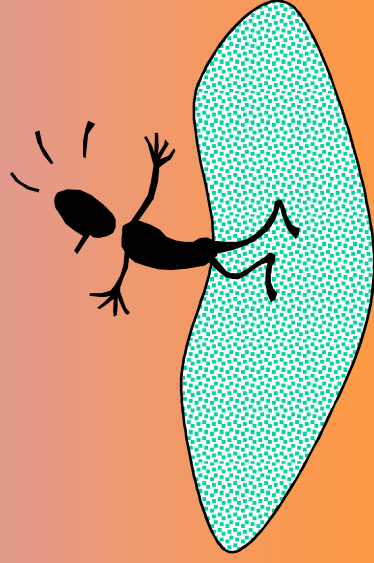
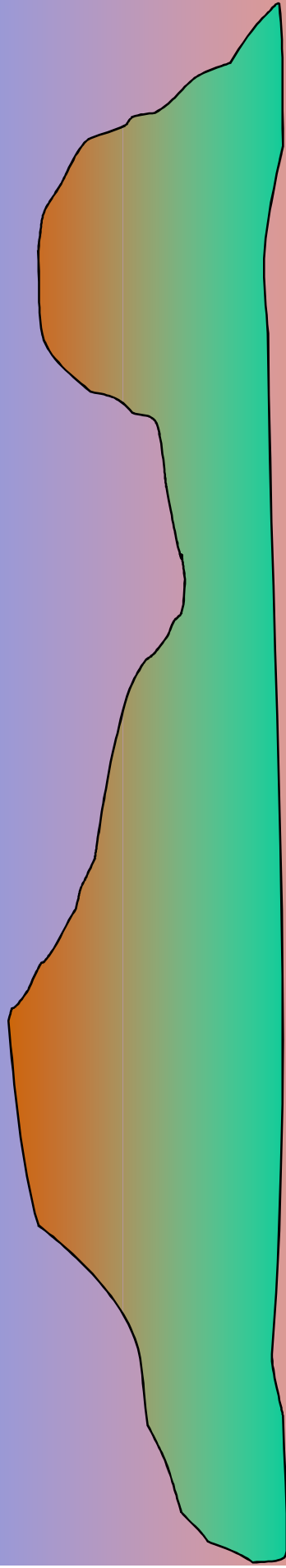


Eclipse Solar Parcial



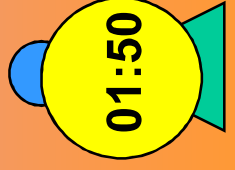
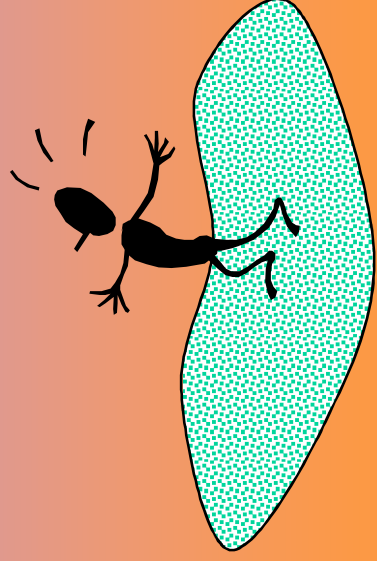
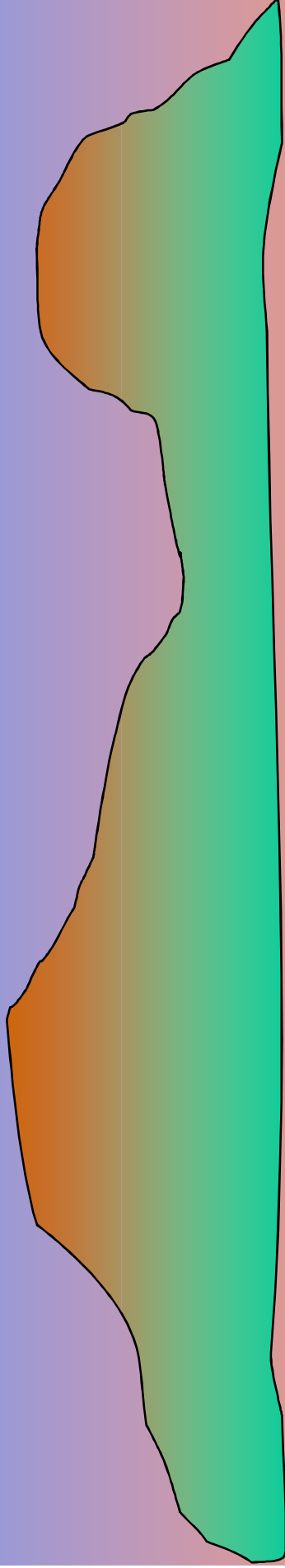


Finalzinho do Eclipse Solar Parcial



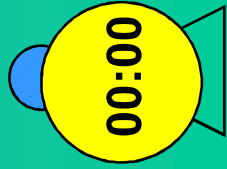
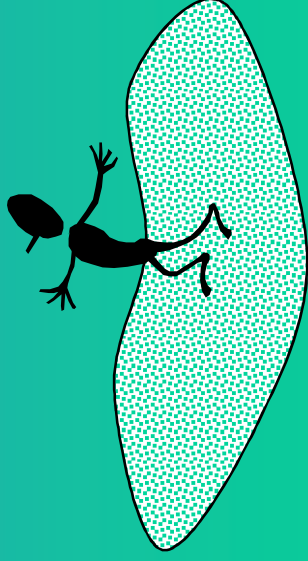
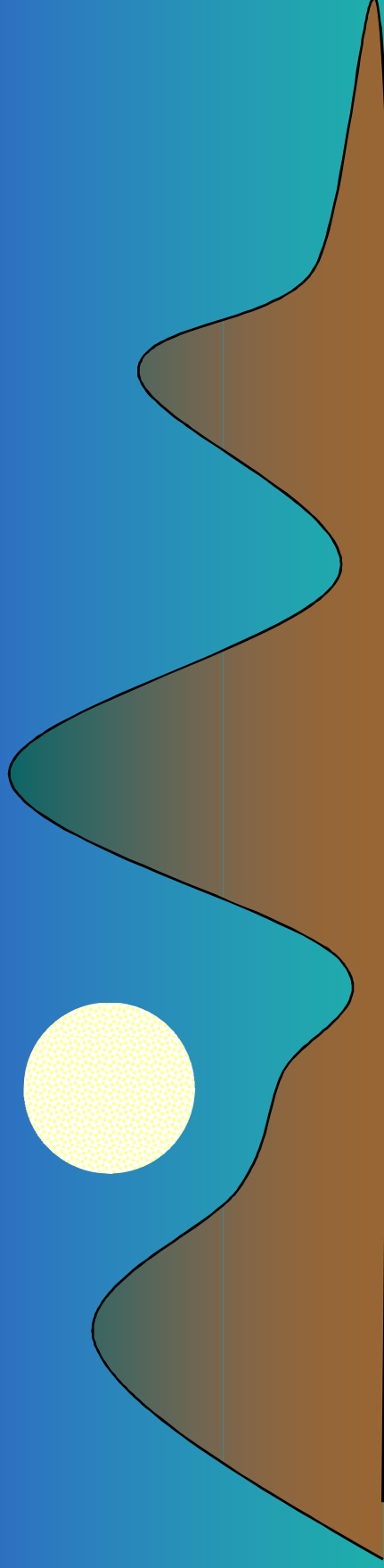


Fim do Eclipse Solar

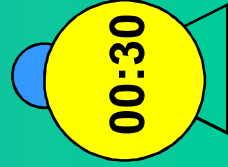
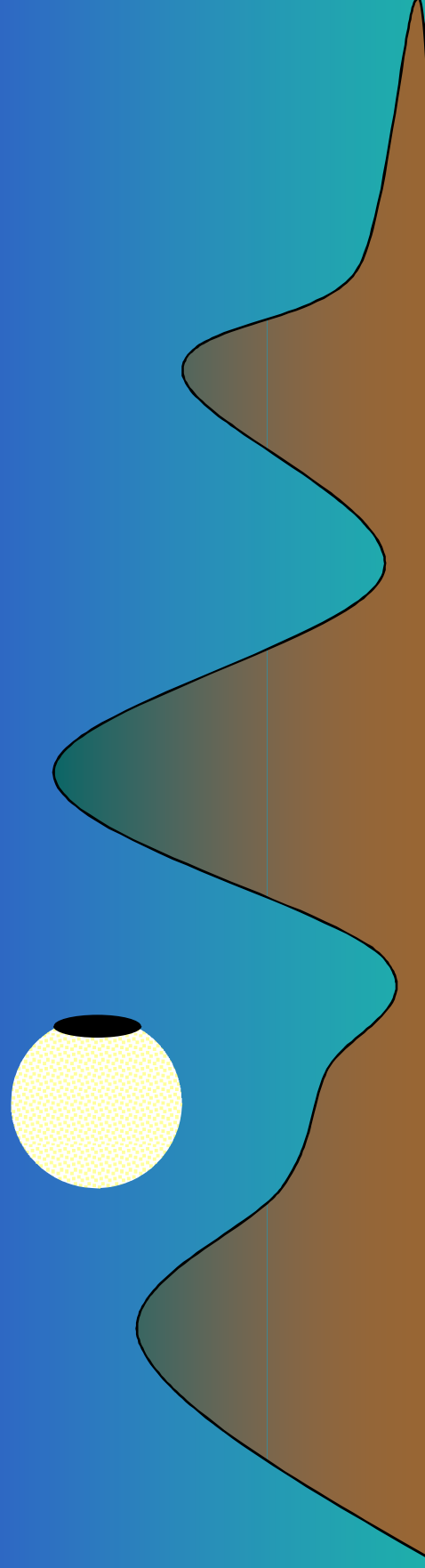


Seqüência de um Eclipse Lunar

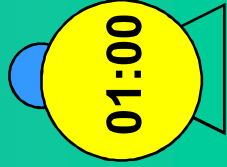
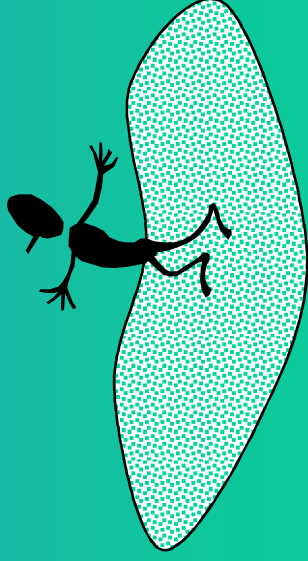
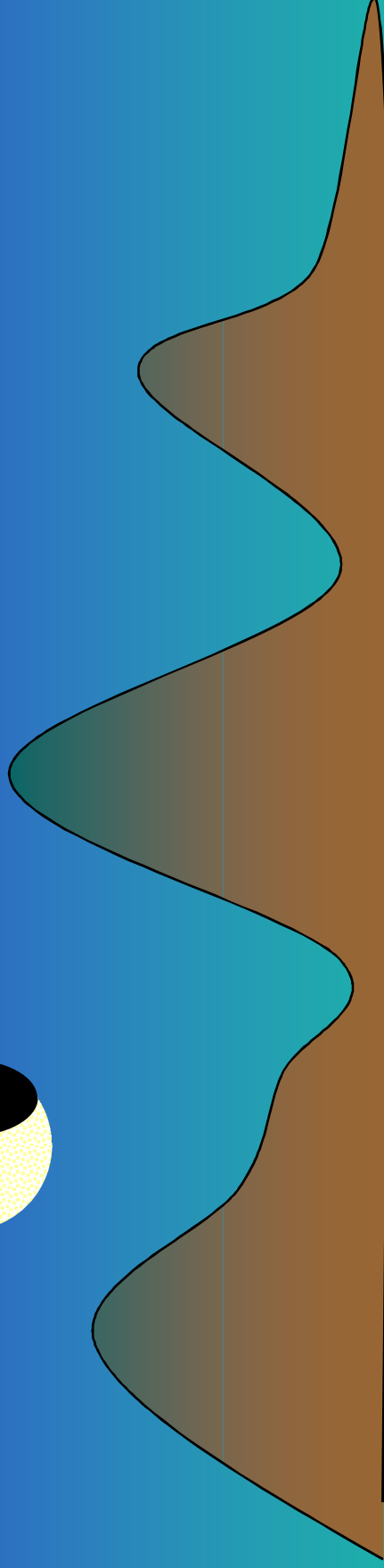
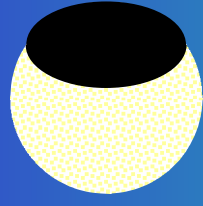
Lua Cheia vista no céu



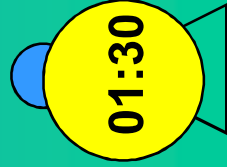
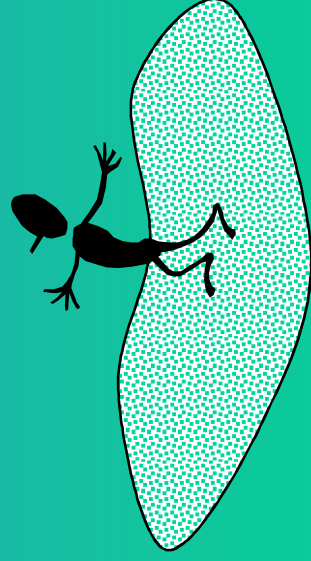
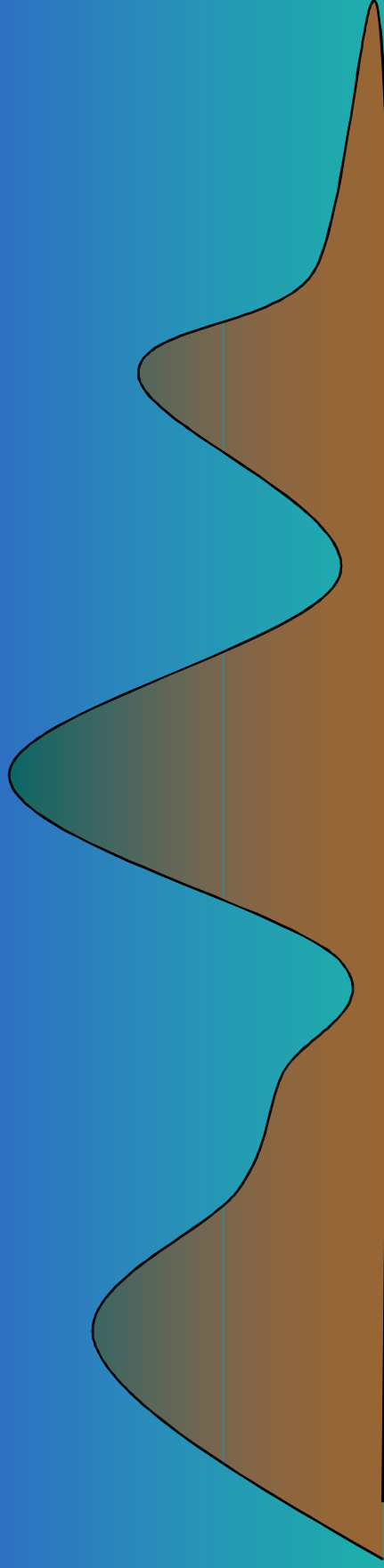
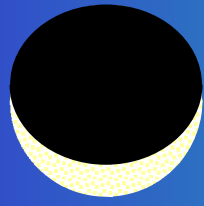
Lua Cheia (?) vista no céu



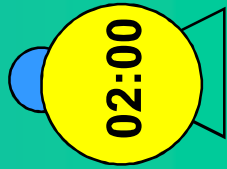
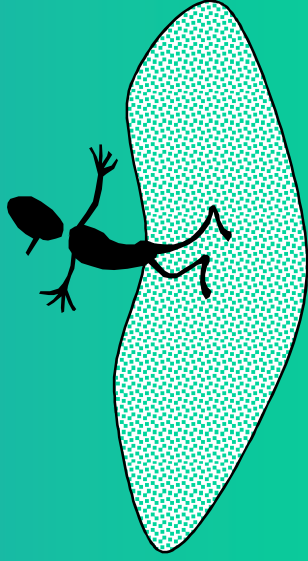
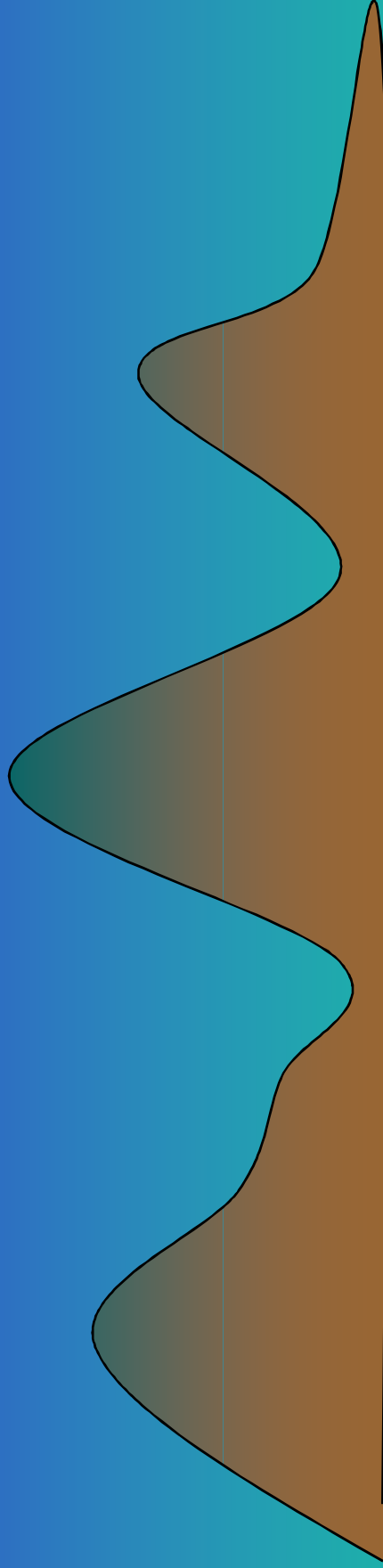
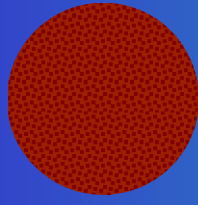
Lua Cheia (?) vista no céu



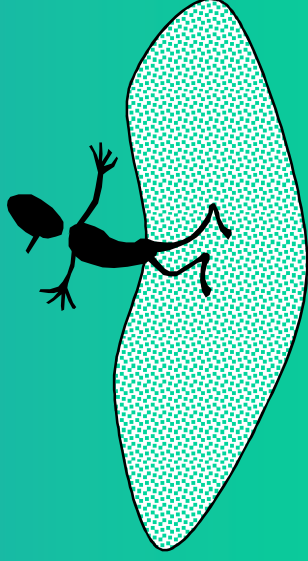
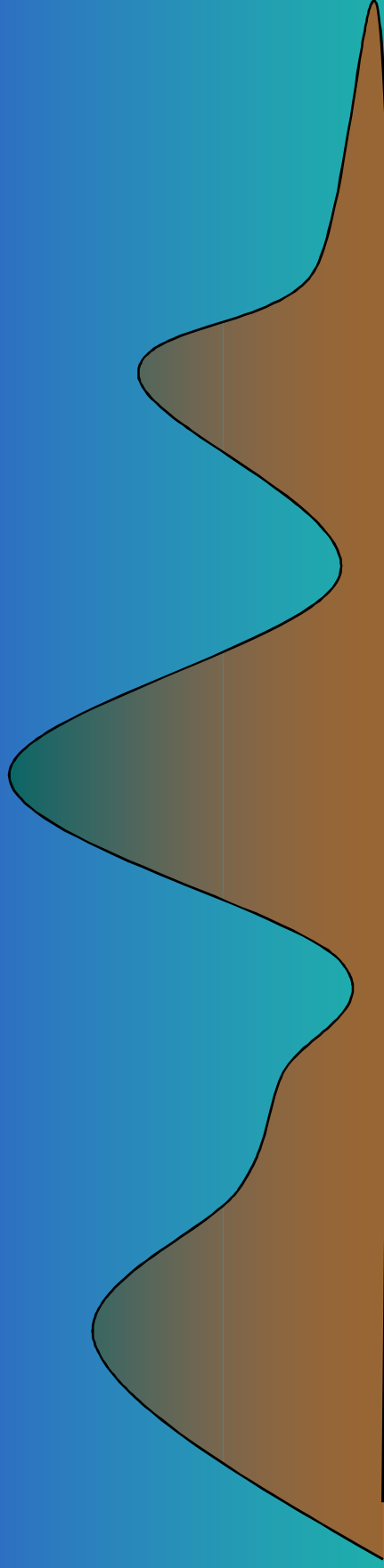
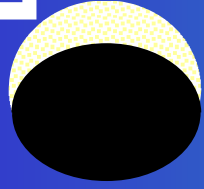
Lua Cheia (?) vista no céu



Eclipse Total Lunar

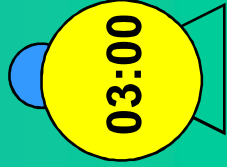
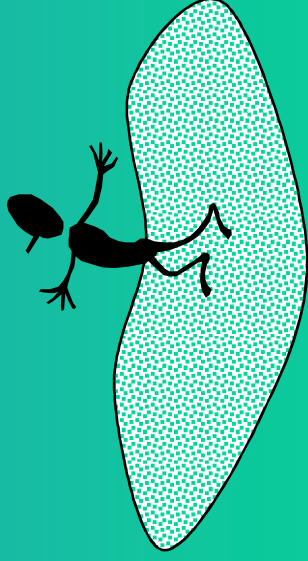
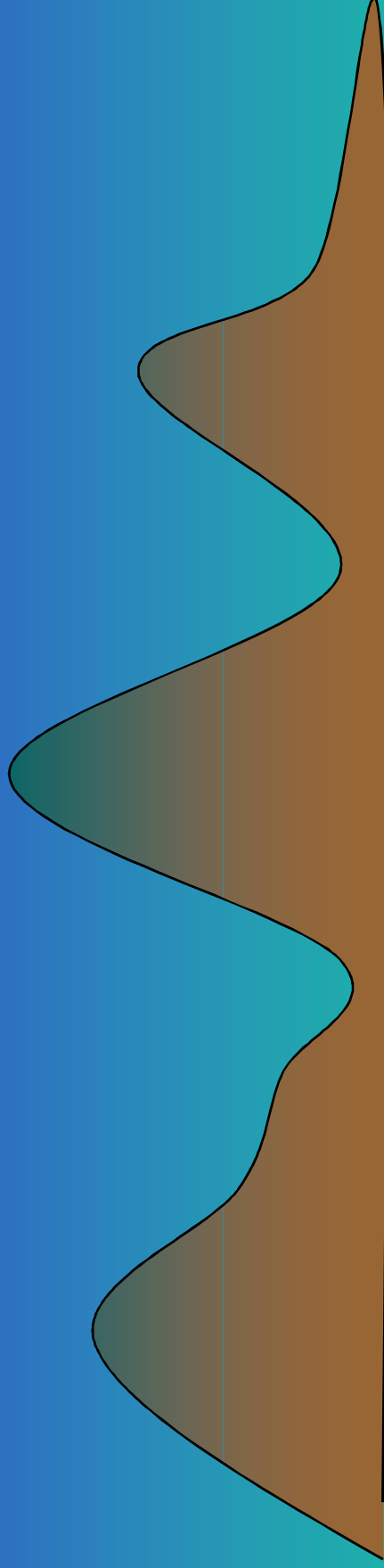
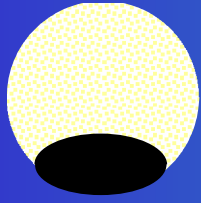


Lua Cheia (?) vista no céu



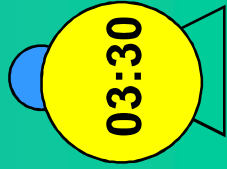
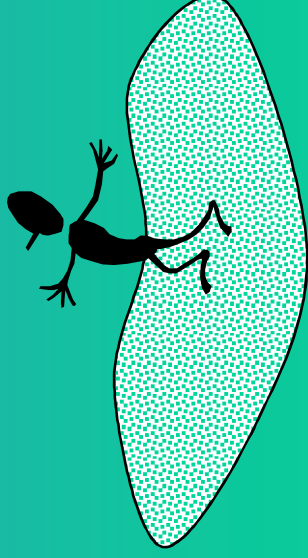
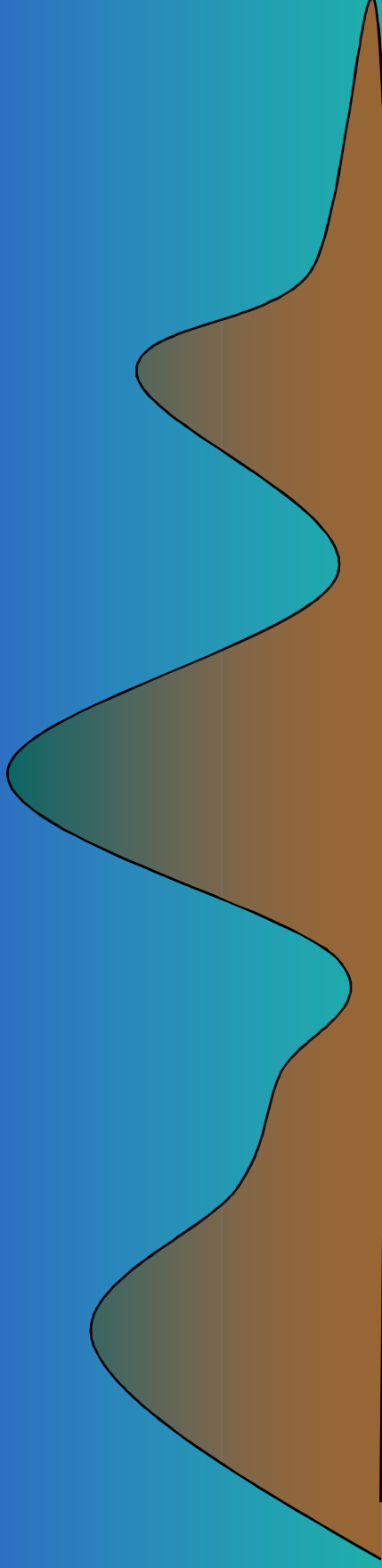
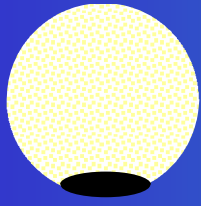
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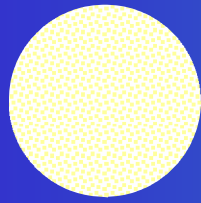
Lua Cheia (?) vista no céu



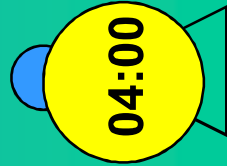
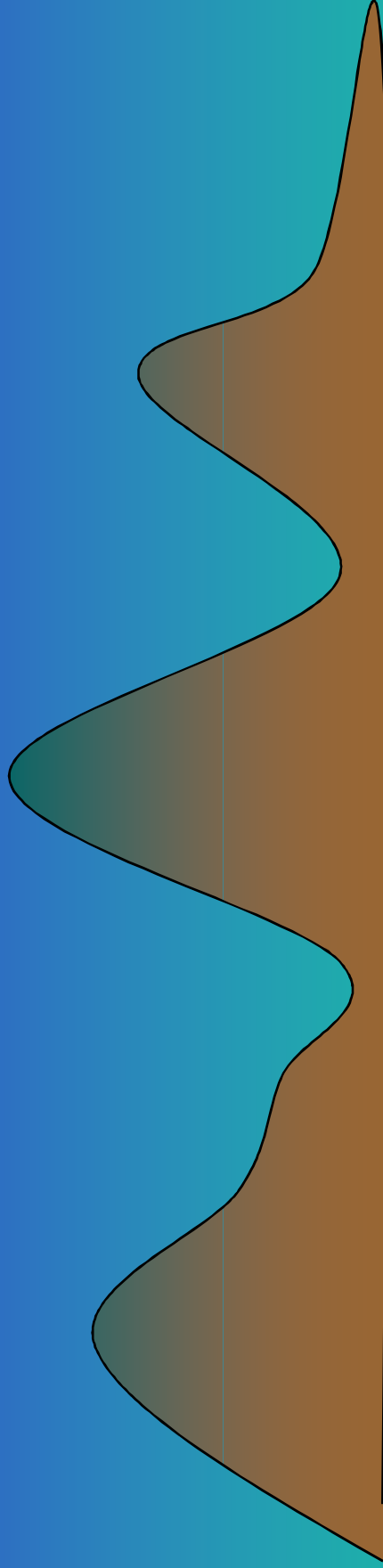
Lua Cheia (?) vista no

céu



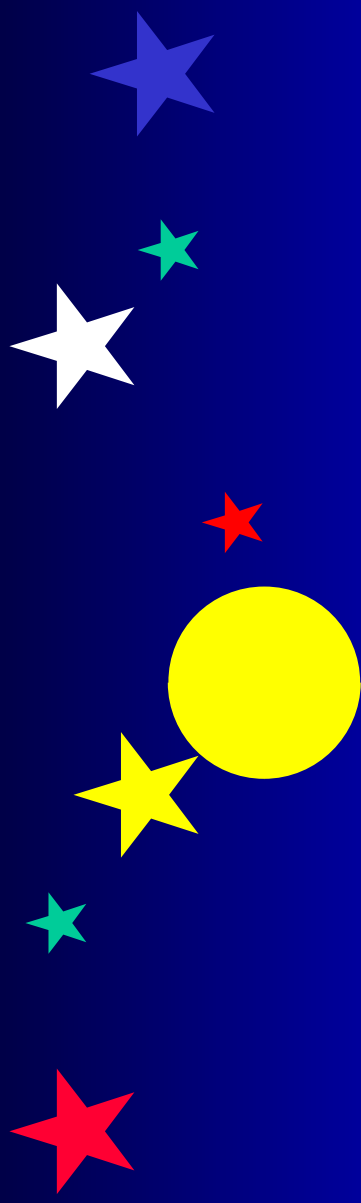


Lua Cheia vista no céu



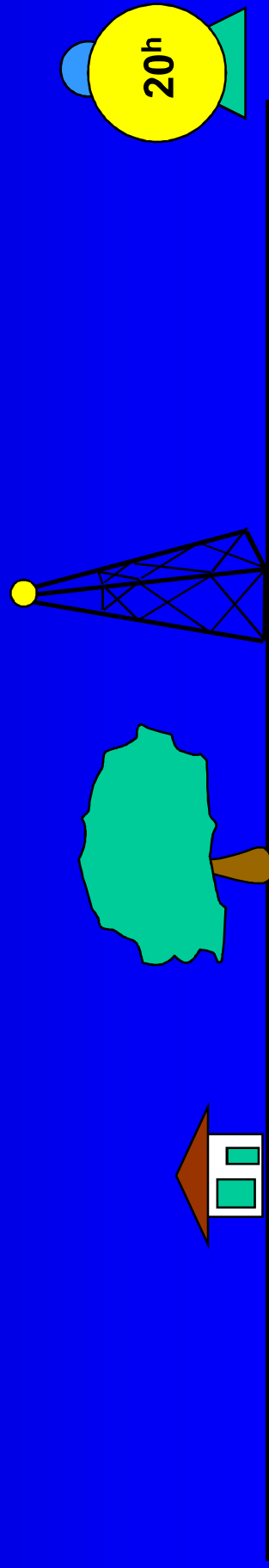
Movimento diurno apparente da Lua

Movimento da Lua no céu

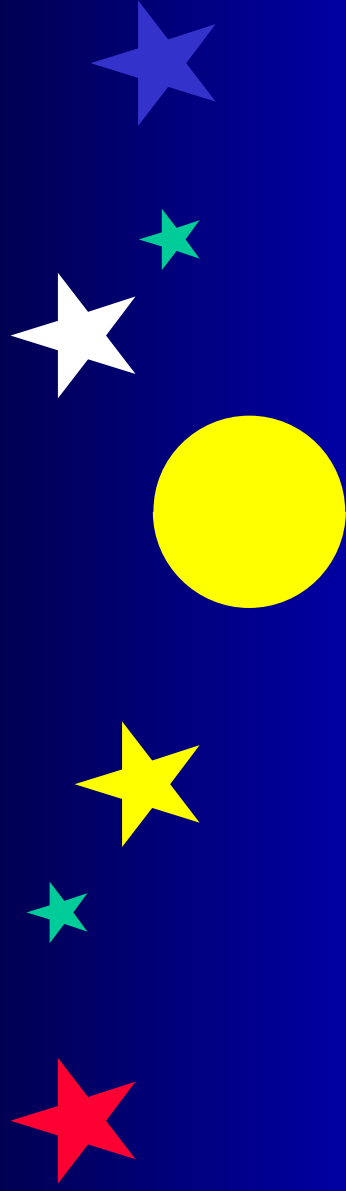


Oeste

Leste

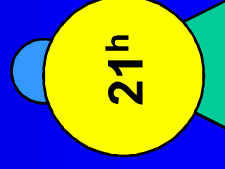
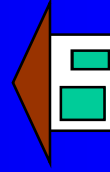
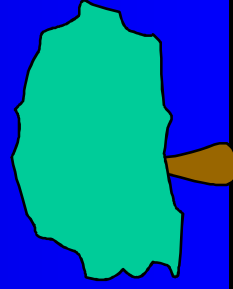
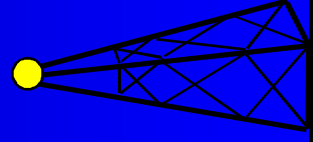


Movimento da Lua no céu

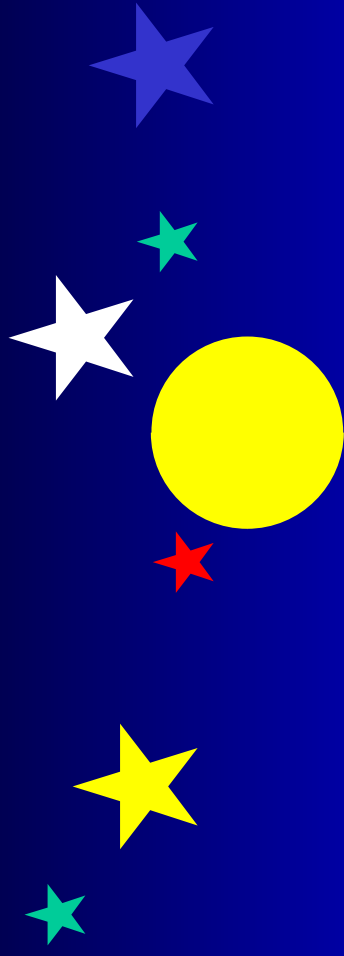


Oeste

Leste

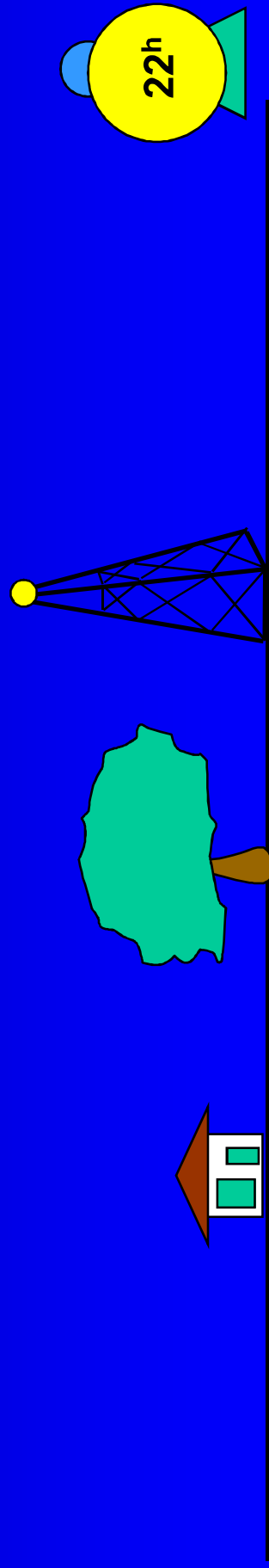


Movimento da Lua no céu

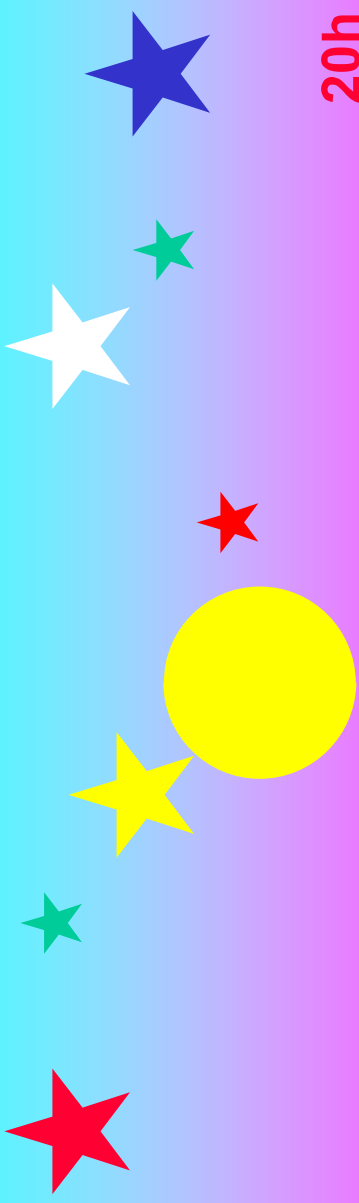


Oeste

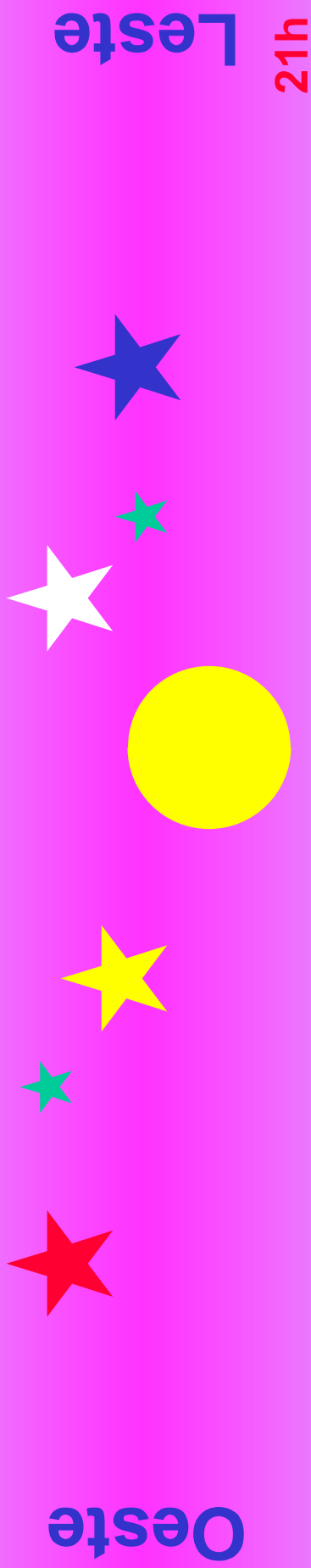
Leste



Movimento da Lua no céu

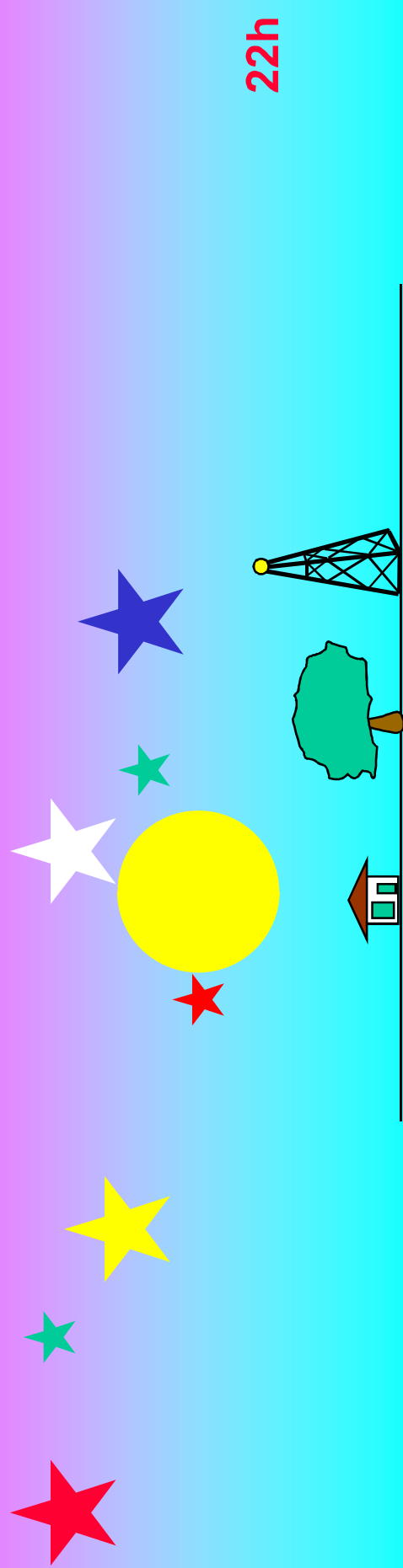


20h



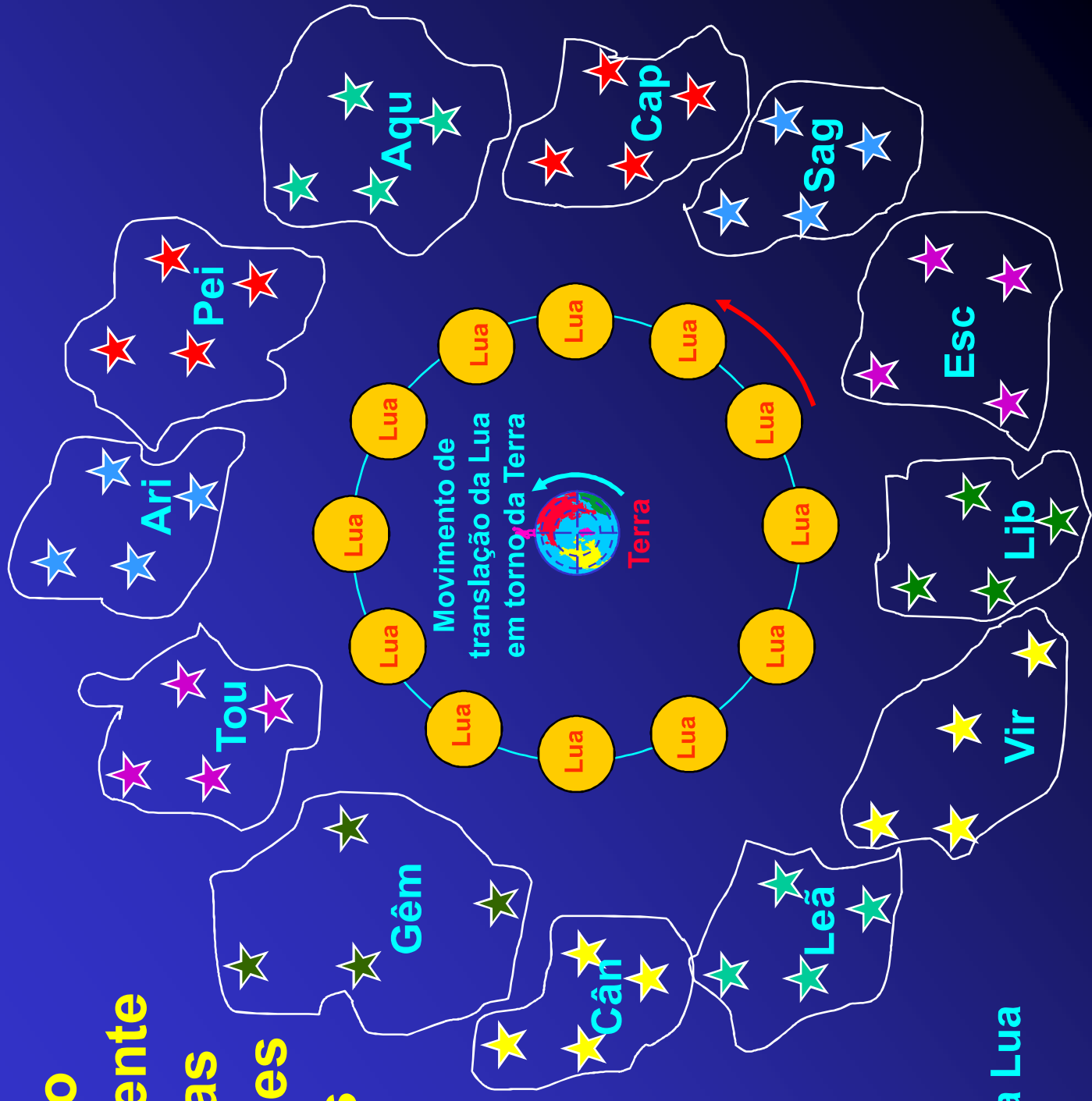
Leste

21h



22h

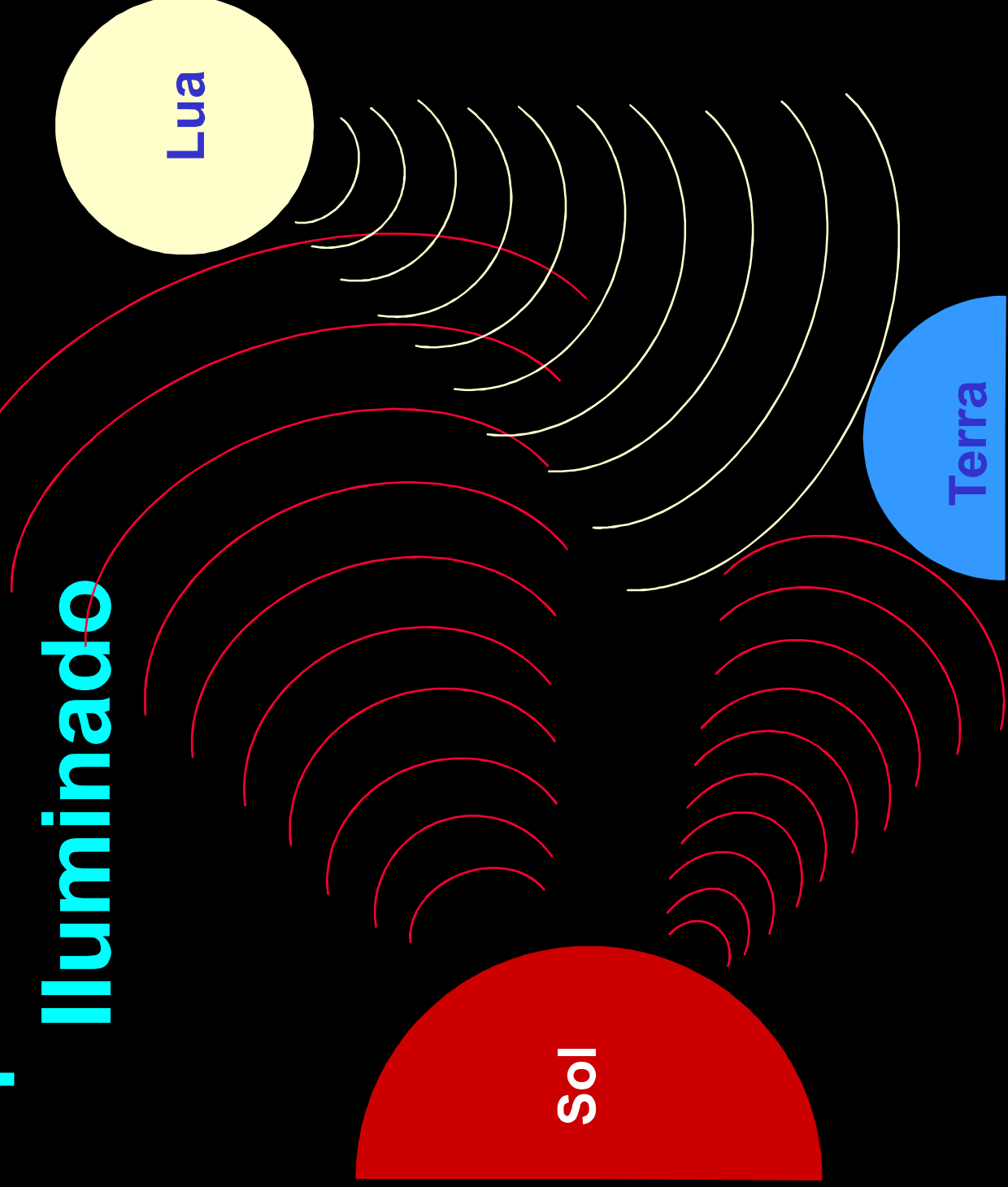
Movimento Mensal Aparente da Lua pelas Constelações Zodiacais



Período orbital da Lua
~27,3 dias

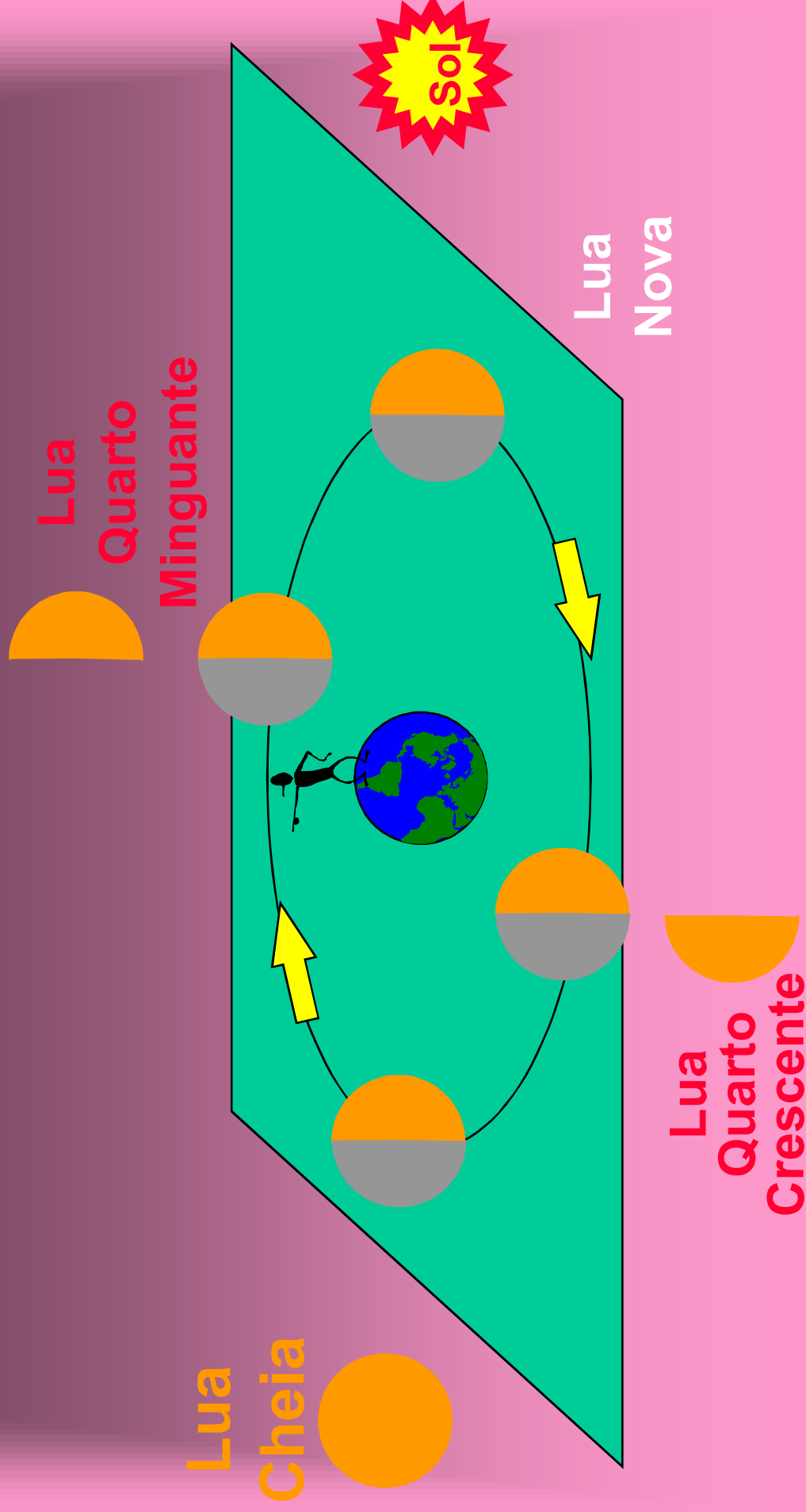
Fases da Lua

Corpo Luminoso ou Iluminado

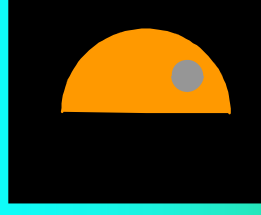
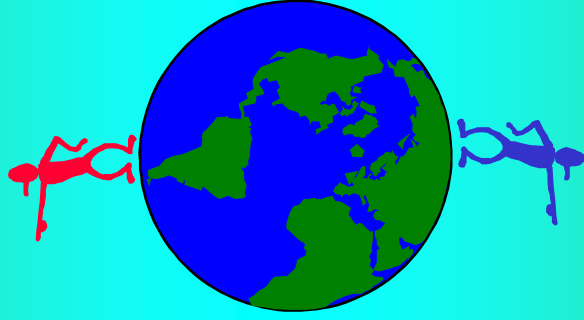
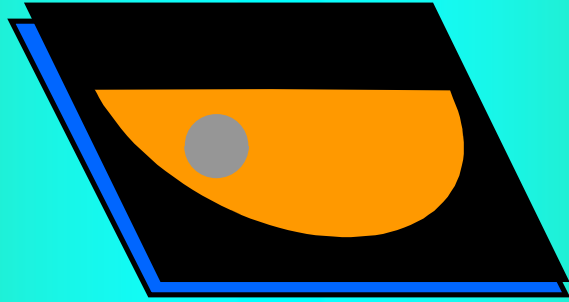


Motivos das fases da Lua

(Aristarco, séc. III a .C.)

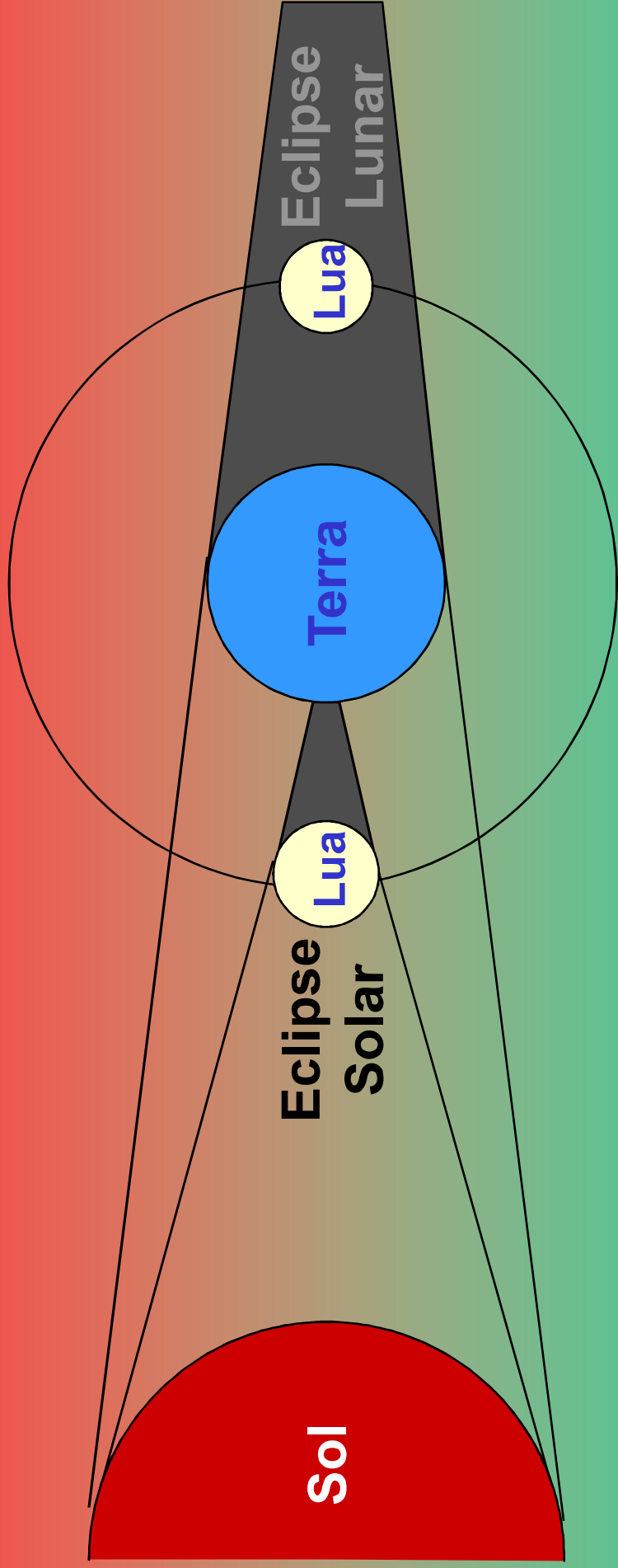


Visão da Lua

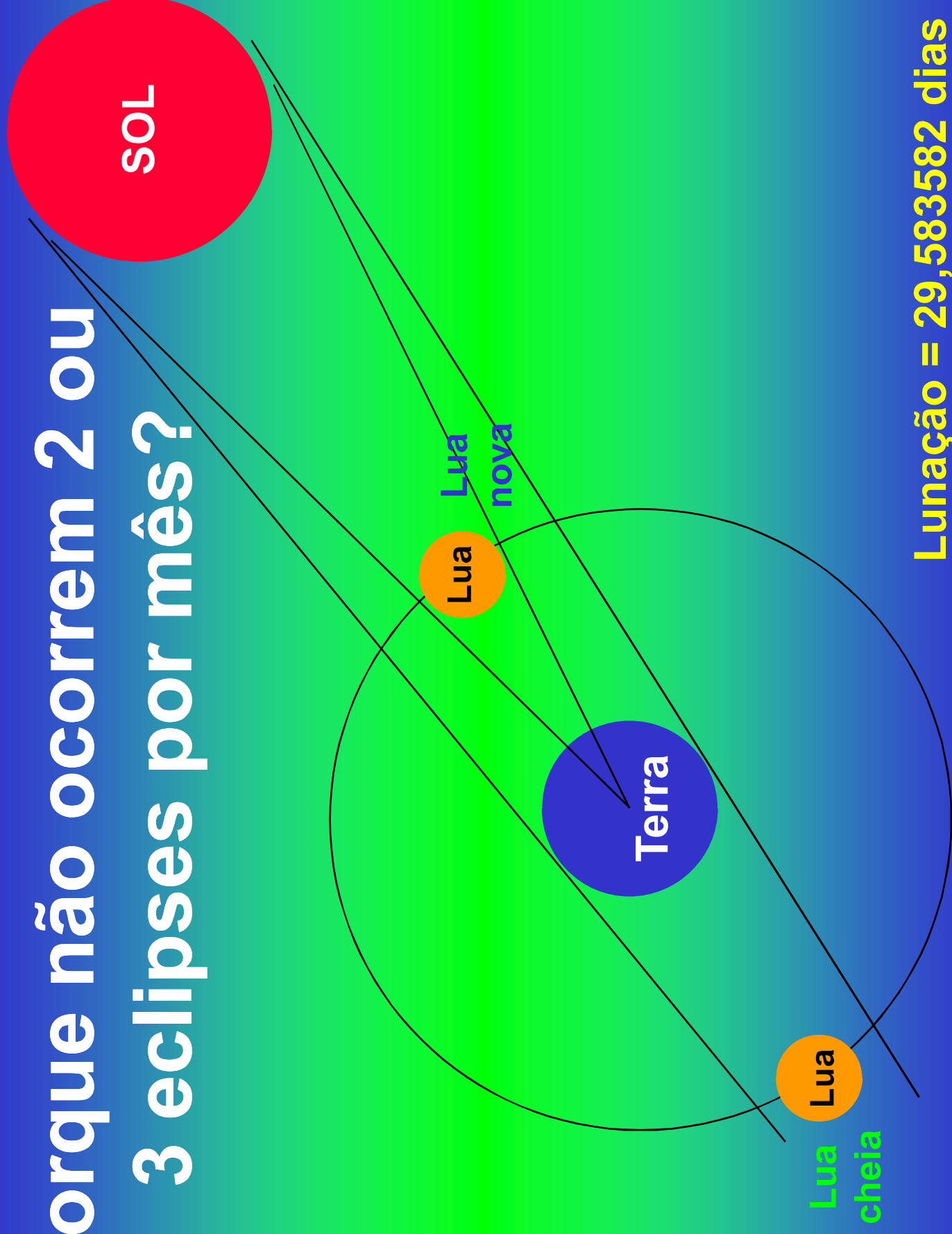


Eclipses

Tipos de Eclipses

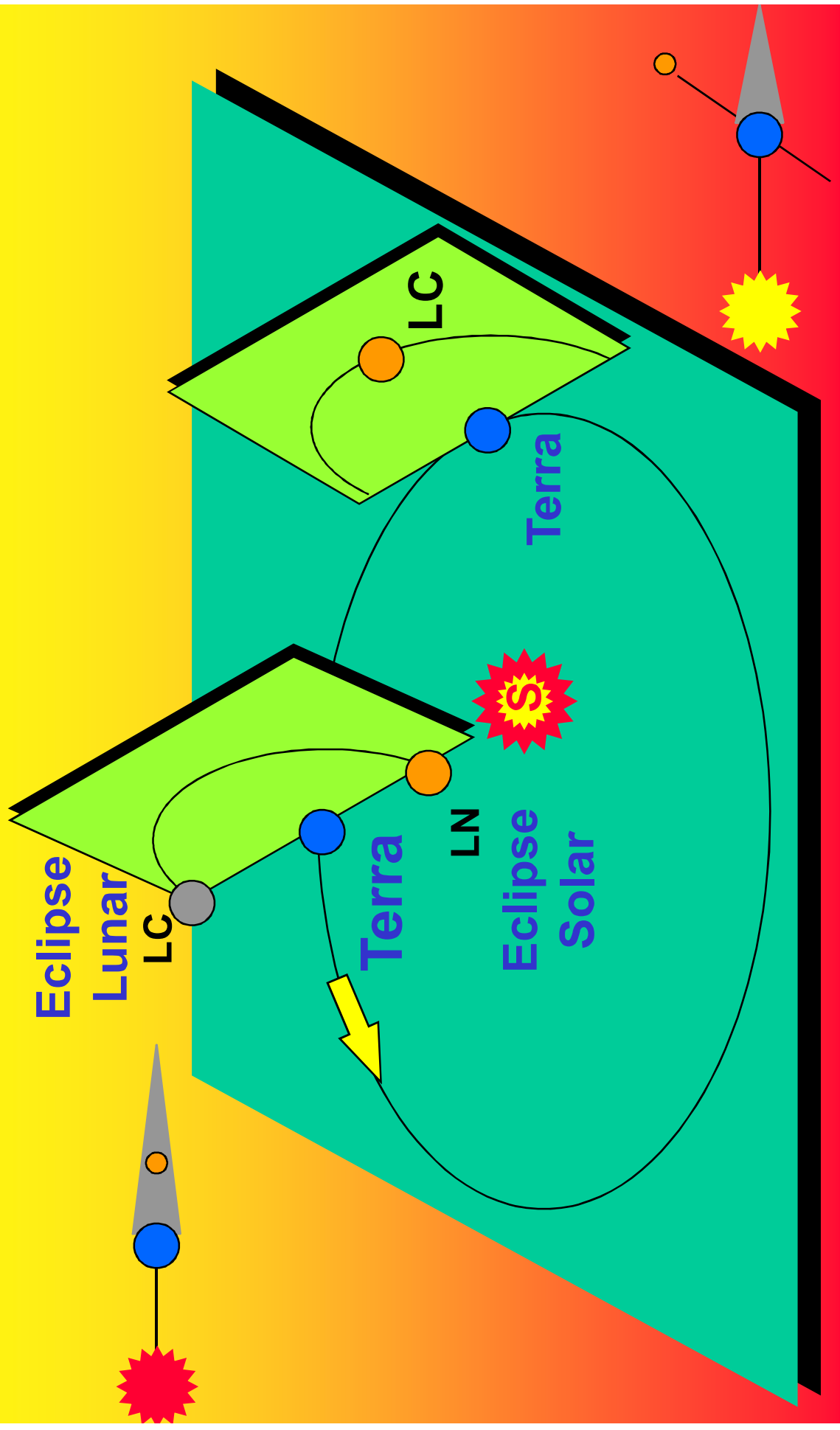


Porque não ocorrem 2 ou 3 eclipses por mês?



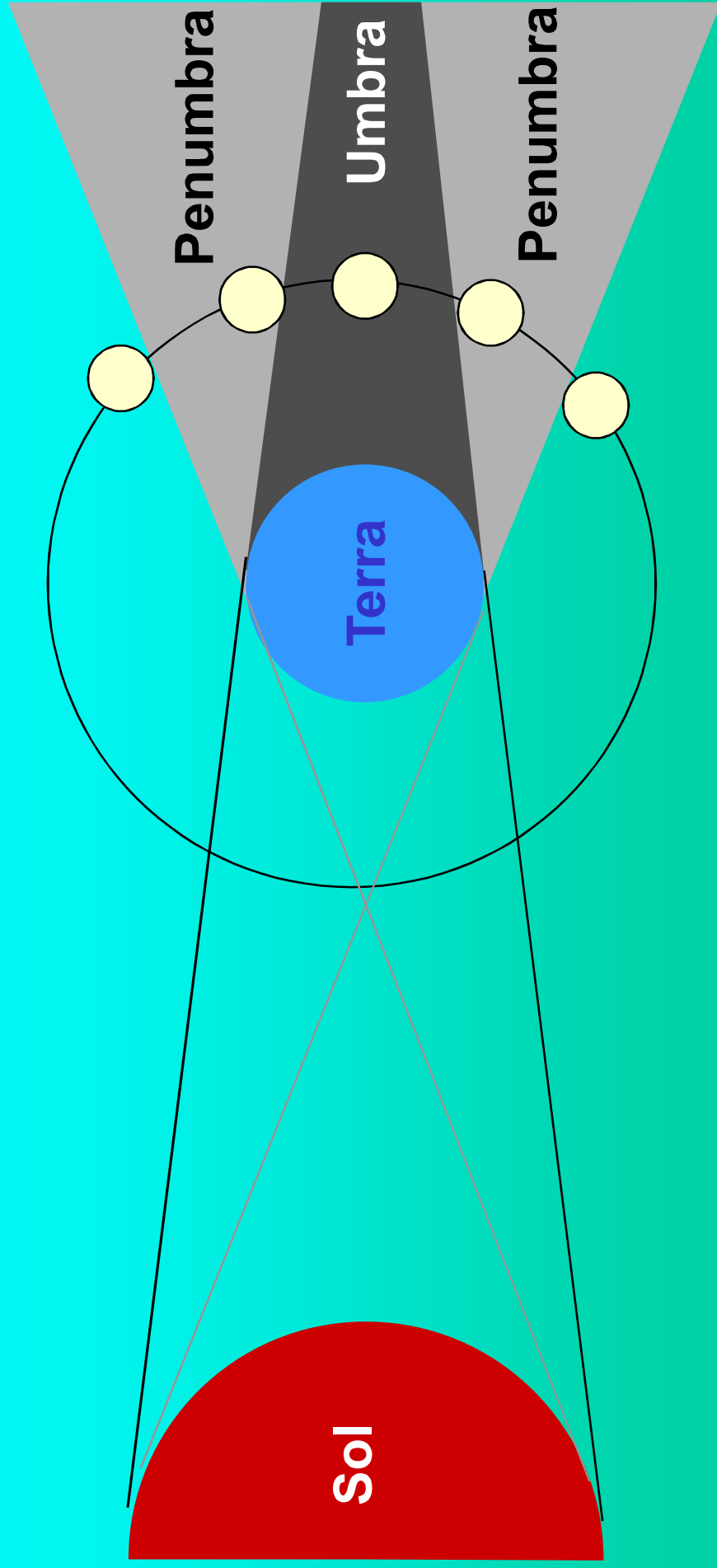
Lunação = 29,583582 dias

Eclipses e fases da Lua

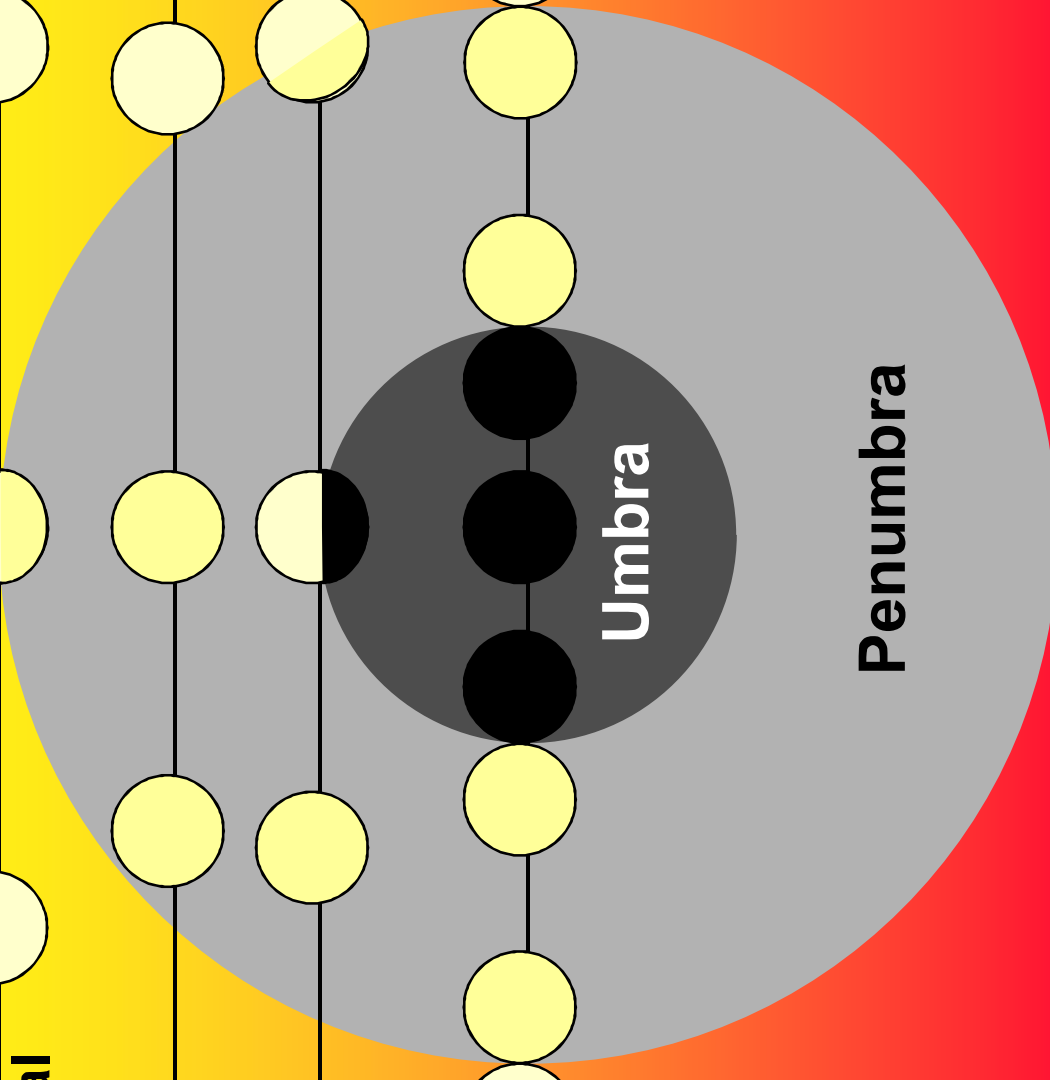
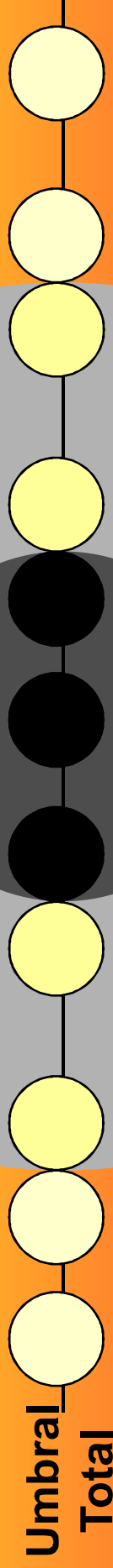
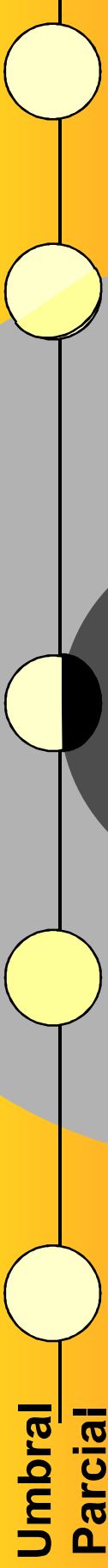
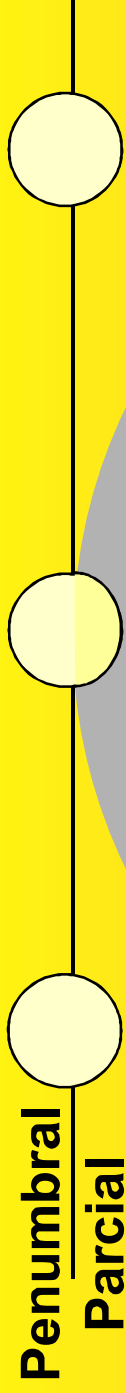
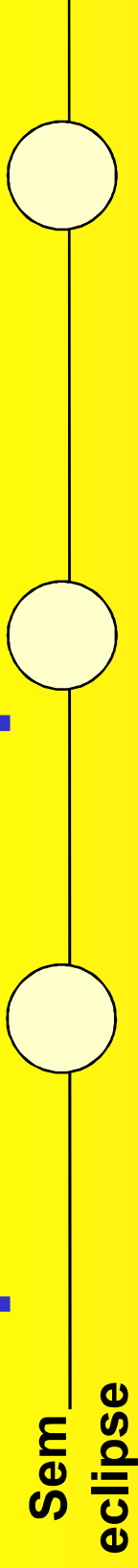


Eclipses Lunares

Ocorrência de Eclipse Lunar

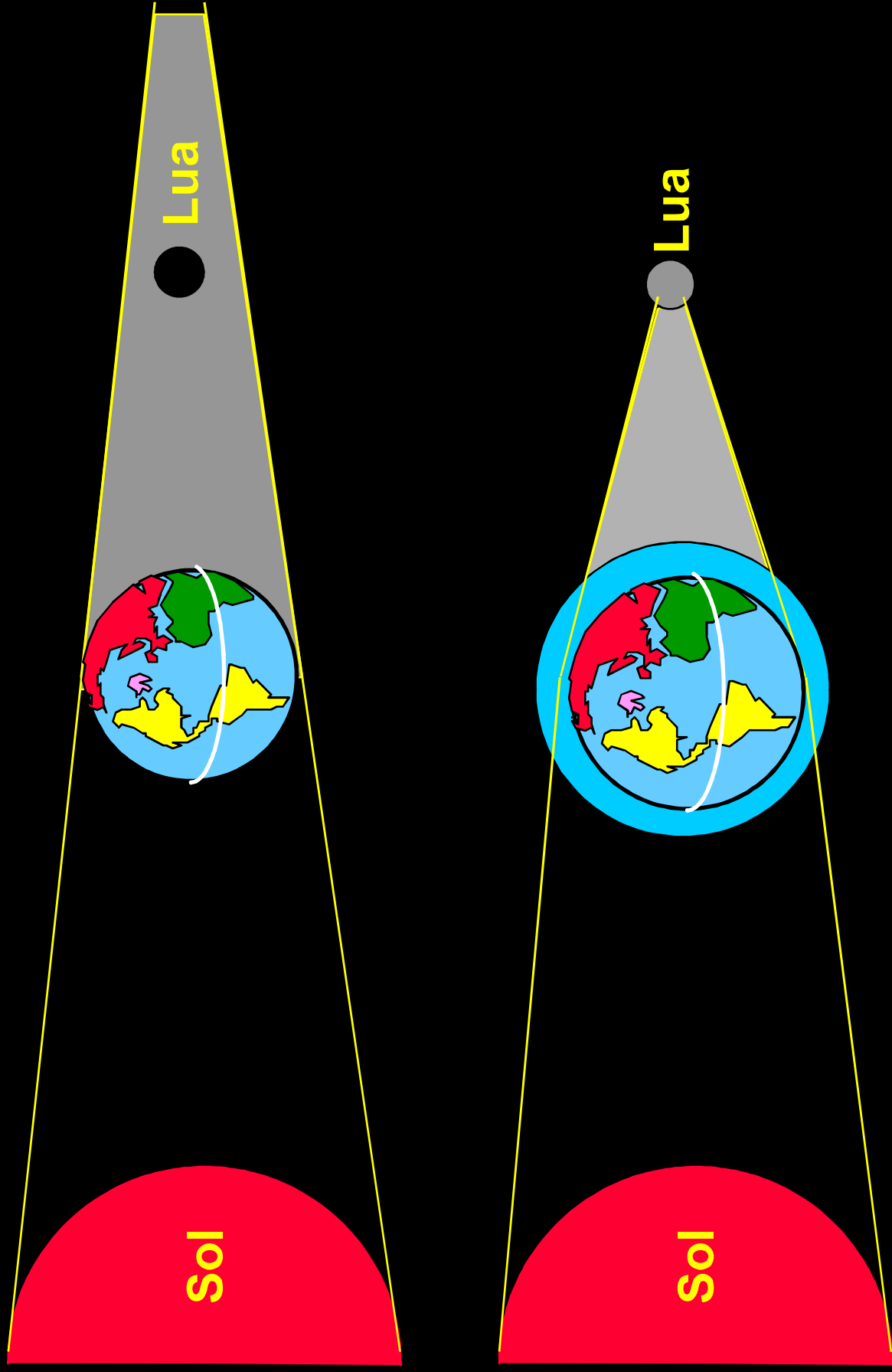


Tipos de eclipses lunares



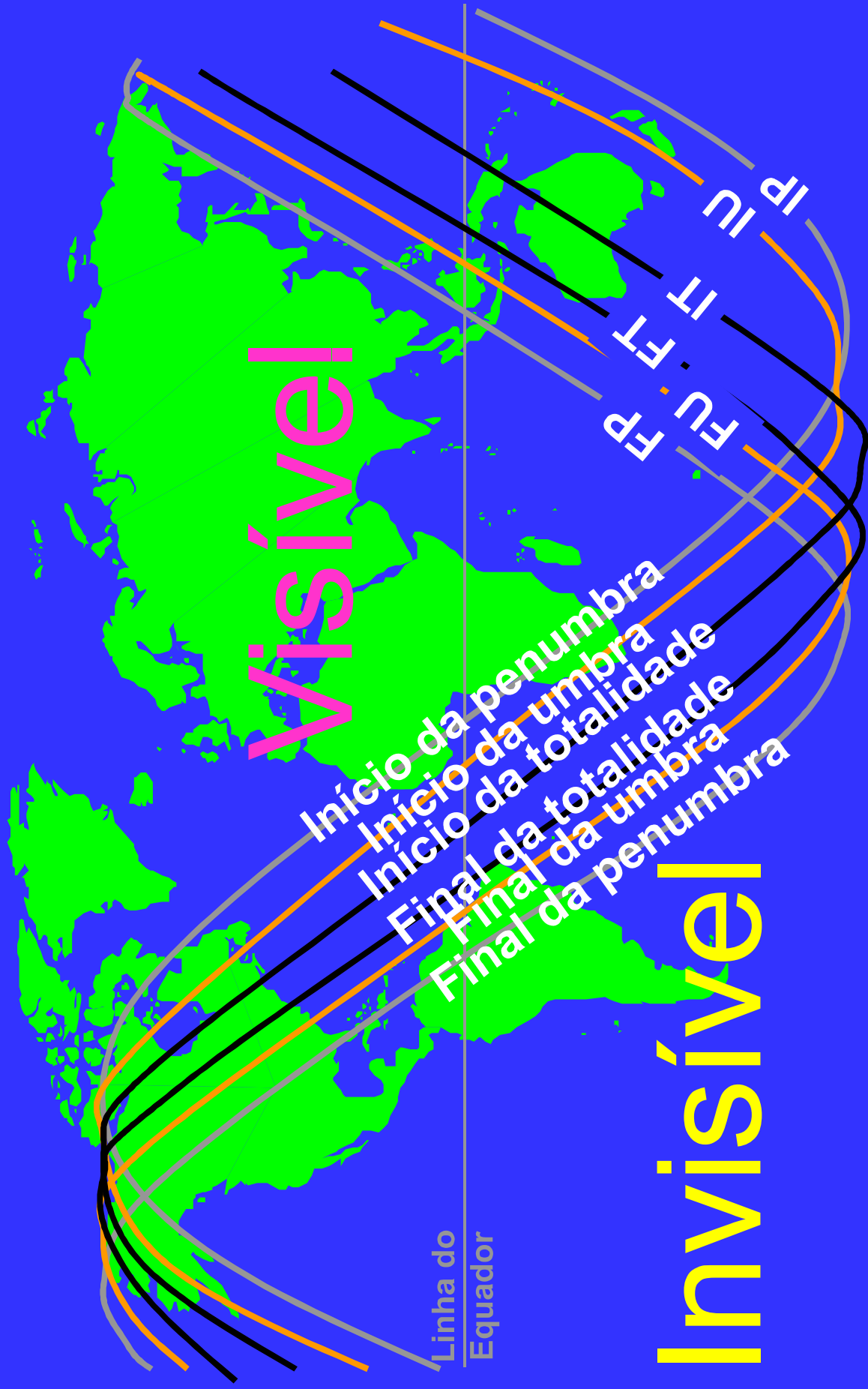
**Por que se pode ver a
Lua mesmo durante
um eclipse lunar total?**

Iluminação da Lua no Eclipse



Visibilidade de um eclipse lunar

Visibilidade de um eclipse lunar

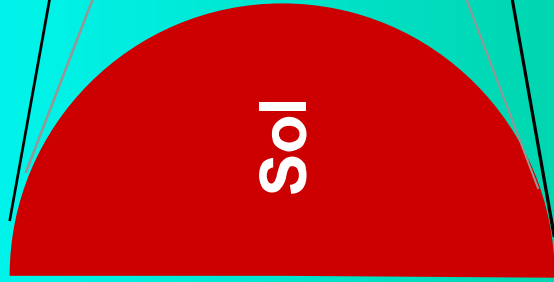


Eclipses

Solares

Eclipse Solar Total ou Parcial

Eclipse Solar total



Penumbra

Umbral

Penumbra

Lua

Terra

Eclipse Solar parcial



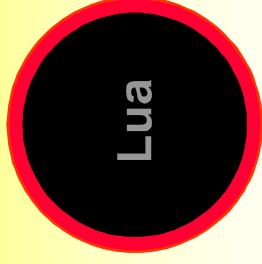
Lua: perto

Sol: longe



Eclipse Solar Anular

Anel luminoso



Penumbra

Penumbra

Umbra

Lua

Penumbra

Terra



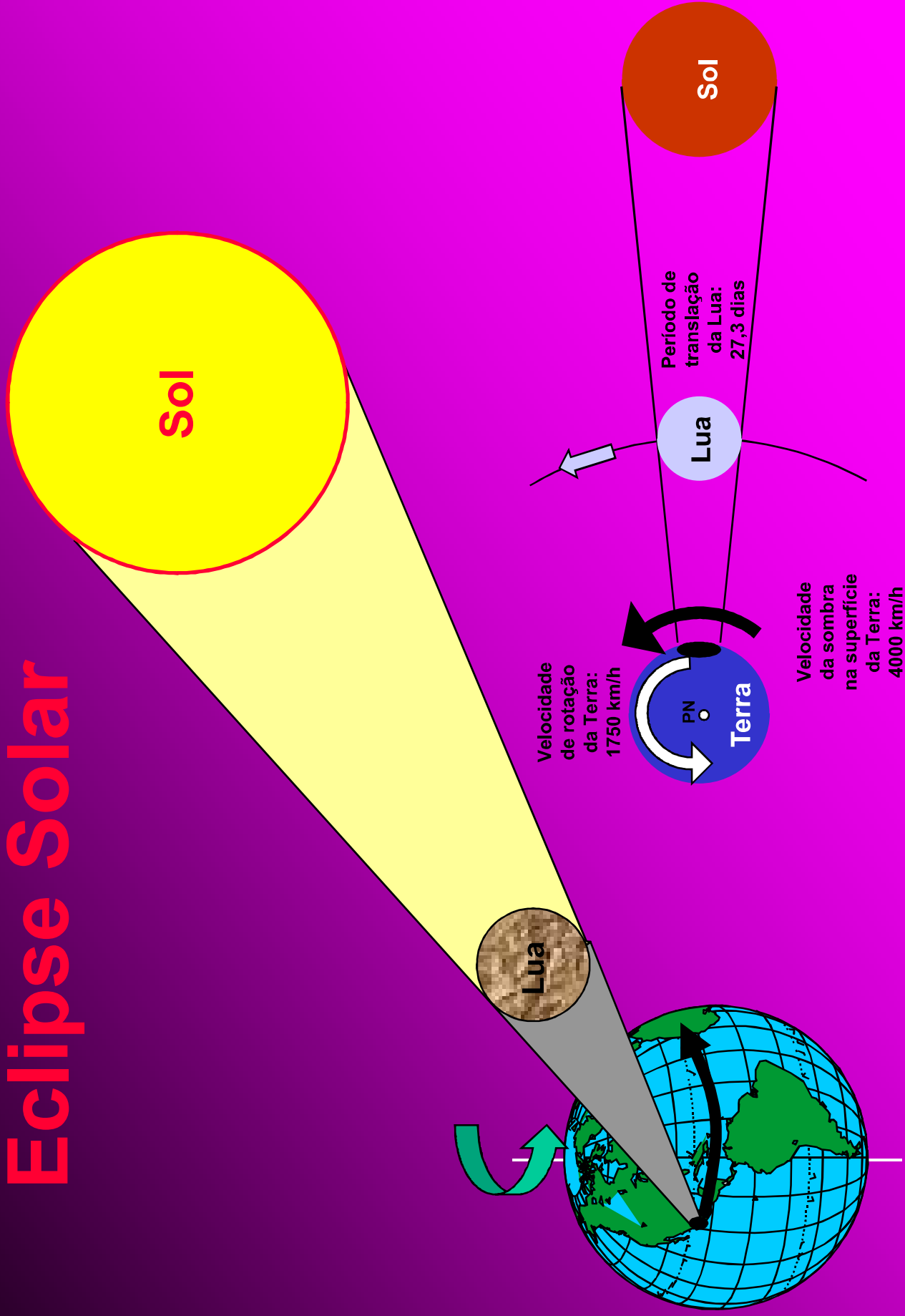
Lua: longe

Sol: perto

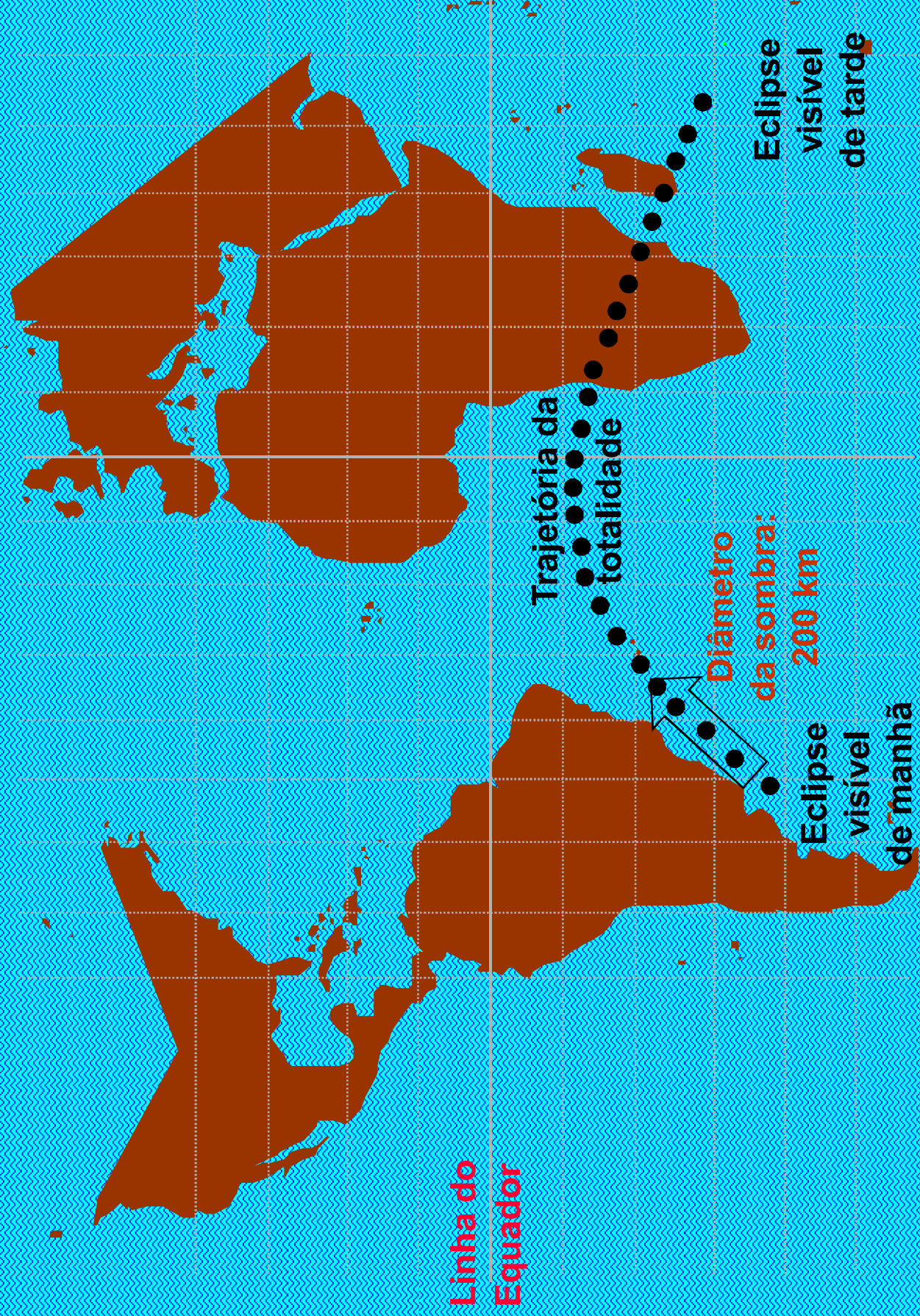


Trajetórias da sombra durante um eclipse solar

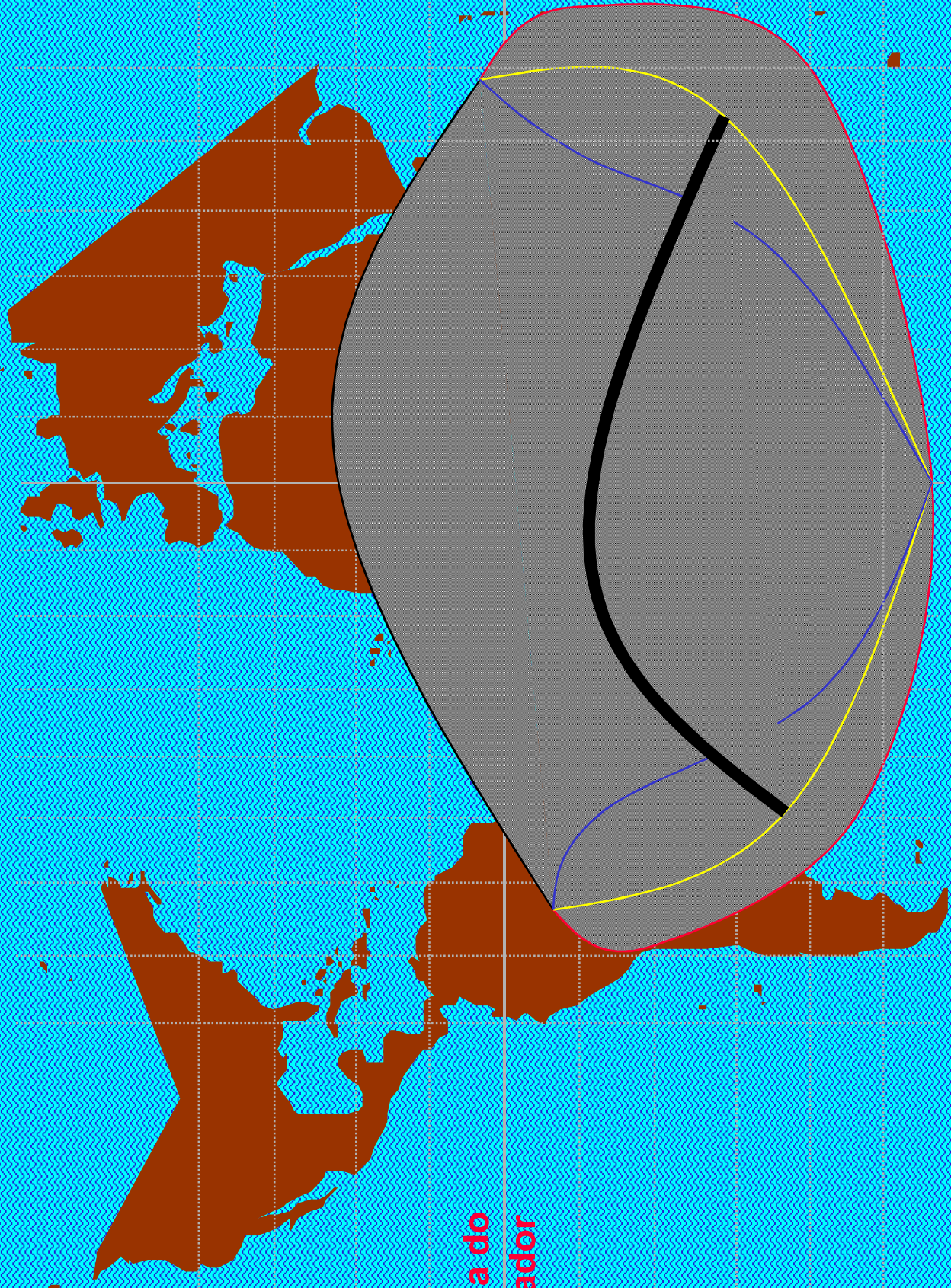
Eclipse Solar



Eclipse Solar Total de 21 jun 2001

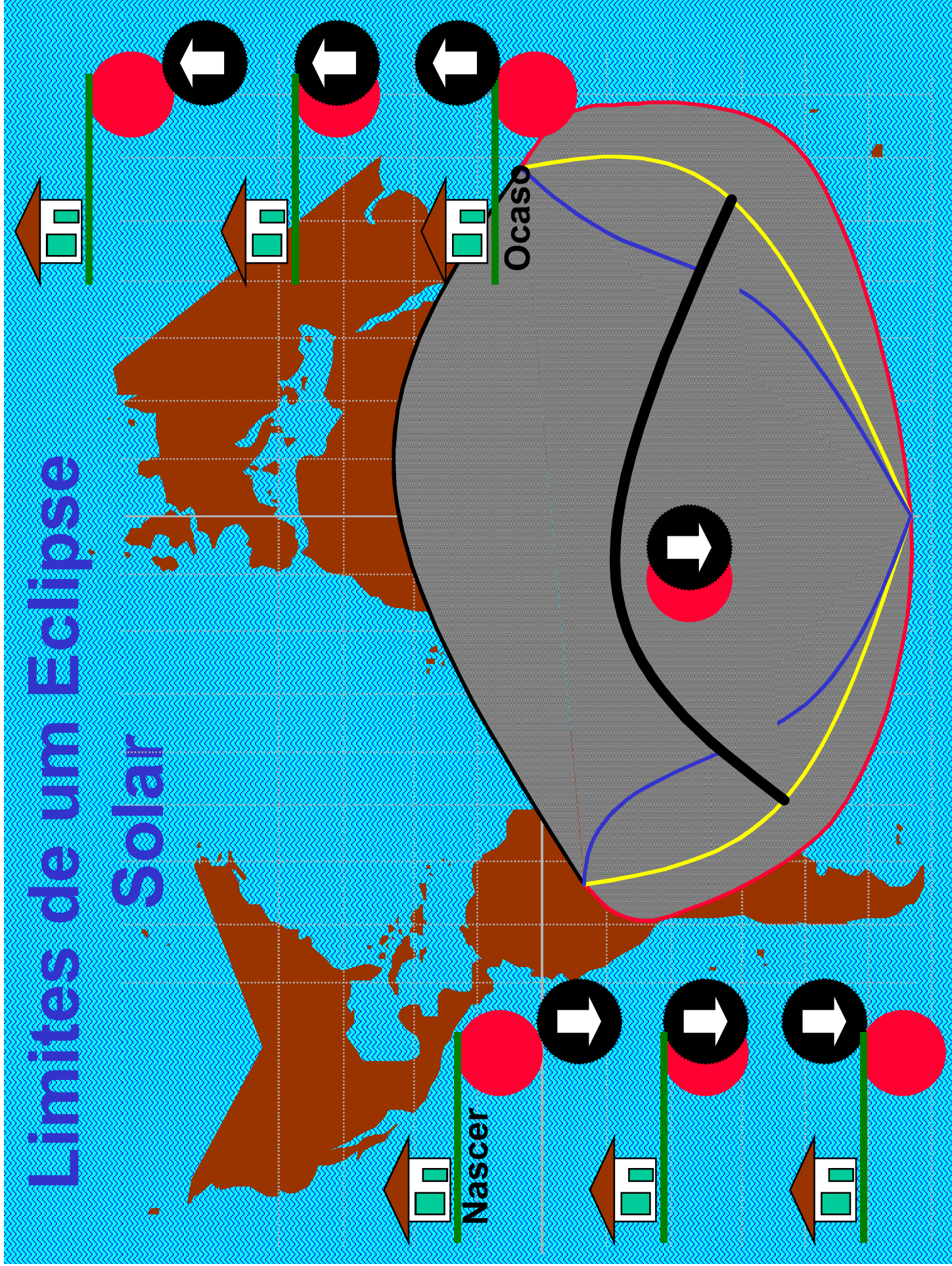


Eclipse Solar Total de 21 jun 2001

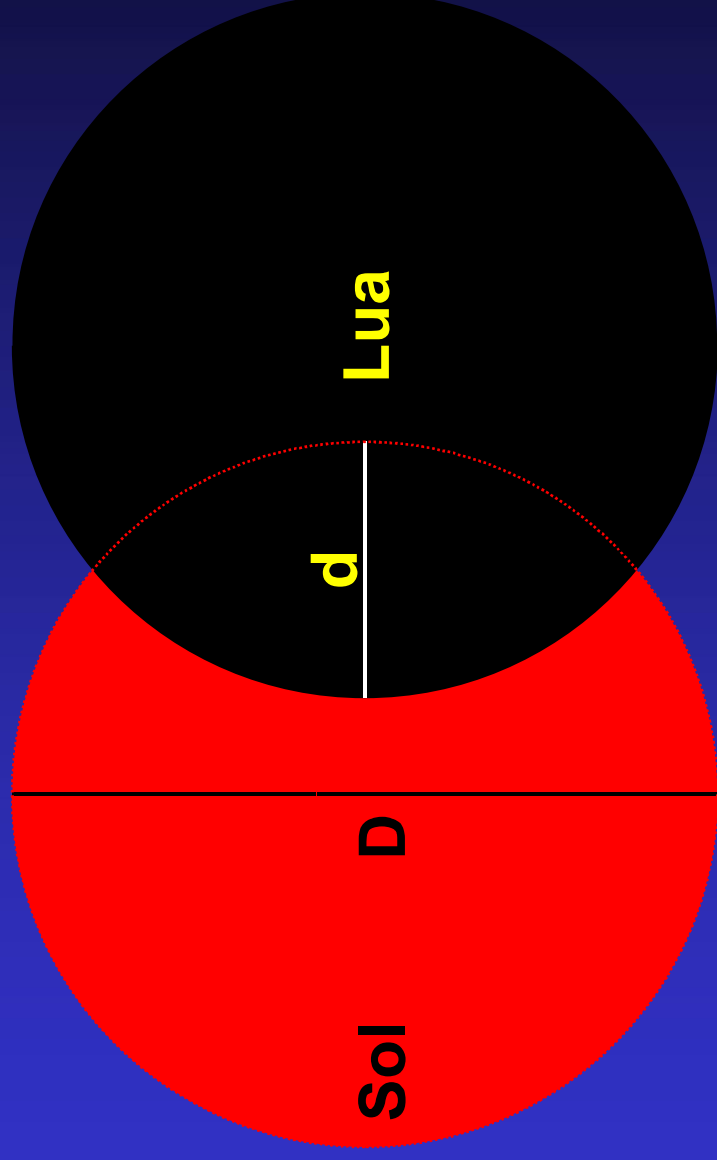


Linha do
Equador

Límites de um Eclipse Solar



Magnitude de um eclipse

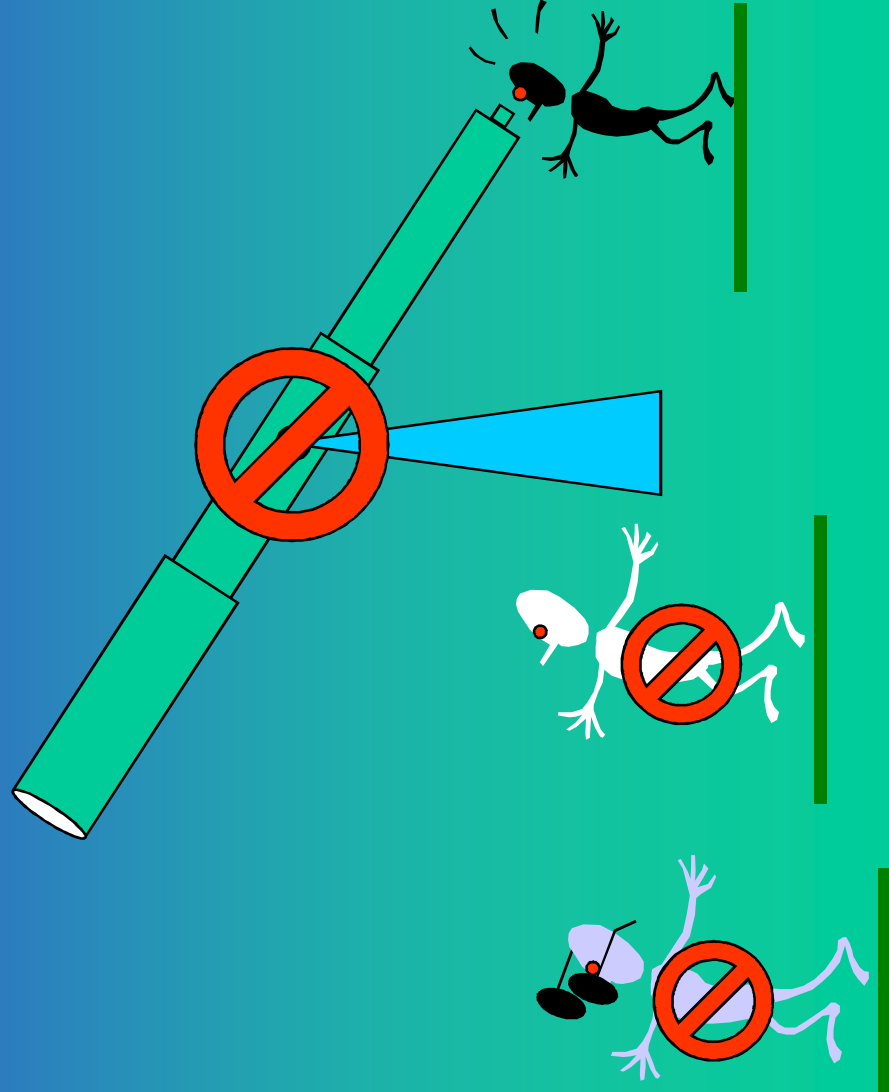


$$m = (d / D) * 100 \%$$

Cuidados para a observação de um eclipse solar



Como não observar um eclipse

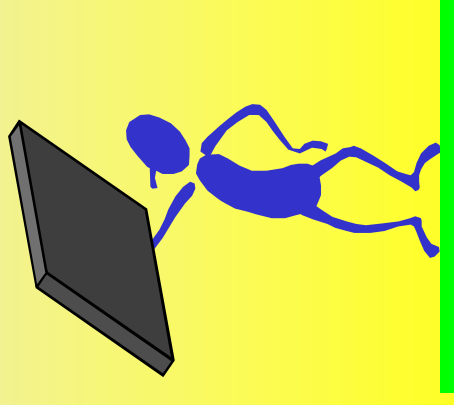


Como observar um eclipse

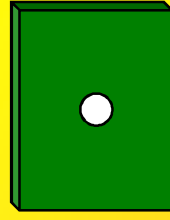


- Sanduíche de filmes branco e preto velados e revelados
- Filme de raio X (parte bem escura)
- Vidro de máscara de soldador # 14

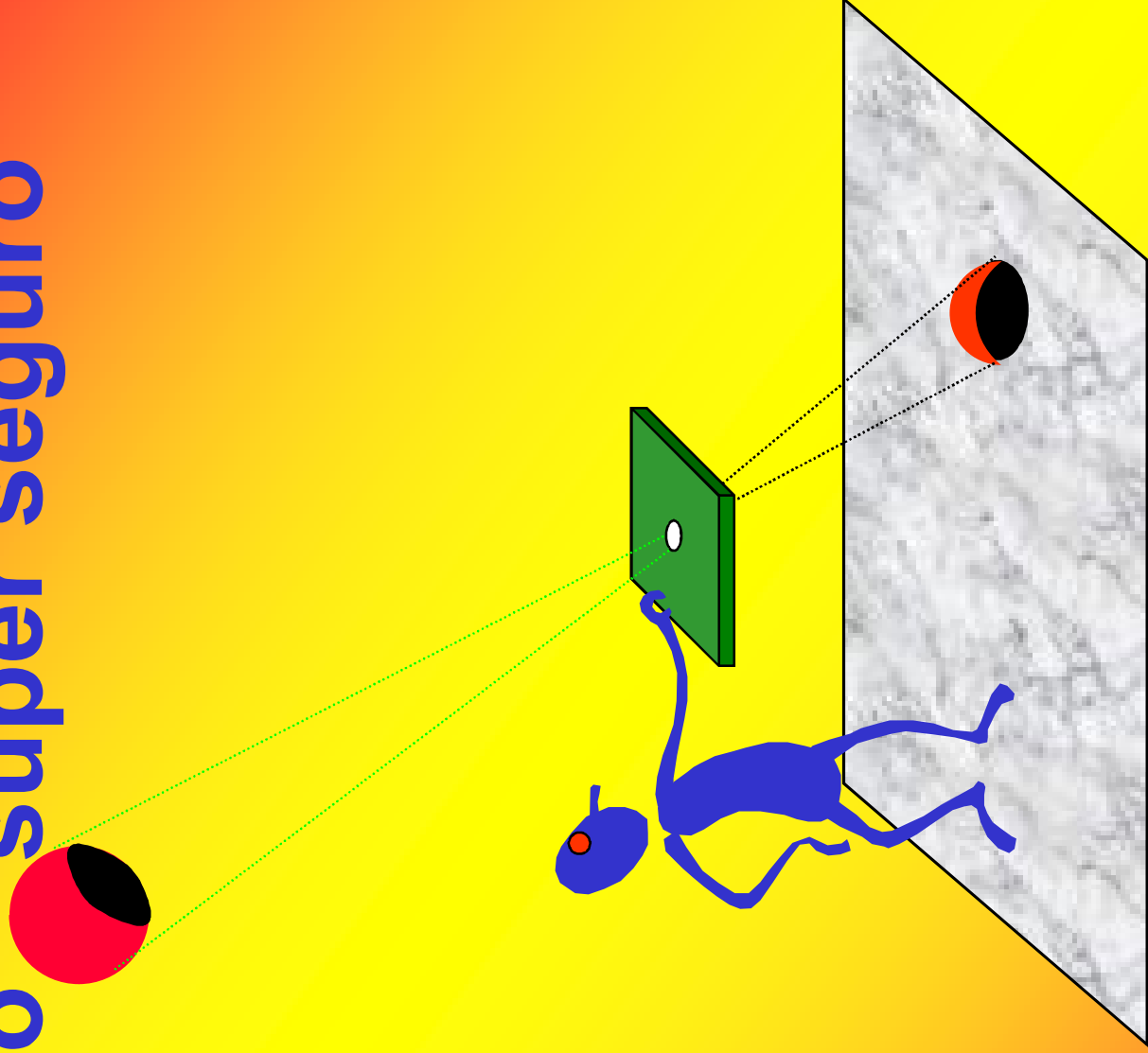
Mesmo com esses cuidados, deve-se observar por pouco tempo!!!!!!



Como observar um eclipse de modo super seguro

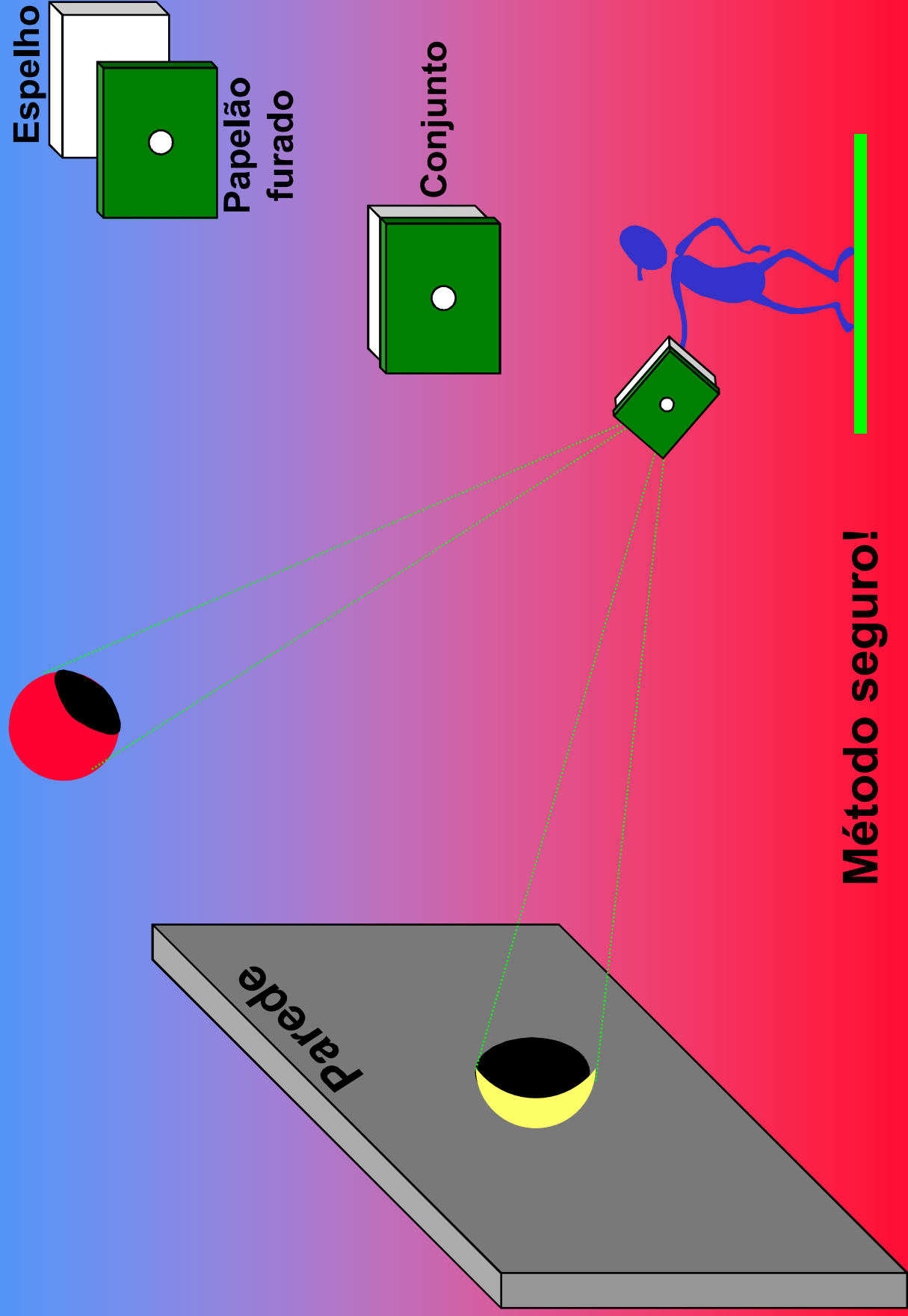


Papelão
furado



Método seguro!

Como bem observar um eclipse



**Utilidade de um
eclipse solar total**

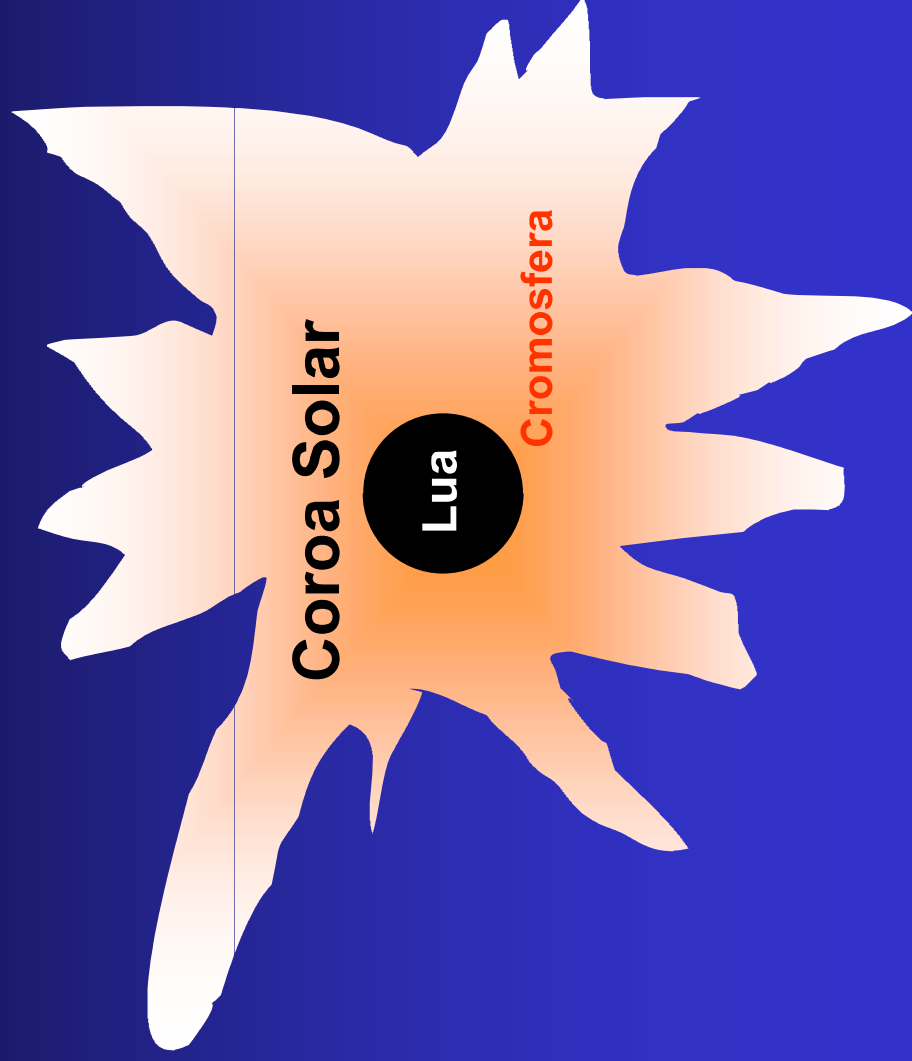
Para que observar o Sol durante o eclipse total?

Sol não eclipsado



Fotosfera do Sol

Sol eclipsado totalmente



Repetição dos eclipses

Repetição dos eclipses

Em média, a cada 18 anos e 11 dias temos:

$$43 \text{ ☺} + 43 \text{ ☾} = 86 \text{ eclipses}$$

Período de Saros

(Descoberto pelos antigos caldeus)

Em média, a cada 18 anos e 11 dias temos:

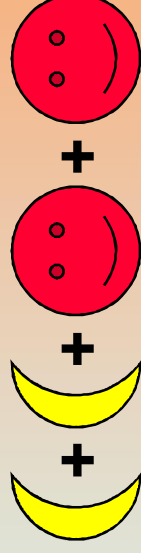
$$41 \text{ ☺} + 29 \text{ ☾} = 70 \text{ eclipses visíveis}$$

**Não estão computados os penumbrais da Lua.
Porque?**

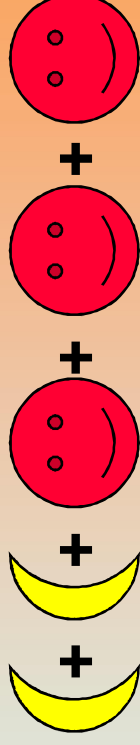
**Eclipses visíveis
por ano:**

Curiosidades

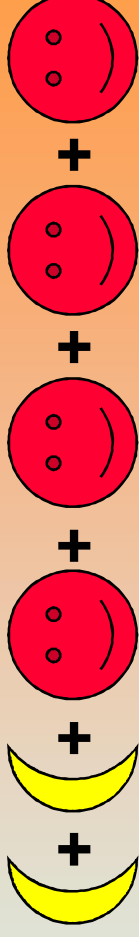
2 da Lua + 2 do Sol



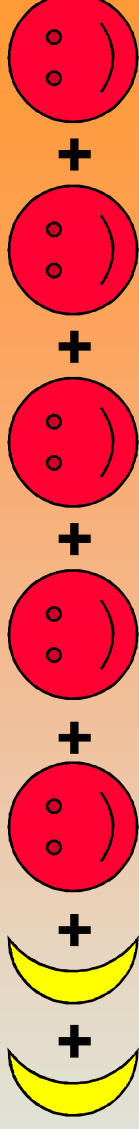
2 da Lua + 3 do Sol



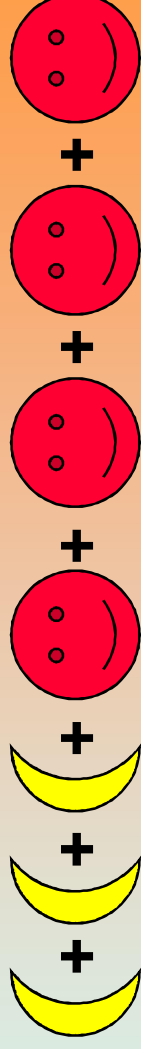
2 da Lua + 4 do Sol



2 da Lua + 5 do Sol



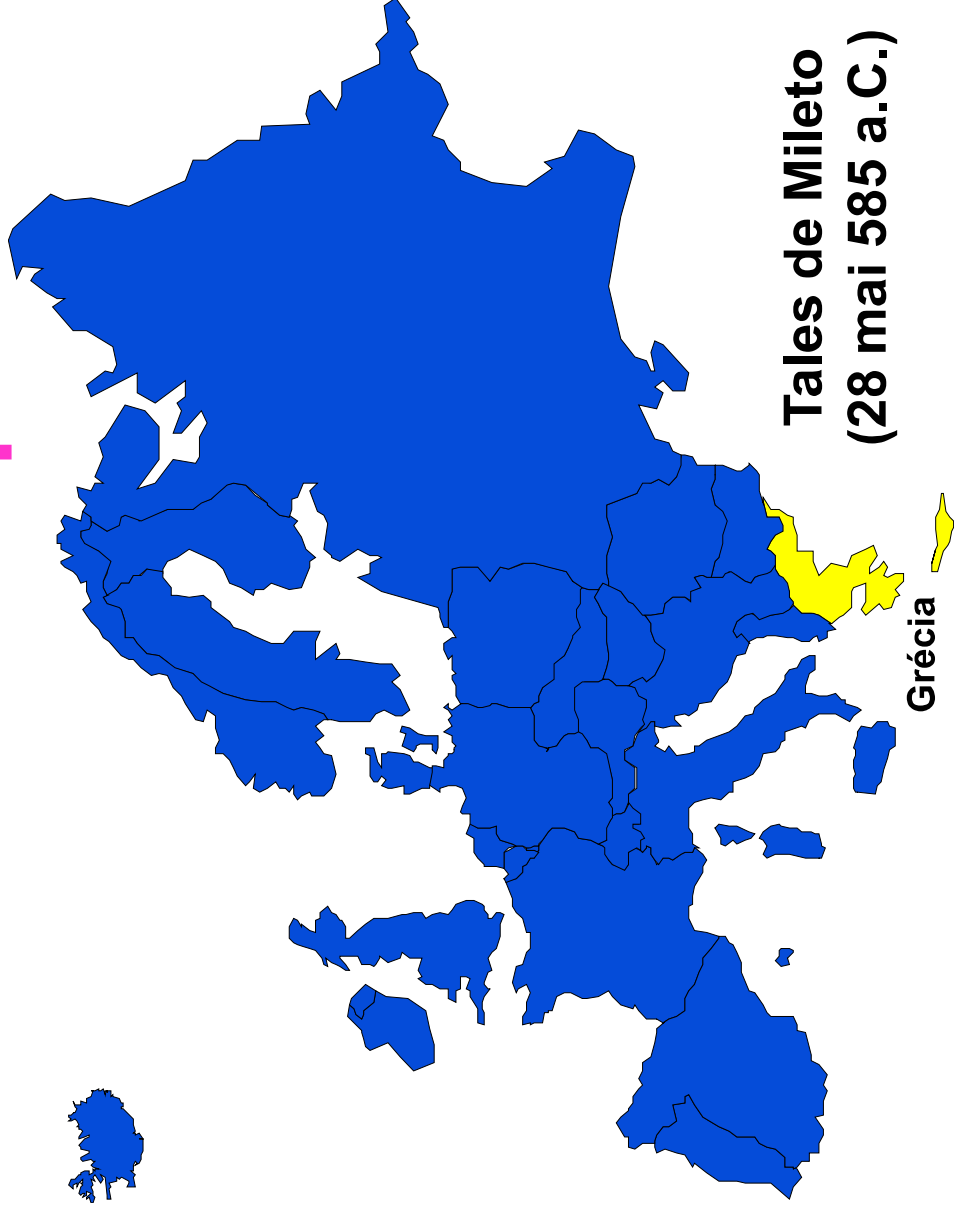
3 da Lua + 4 do Sol



Último eclipse Total do Sol visto no Brasil : 03 nov 1994

Próximo eclipse Total do Sol visível no Brasil : 02 ago 2046

Primeira previsão de um eclipse solar



Tales de Mileto
(28 mai 585 a.C.)

Grécia

Assustou Medos e
Lidos que estavam
prestes a combater
entre si

É o mais antigo
evento histórico
com data
perfeitamente
determinada

Antes de Tales : fenômenos naturais eram divinos e não compreensíveis

Depois de Tales: os céus passam a ser acessíveis ao pensamento humano

Alguns eclipses importantes

- 28 mai 585 a.C.** Primeiro eclipse previsto
- 18 jul 1860** Primeiro a ser fotografado
- 18 ago 1868** Primeira análise da composição química dos gases das proeminências
- 07 ago 1869** Primeira foto e análise espectroscópica da coroa solar
- 29 mai 1919** Confirmação da deflexão da luz num campo gravitacional (Einstein).
Observado em Sobral, Ceará, Brasil

Prova da Teoria da relatividade através de um eclipse solar total

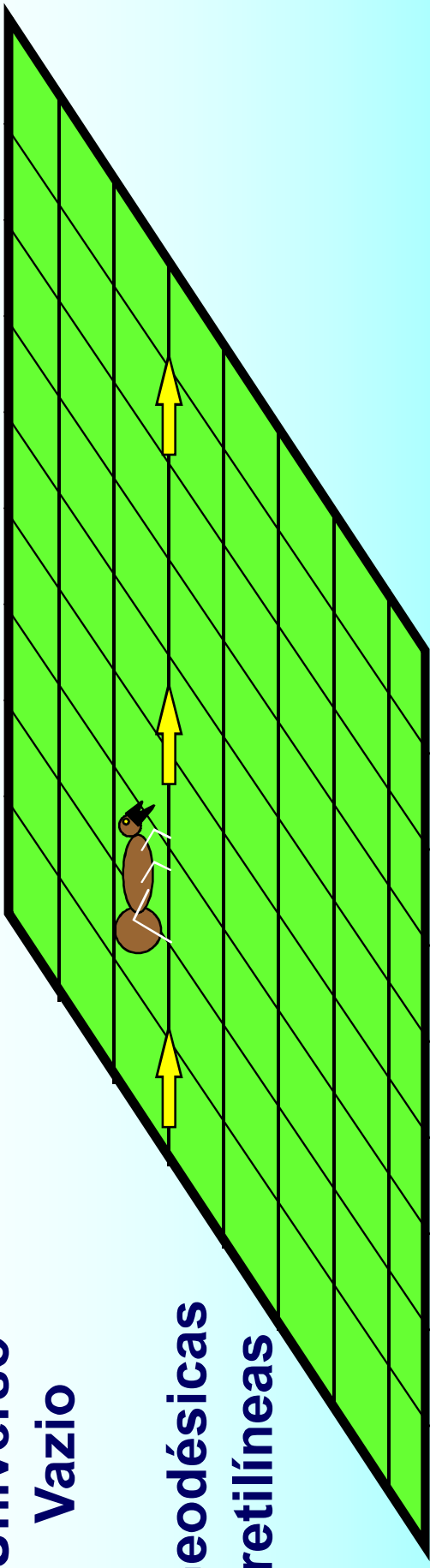
Geodésica

É a trajetória
percorrida pela luz



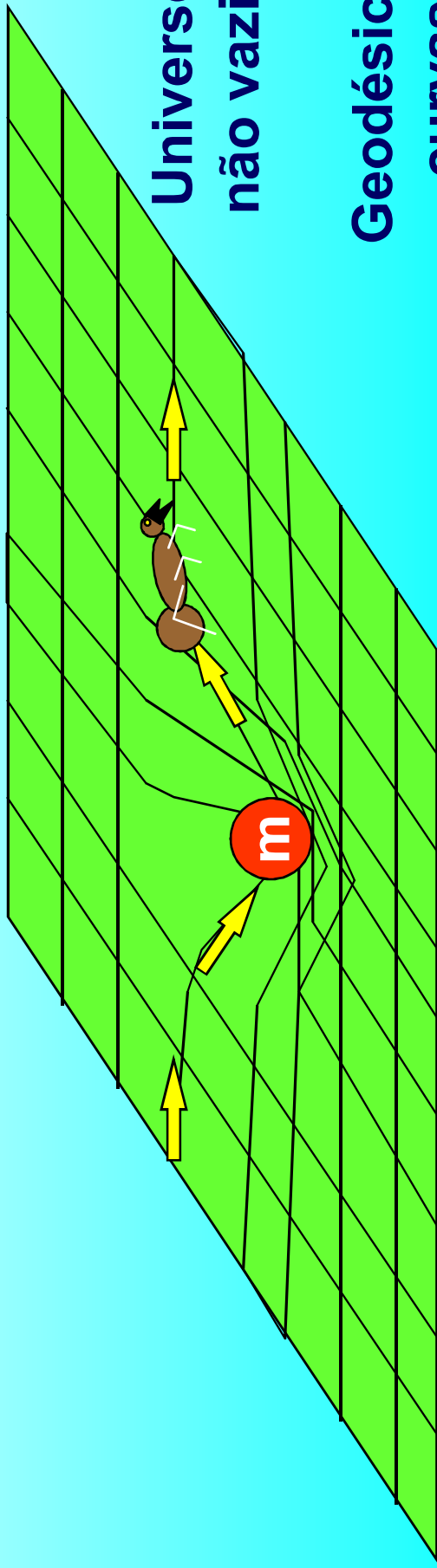
Curvatura do Universo

Universo
Vazio



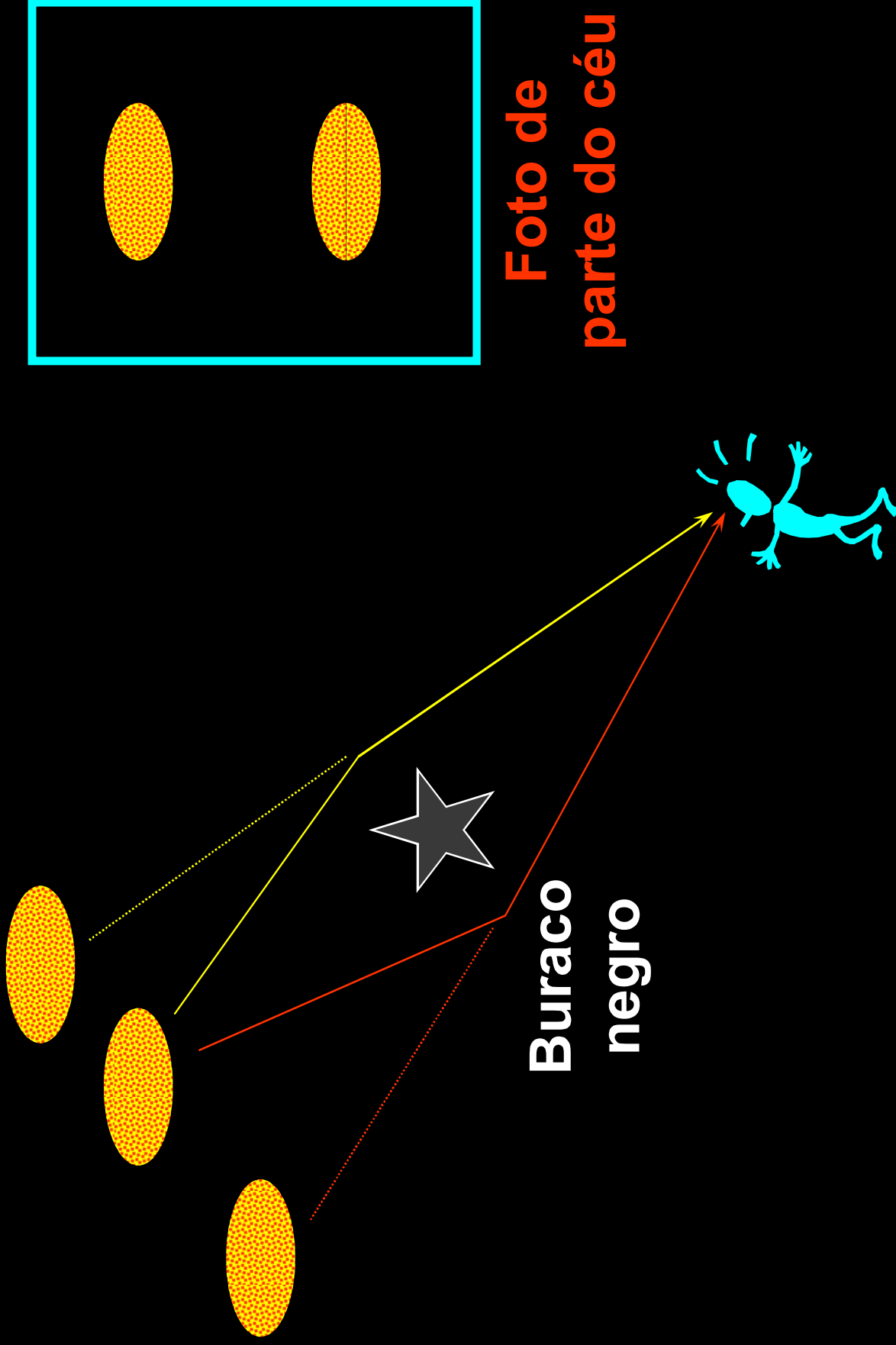
Geodésicas
retilíneas

Universo
não vazio

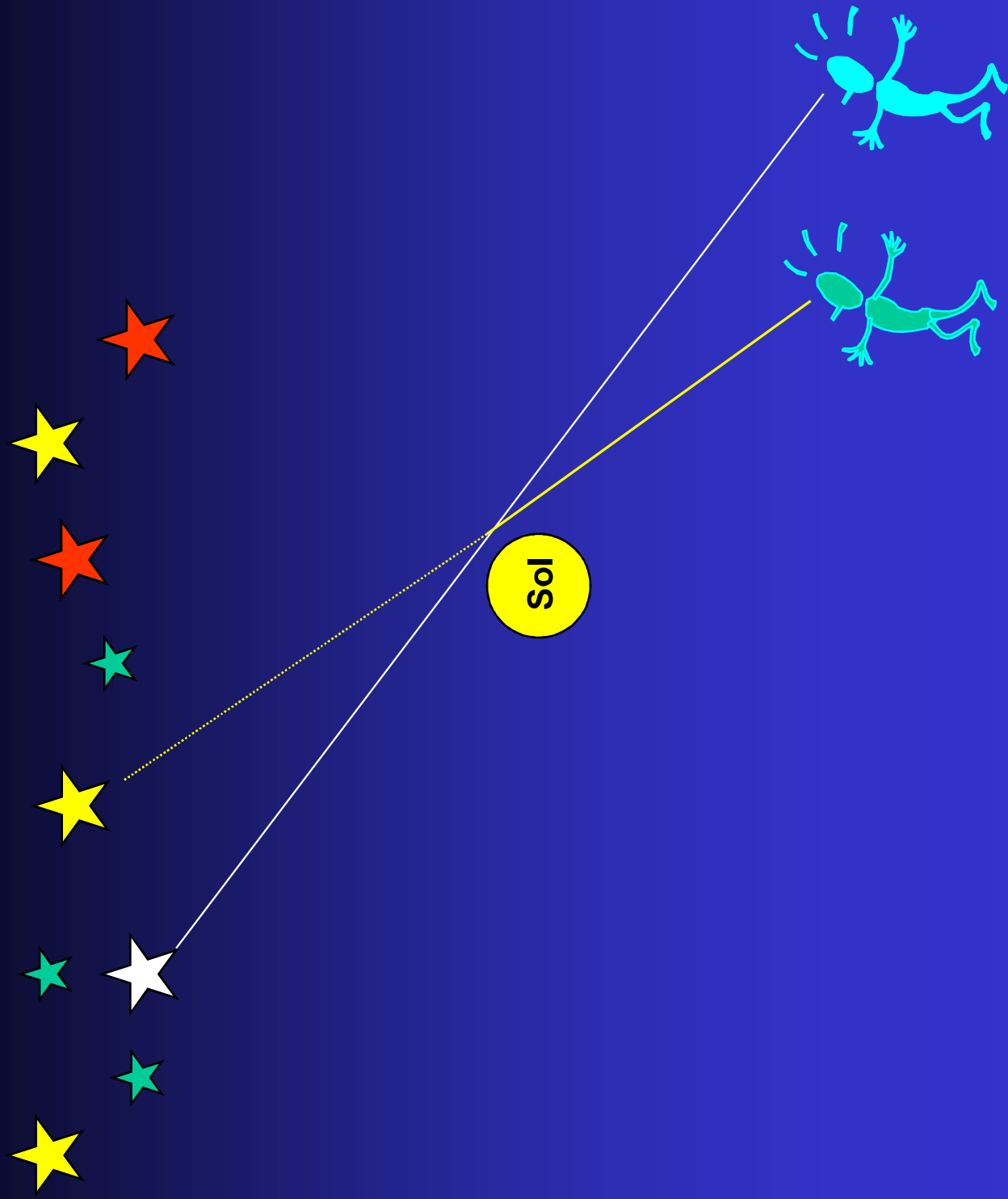


Geodésicas
curvas

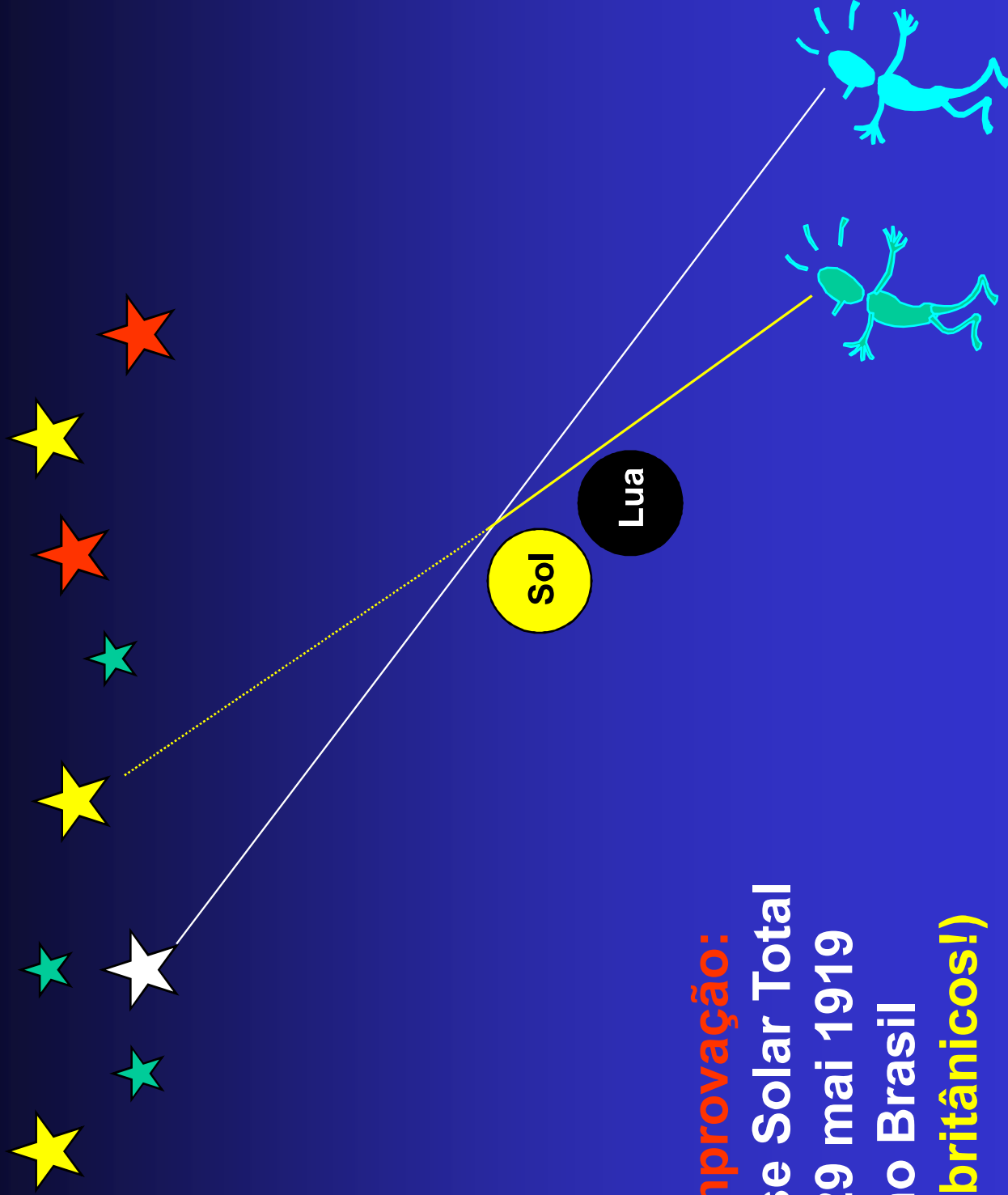
Lente Gravitacional



Deflexão da luz

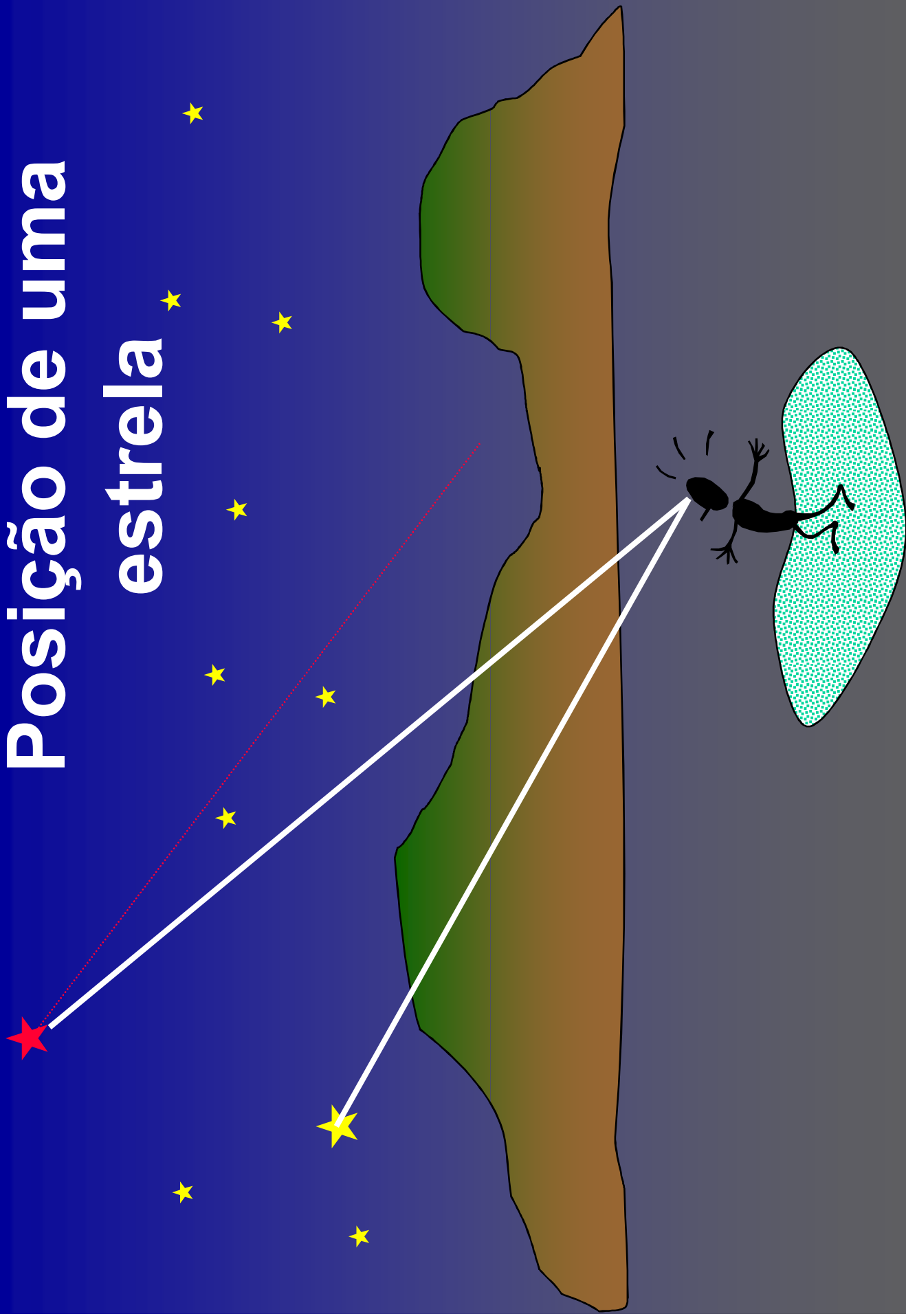


Deflexão da luz

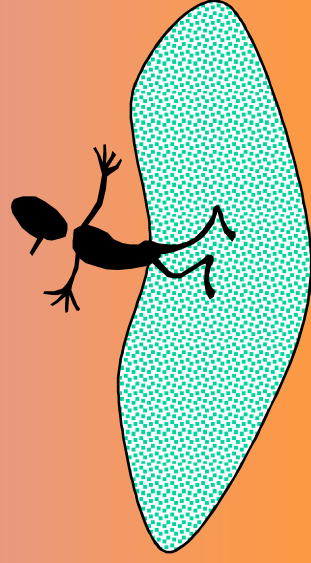
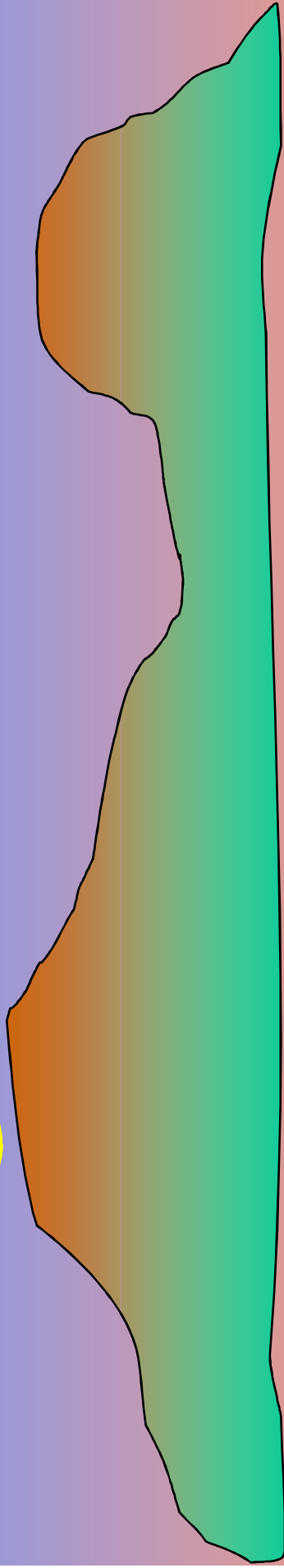


Comprovação:
Eclipse Solar Total
de 29 mai 1919
no Brasil
(por britânicos!)

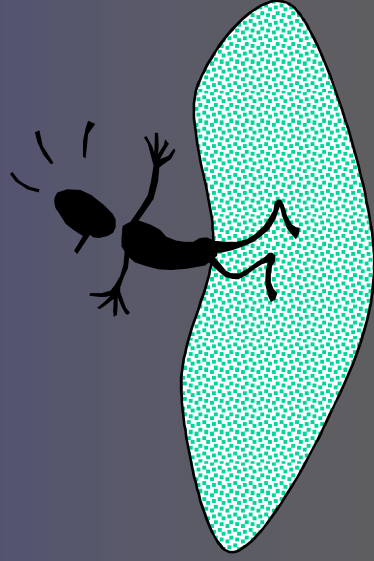
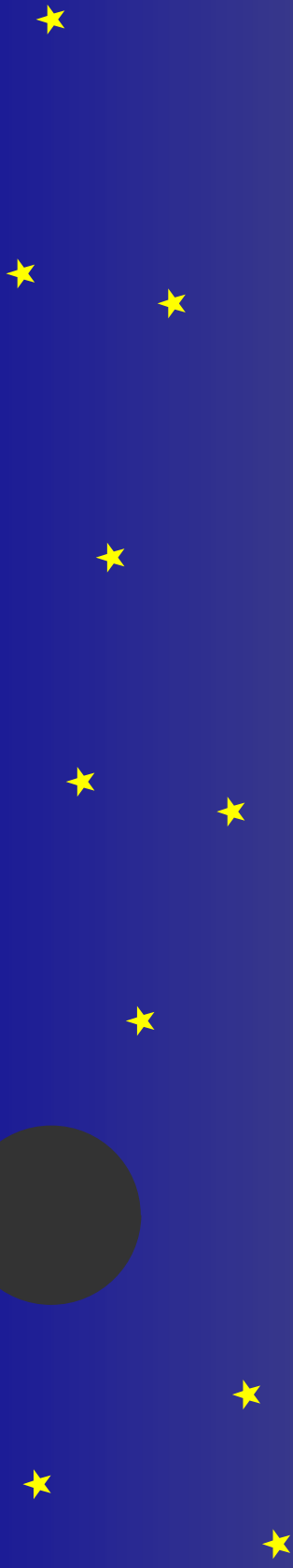
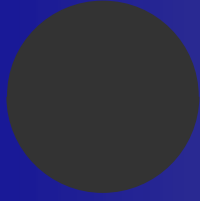
Posição de uma estrela



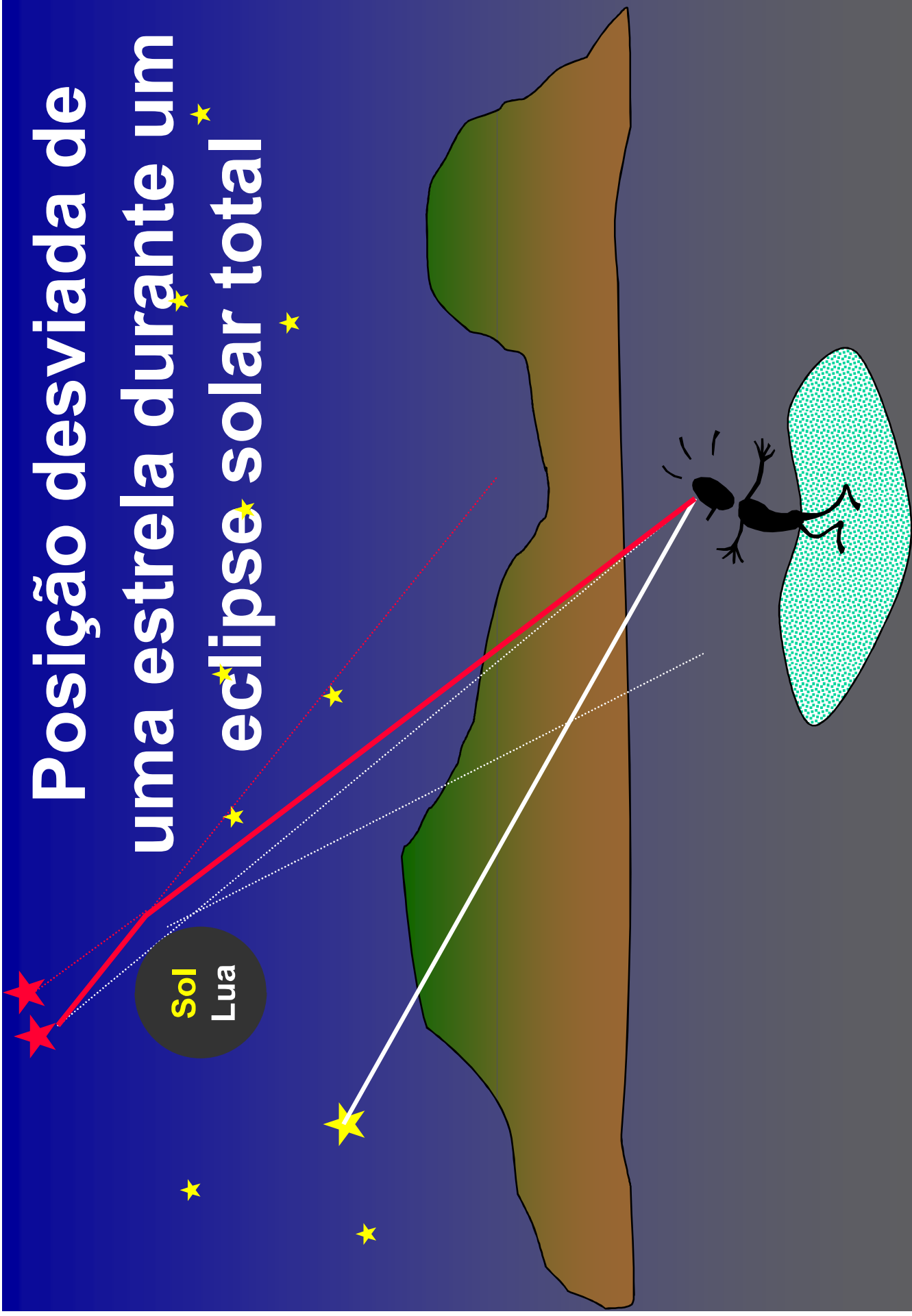
Sol visto no céu



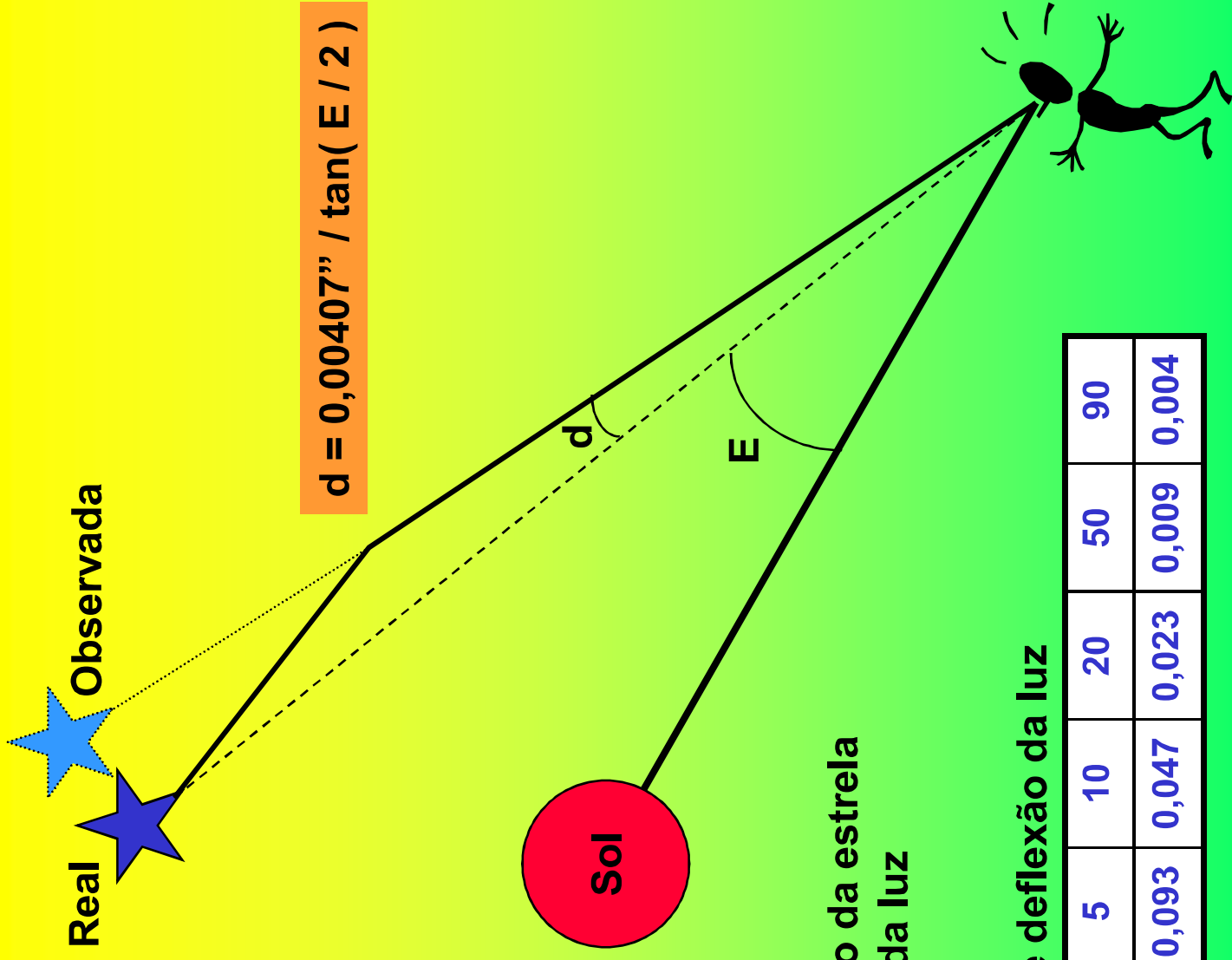
Eclipse Solar Total



Posição desviada de uma estrela durante um eclipse solar total



Deflexão da luz nas proximidades do Sol



E = elongação da estrela
d = deflexão da luz

Alguns valores de deflexão da luz

E (°)	0,25	0,5	1	2	5	10	20	50	90
d (")	1,866	0,933	0,466	0,233	0,093	0,047	0,023	0,009	0,004

Arquivo de eclipses

Canon der Finsternisse

Theodor von Oppolzer
(1841-1886)

Eclipses do Sol e da Lua
desde 1207 a 2161

(sem penumbrais da Lua)

Fifim