

The background of the slide is a vibrant, multi-colored image of the Orion nebula, showing intricate patterns of gas and dust in shades of red, blue, and purple. The text is overlaid on a semi-transparent white rectangular box.


Η Κοσμική Κλίμακα Αποστάσεων

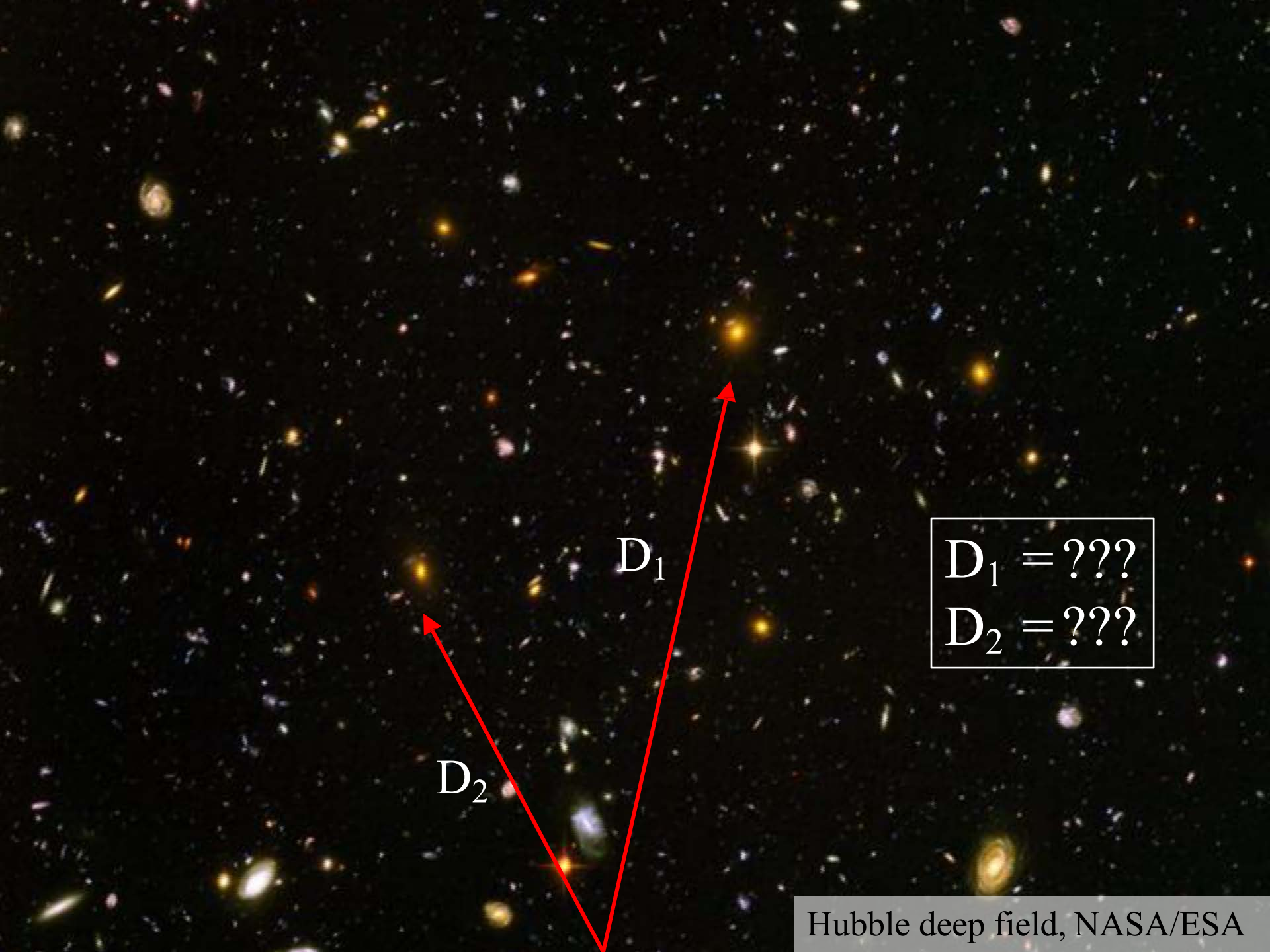
Θέμος Κάλλος μέσω Terence Tao

A collage of planets from the solar system. At the top left is a small orange planet (Mercury). Next to it is Earth, showing blue oceans and white clouds. To the right is Mars, a reddish-orange planet with white polar ice caps. Below Mars is Jupiter, a large planet with prominent horizontal bands of orange, white, and brown. In the foreground, Saturn is shown with its iconic rings. At the bottom are two blue planets (Uranus and Neptune).

Αστρομετρία

Solar system montage, NASA/JPL


- 
- Πόσο μεγάλη είναι η Γη;
 - Πόσο μακριά είναι η σελήνη;
 - Πόσο μακριά είναι ο ήλιος;
 - Πόσο μακριά είναι οι άλλοι πλανήτες;
 - Πόσο μακριά είναι τα άστρα;
 - Πόσο μεγάλος είναι ο Γαλαξίας μας;
 - Πόσο μακριά είναι οι άλλοι Γαλαξίες;



D_1

D_2

$D_1 = ???$
 $D_2 = ???$

- 
- A collage of celestial bodies including Mars, Earth, Jupiter, Saturn, and Uranus. The background is black, and the planets are arranged in a circular pattern. The text is overlaid on a semi-transparent white box in the center.
- Πόσο μακριά είναι οι άλλοι Γαλαξίες;
 - Πόσο μεγάλος είναι ο Γαλαξίας μας;
 - Πόσο μακριά είναι τα άστρα;
 - Πόσο μακριά είναι οι άλλοι πλανήτες;
 - Πόσο μακριά είναι ο ήλιος;
 - Πόσο μακριά είναι η σελήνη;
 - Πόσο μεγάλη είναι η Γη;



**1^ο Σκαλοπάτι
η Γη**

240 πX



7°
5000 στάδια
Αλεξάνδρια
Συένη




$$2\pi r * 7^\circ / 360^\circ = 5000 \text{ στάδια}$$

$$r=40000 \text{ στάδια}$$



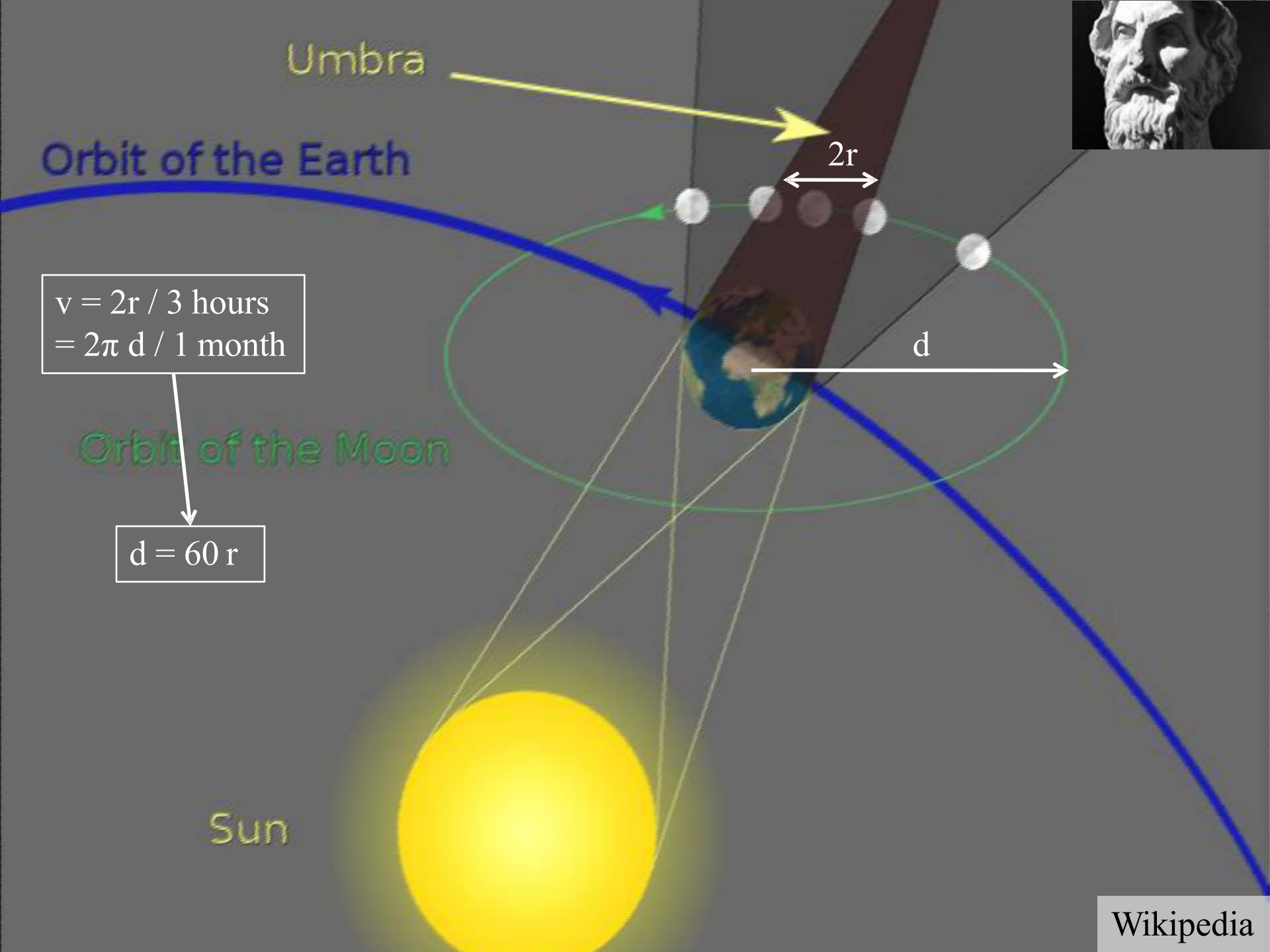
**2^ο Σκαλοπάτι
η Σελήνη**

270 πX

- 
- Τι σχήμα έχει;
 - Πόσο μεγάλη είναι;
 - Πόσο μακριά είναι;



György Soponyai





$$V = 2R / 2 \text{ min} \\ = 2\pi d / 24 \text{ hours}$$

$$R = d / 180 \\ = r / 3$$

$2R$




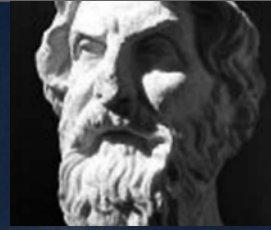
Moonset over the Colorado Rocky Mountains,
Sep 15 2008, Alek Kolmarnitsky 008-www.ko



**3^ο Σκαλοπάτι
ο Ήλιος**

270 πX

- 
- **Πόσο μεγάλος είναι ο Ήλιος;
Πόσο μακριά είναι ο Ήλιος;**



2017 Total Solar Eclipse, Jerry Lodriguss

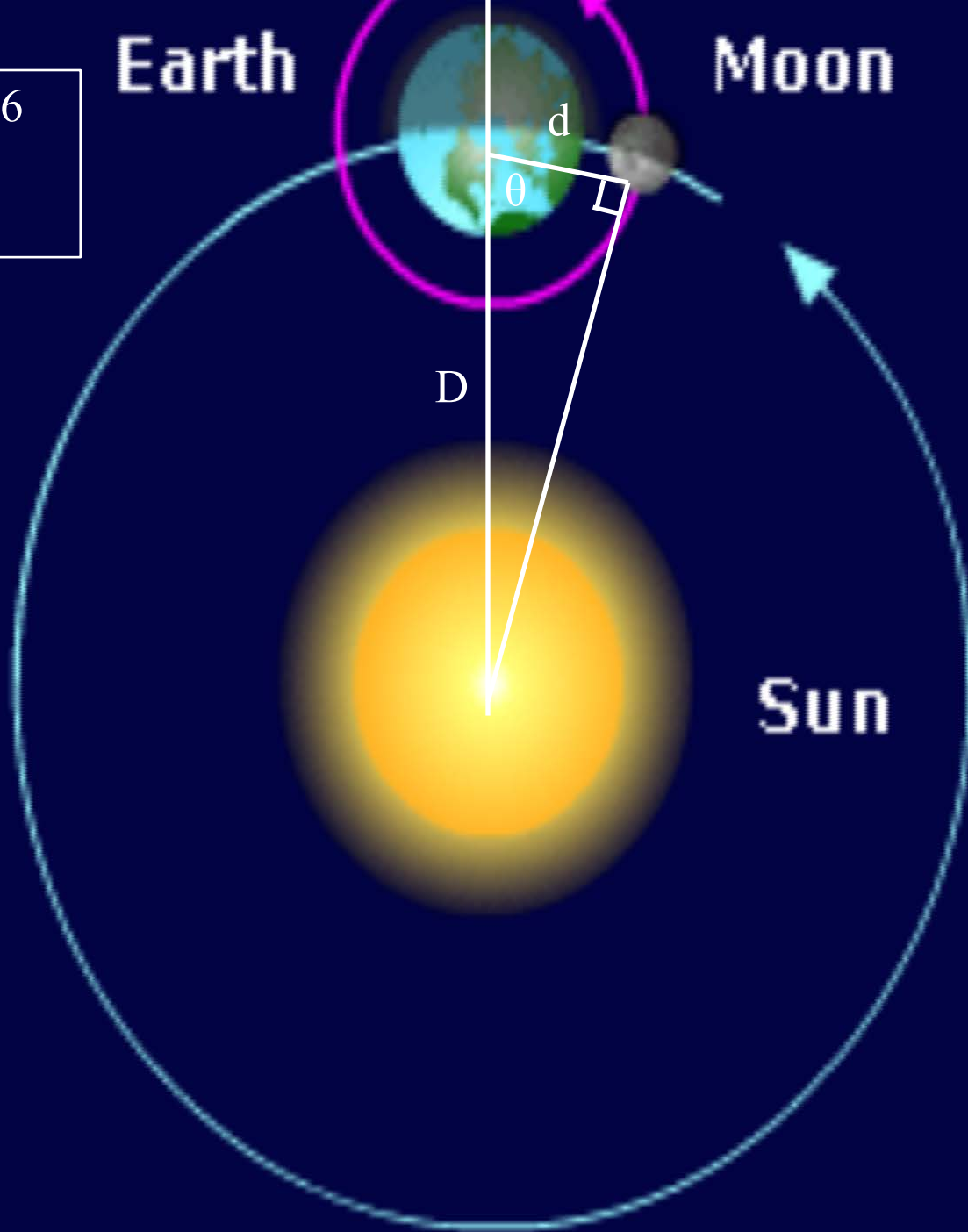


Earth

Moon

$$\theta = \pi/2 - 2\pi * 6 \text{ hours} / 1 \text{ month}$$
$$\cos \theta = d/D$$

$$D = 20 d$$



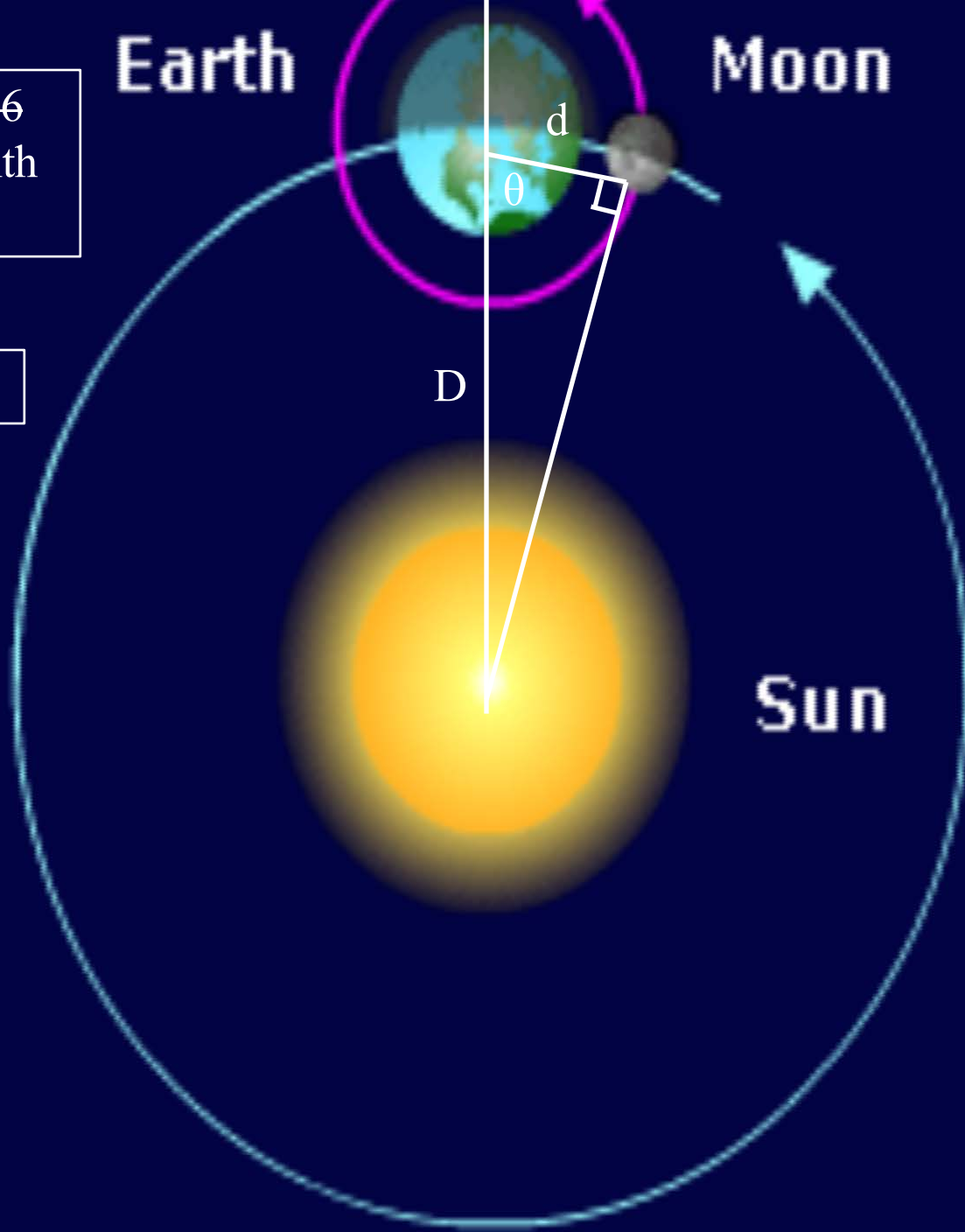


Earth

Moon

$$\theta = \pi/2 - 2\pi * \epsilon$$
$$0.5 \text{ hour}/1 \text{ month}$$
$$\cos \theta = d/D$$

$$D = 20\,390 d$$



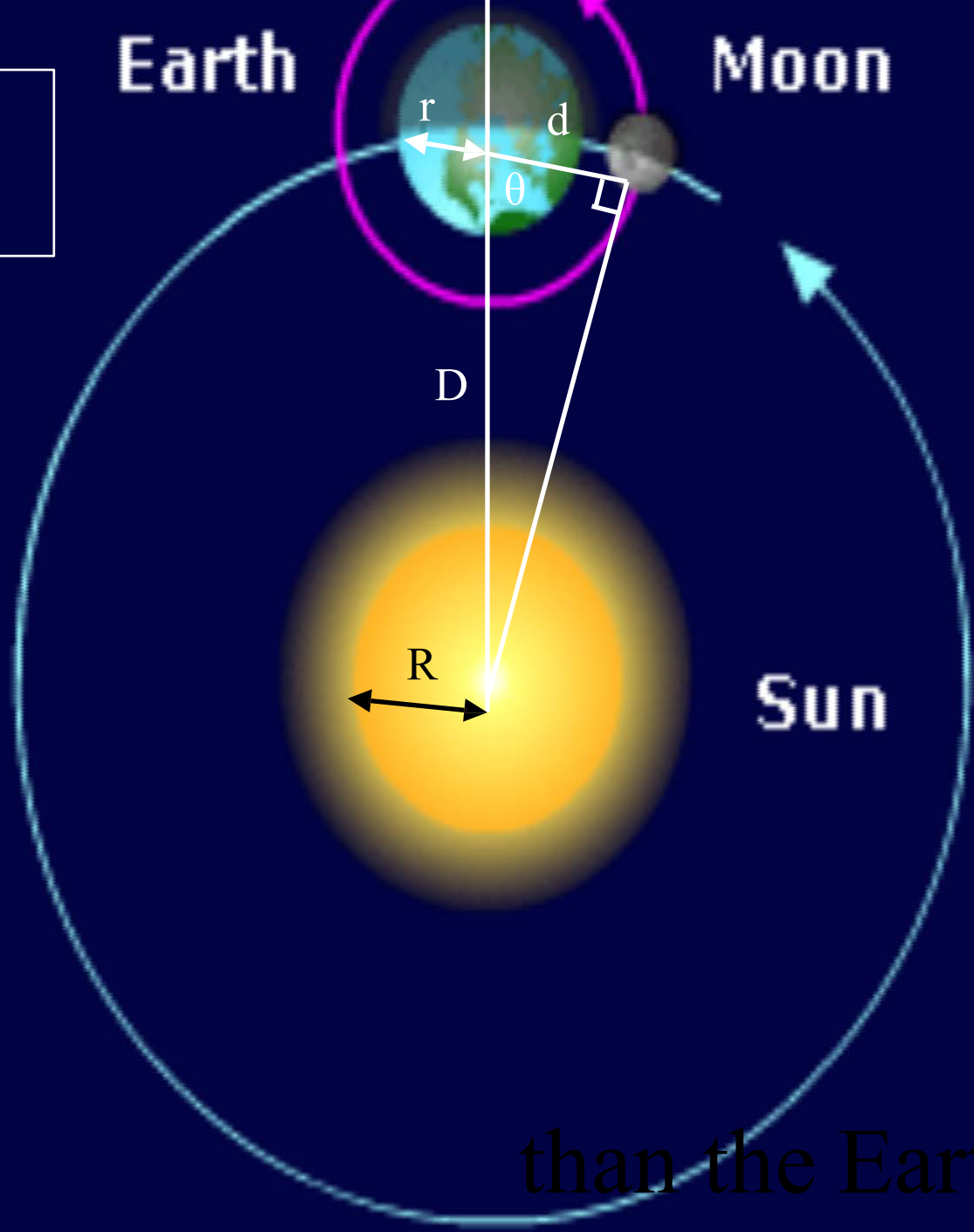


Earth

Moon

$$\begin{aligned}d &= 60 r \\ D/d &= 20 \\ R/D &= 1/180\end{aligned}$$

$$R \sim 7 r$$

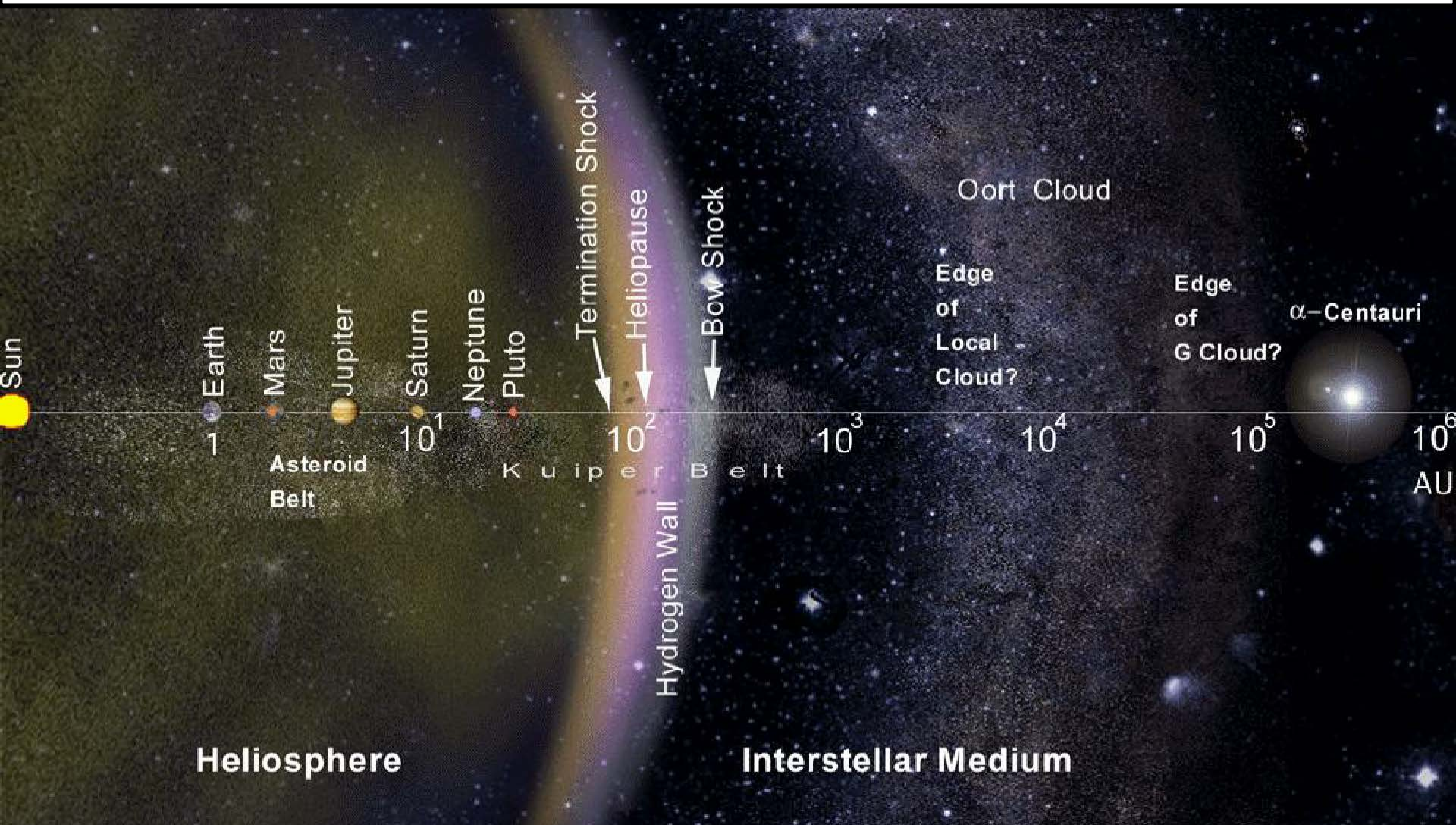



than the Earth.



 ← **Approx. size of Earth**


Η Αστρονομική Μονάδα (AU)






**4^ο Σκαλοπάτι
Οι Πλανήτες**

1543

- 
- Πόσο μακριά είναι οι πλανήτες;
 - Ποιες είναι οι τροχιές τους;



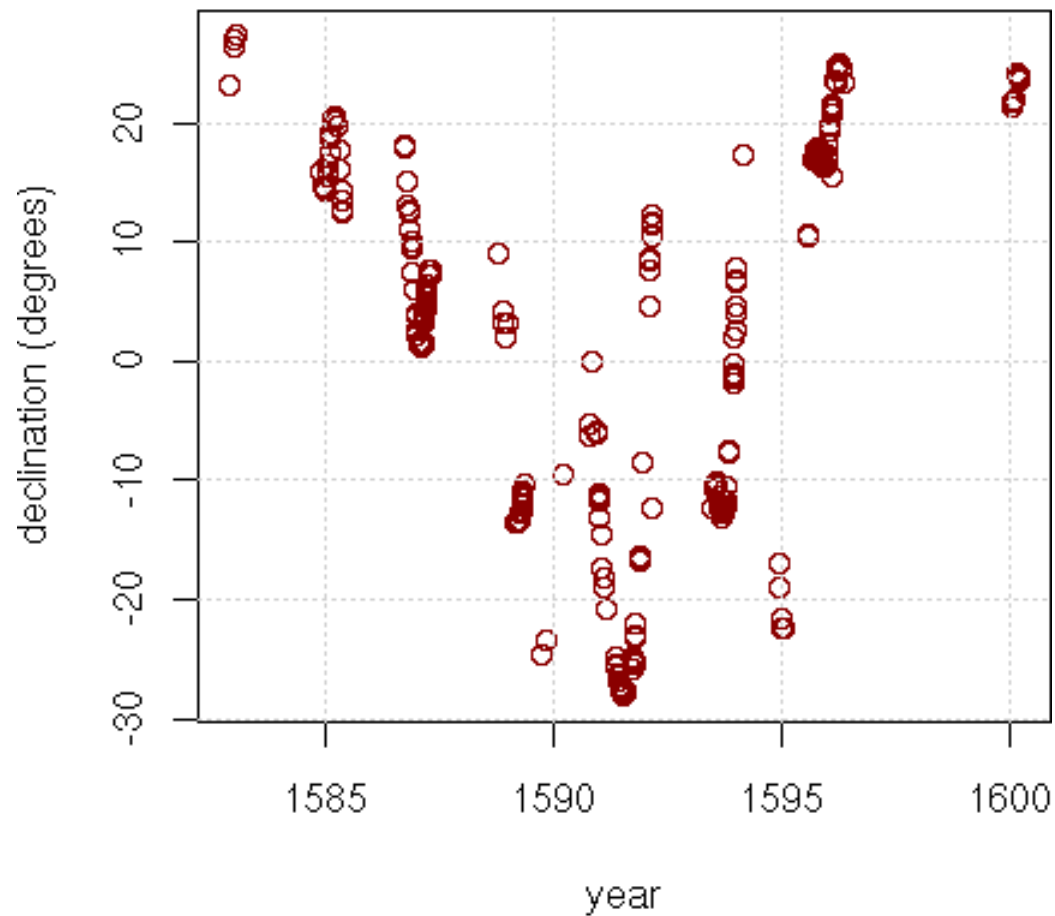
$$\omega_{\text{Earth}} - \omega_{\text{Mars}} = 1/780 \text{ days}$$
$$\omega_{\text{Earth}} = 1/\text{year}$$


$$\omega_{\text{Mars}} = 1/687 \text{ days}$$

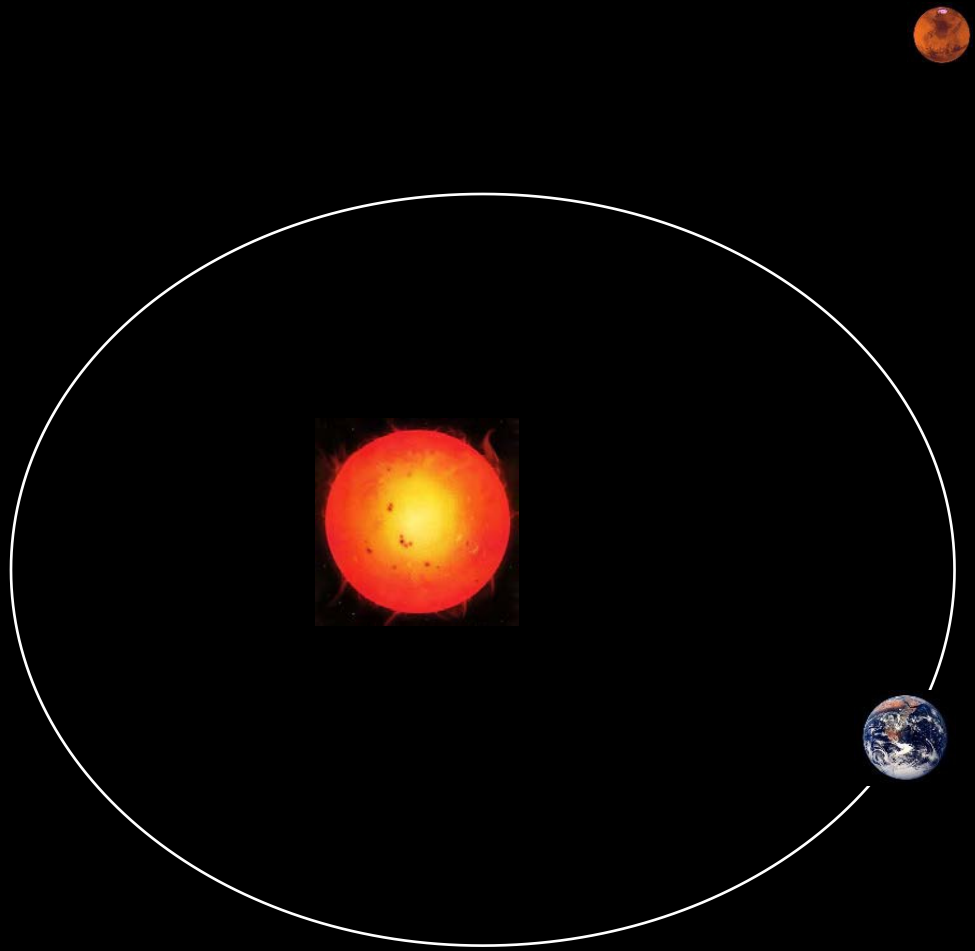
Babylonian world map, 7th-8th century BCE, British Museum

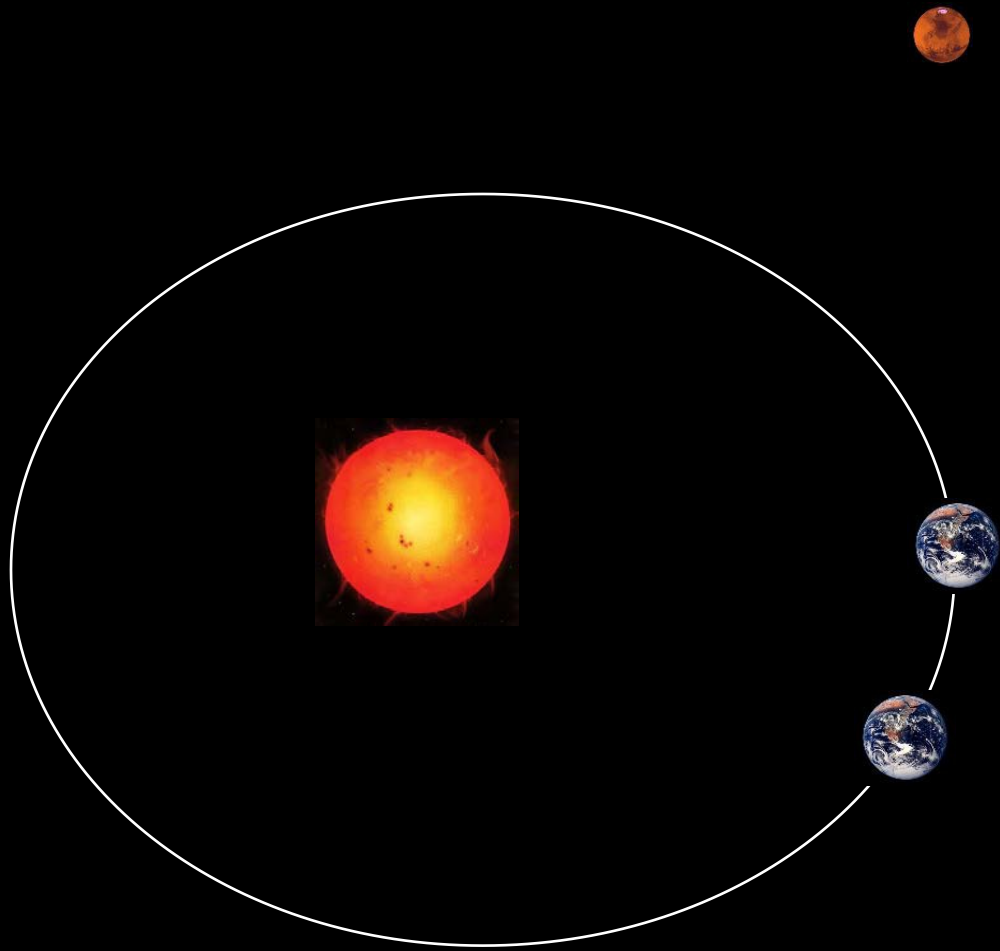


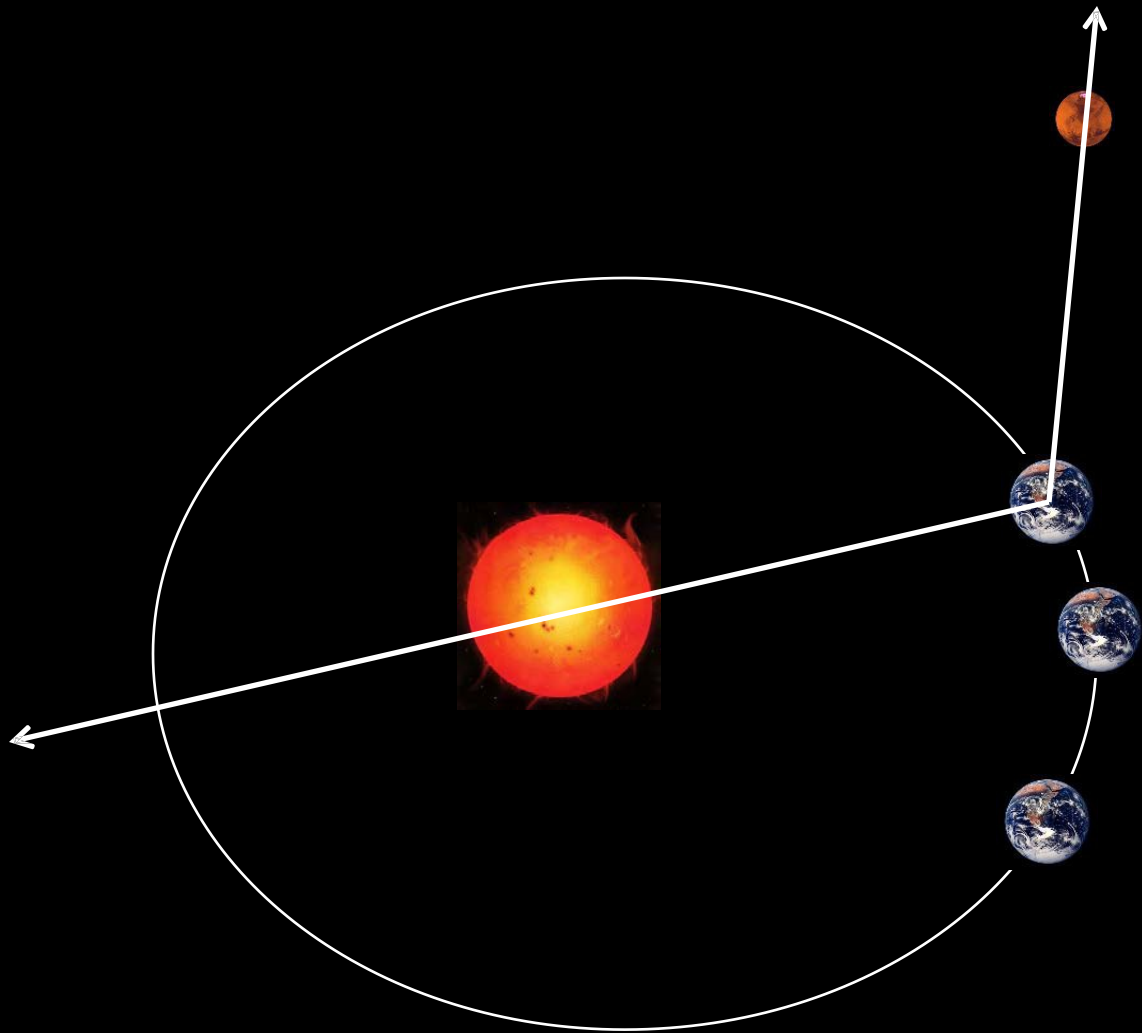
Tycho Brahe's Mars Observations

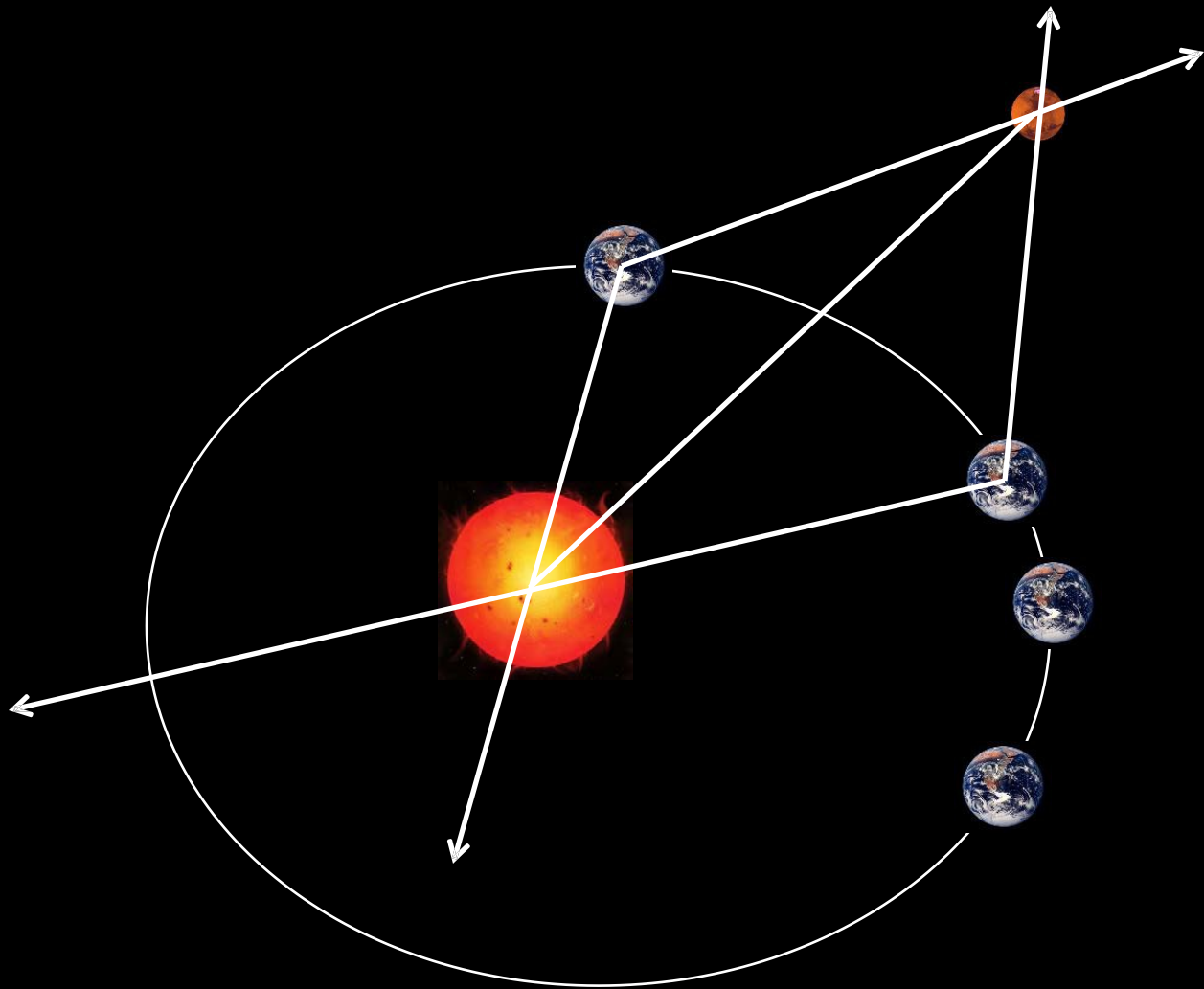


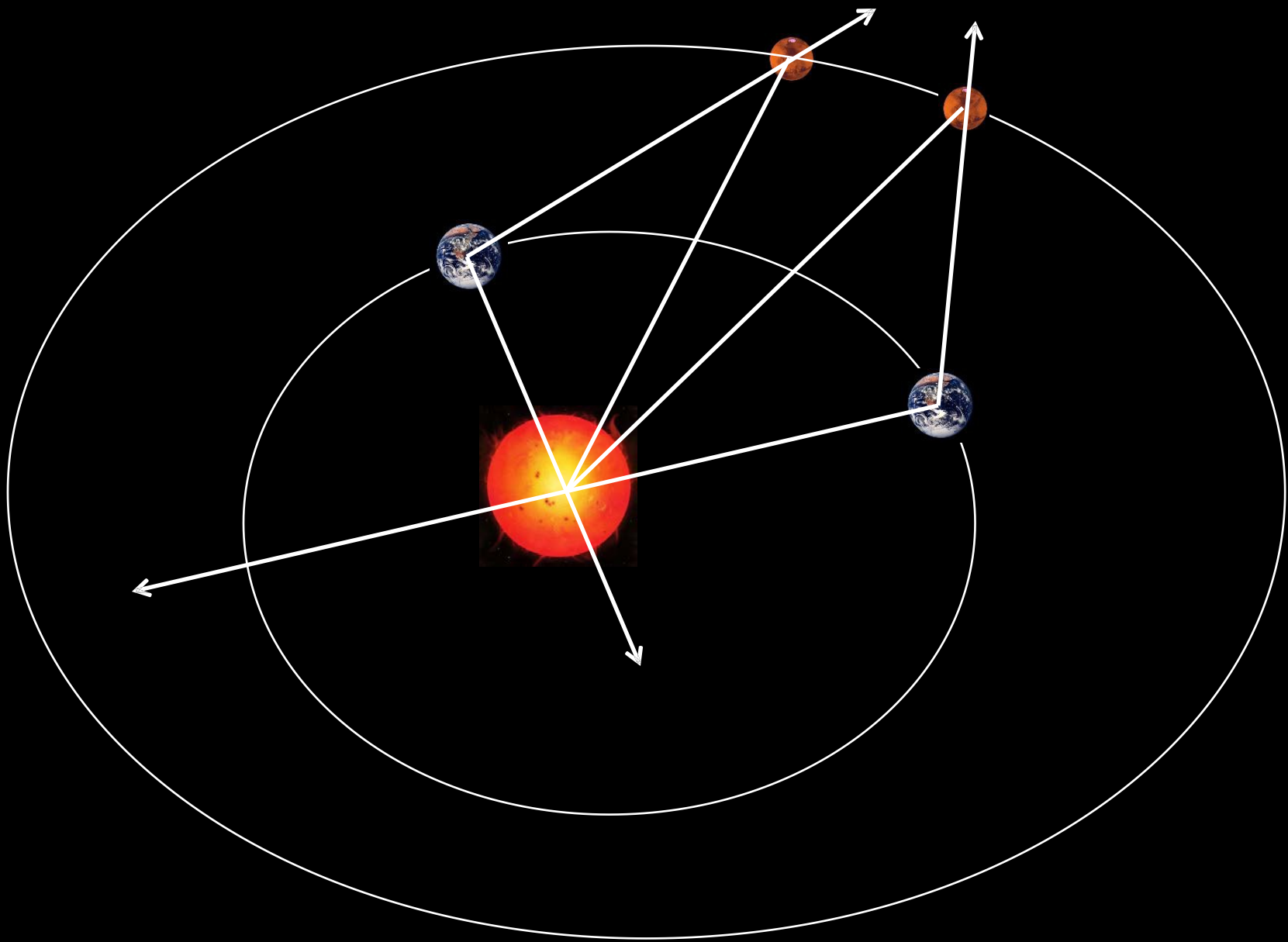
source: Tychonis Brahe Dani Opera Omnia

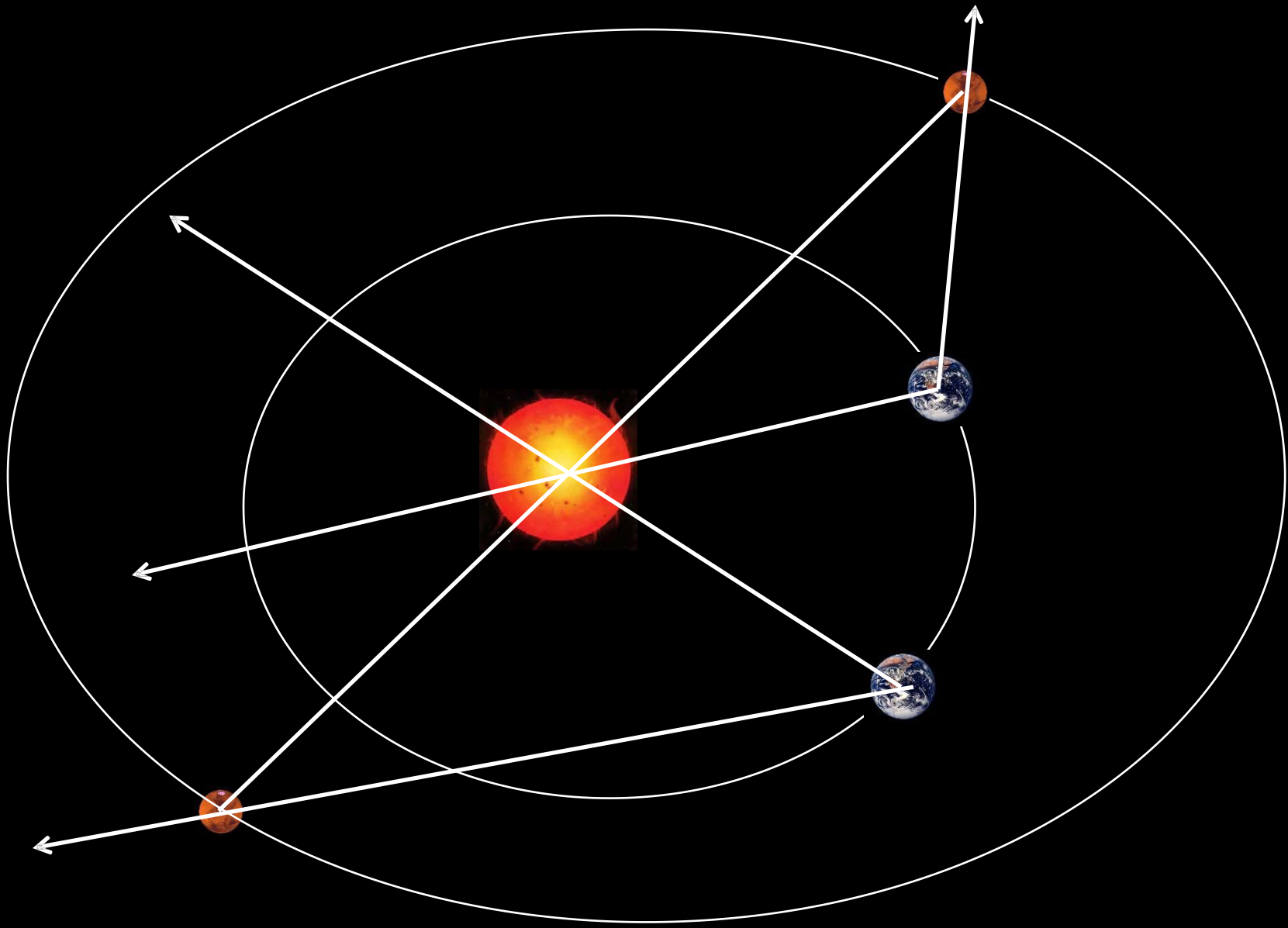


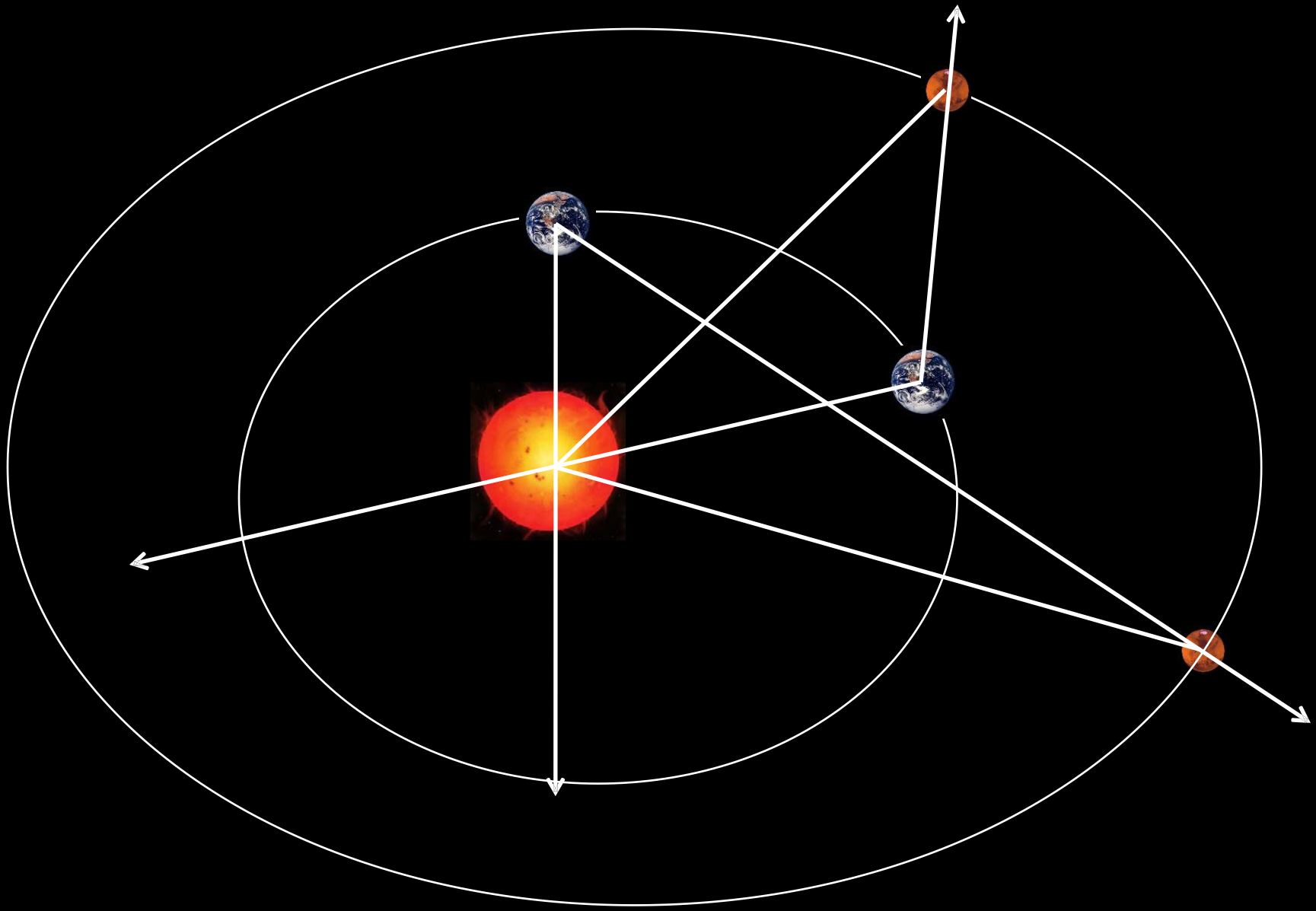


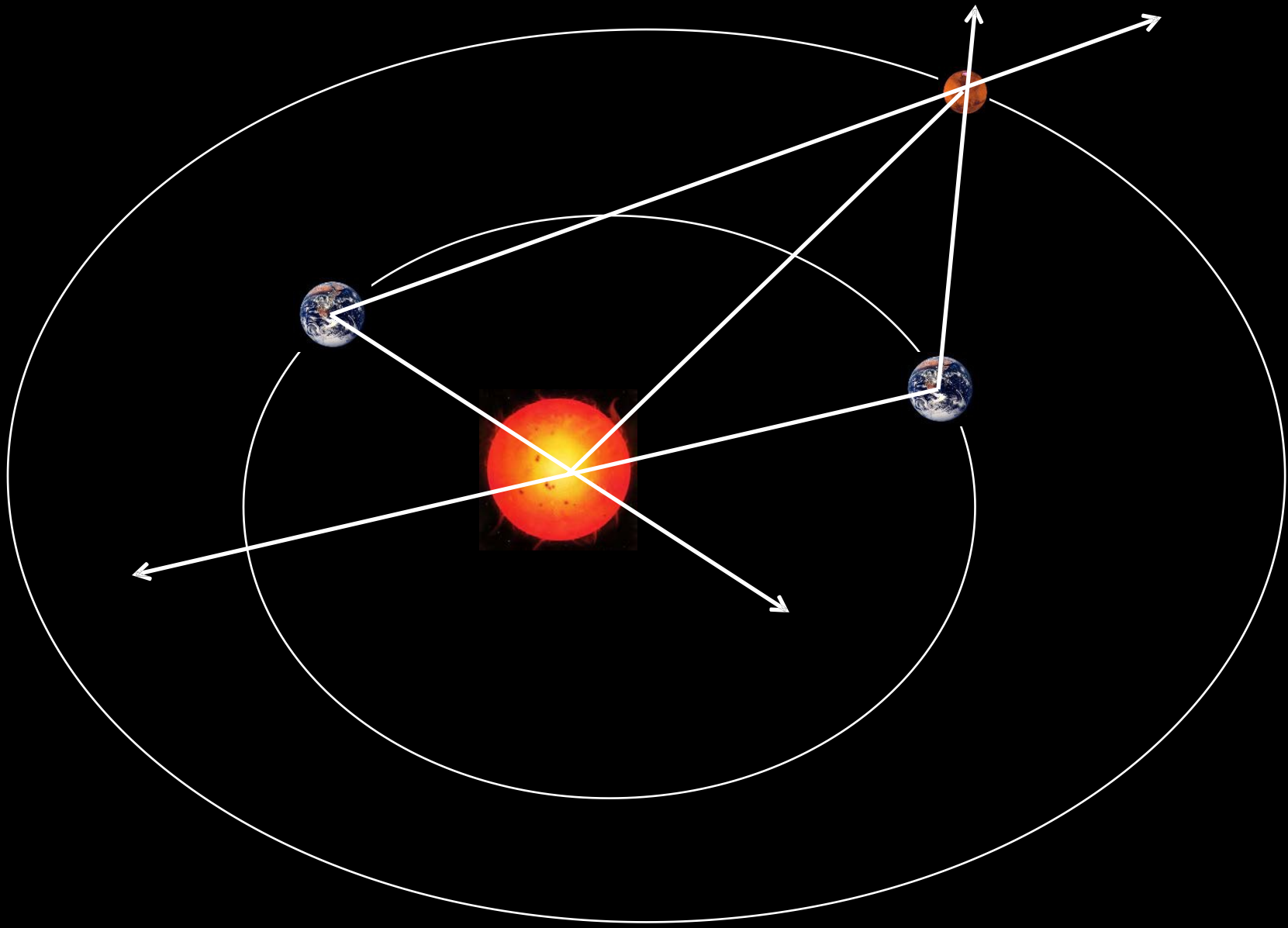


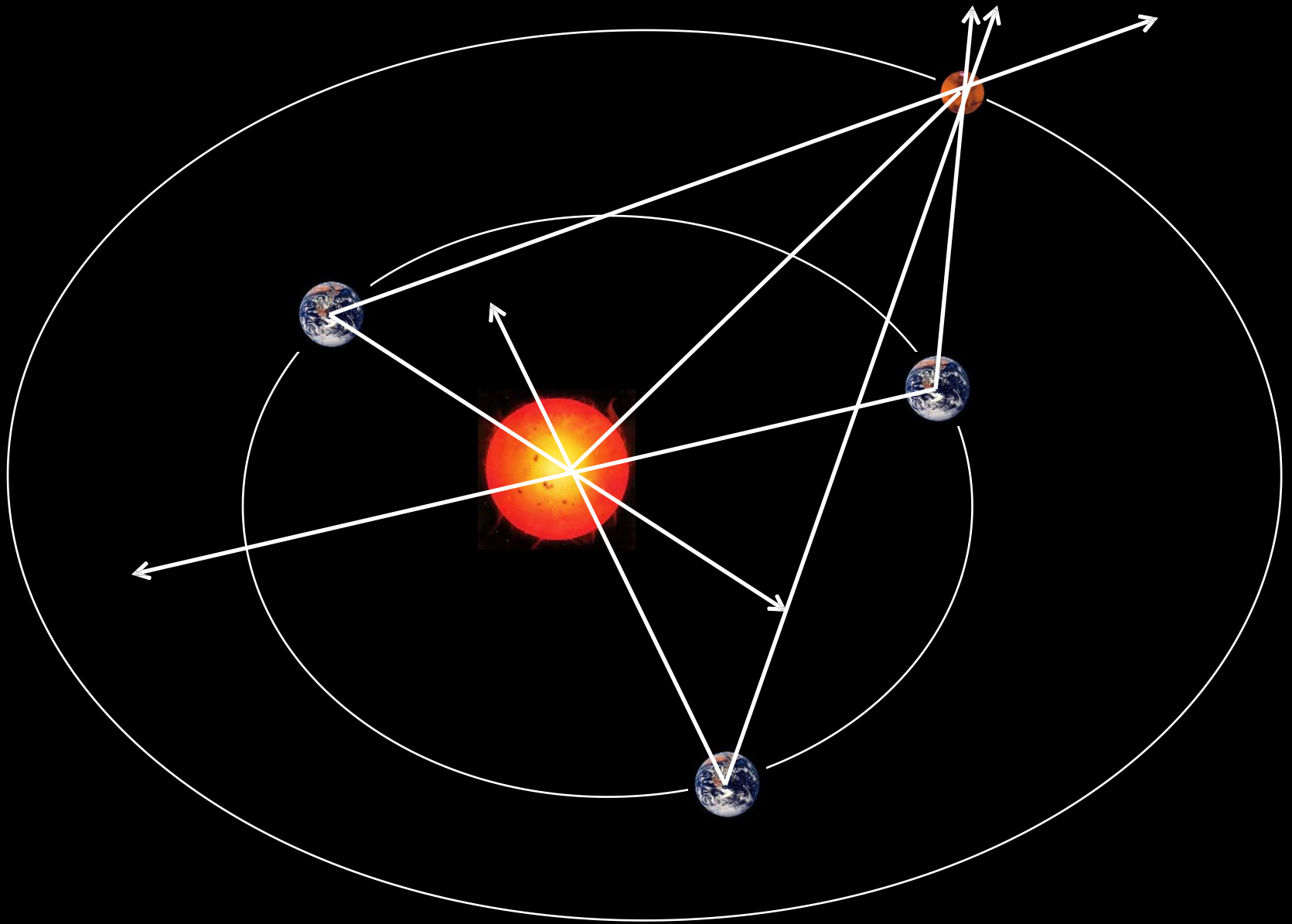


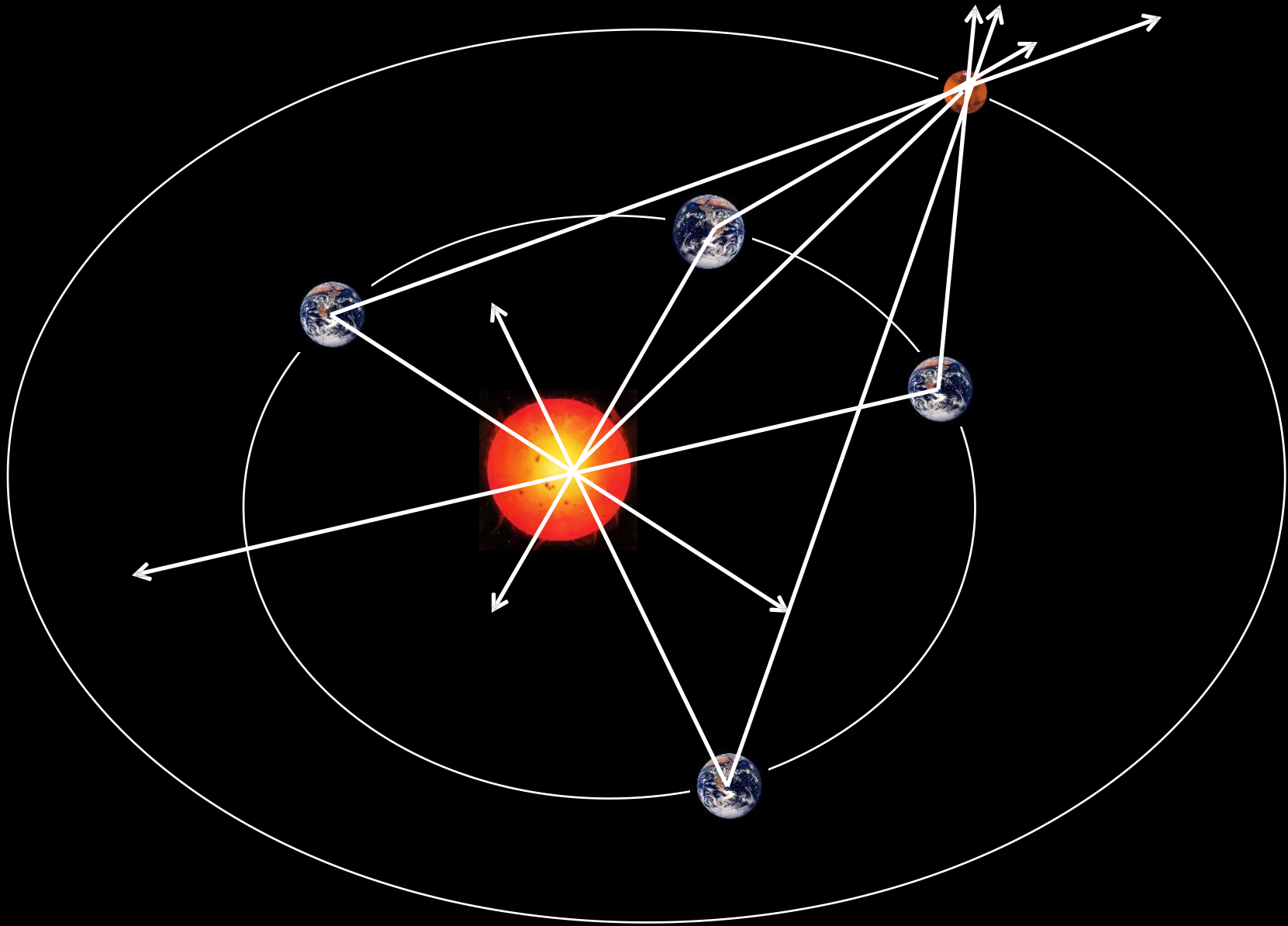


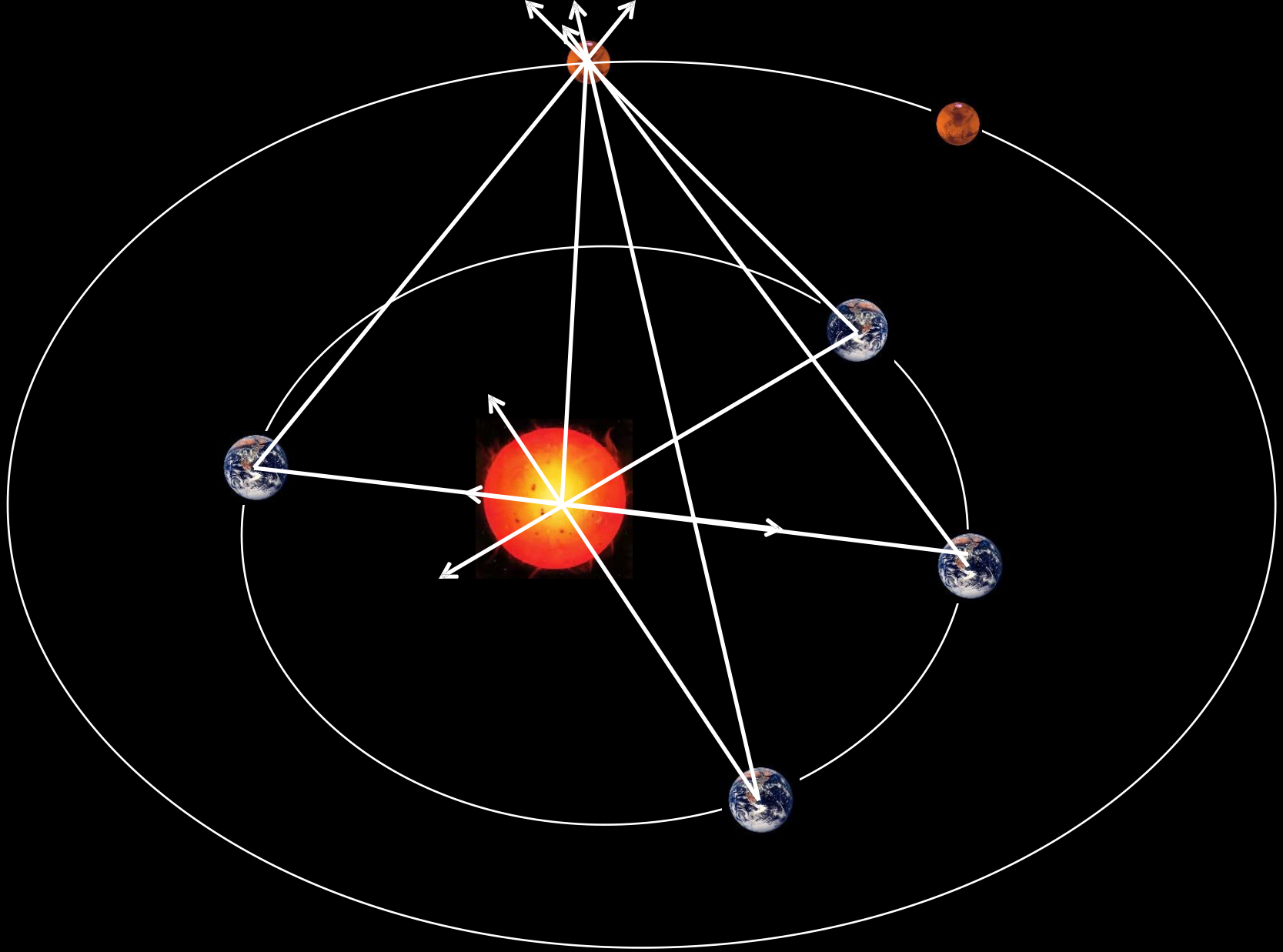


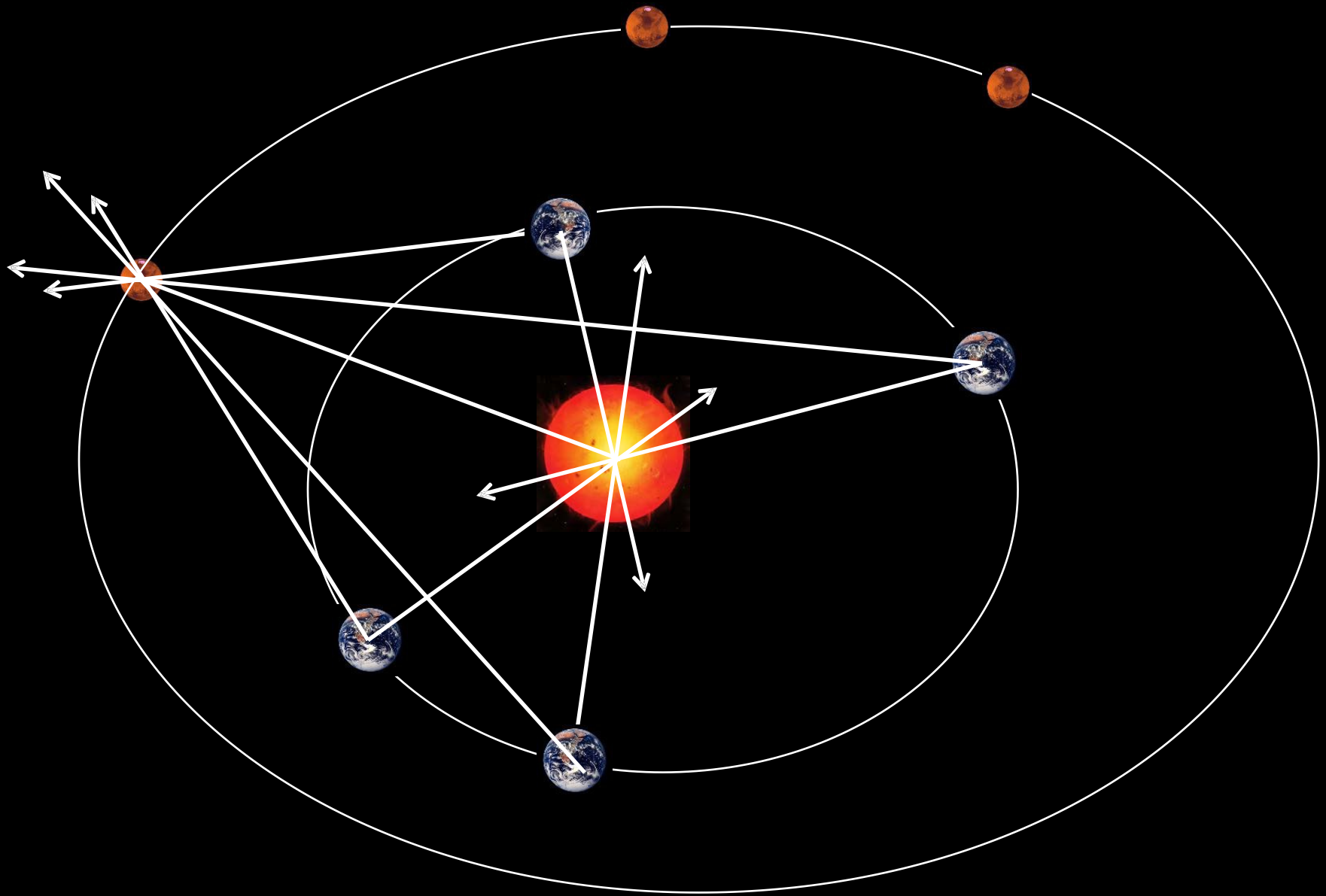












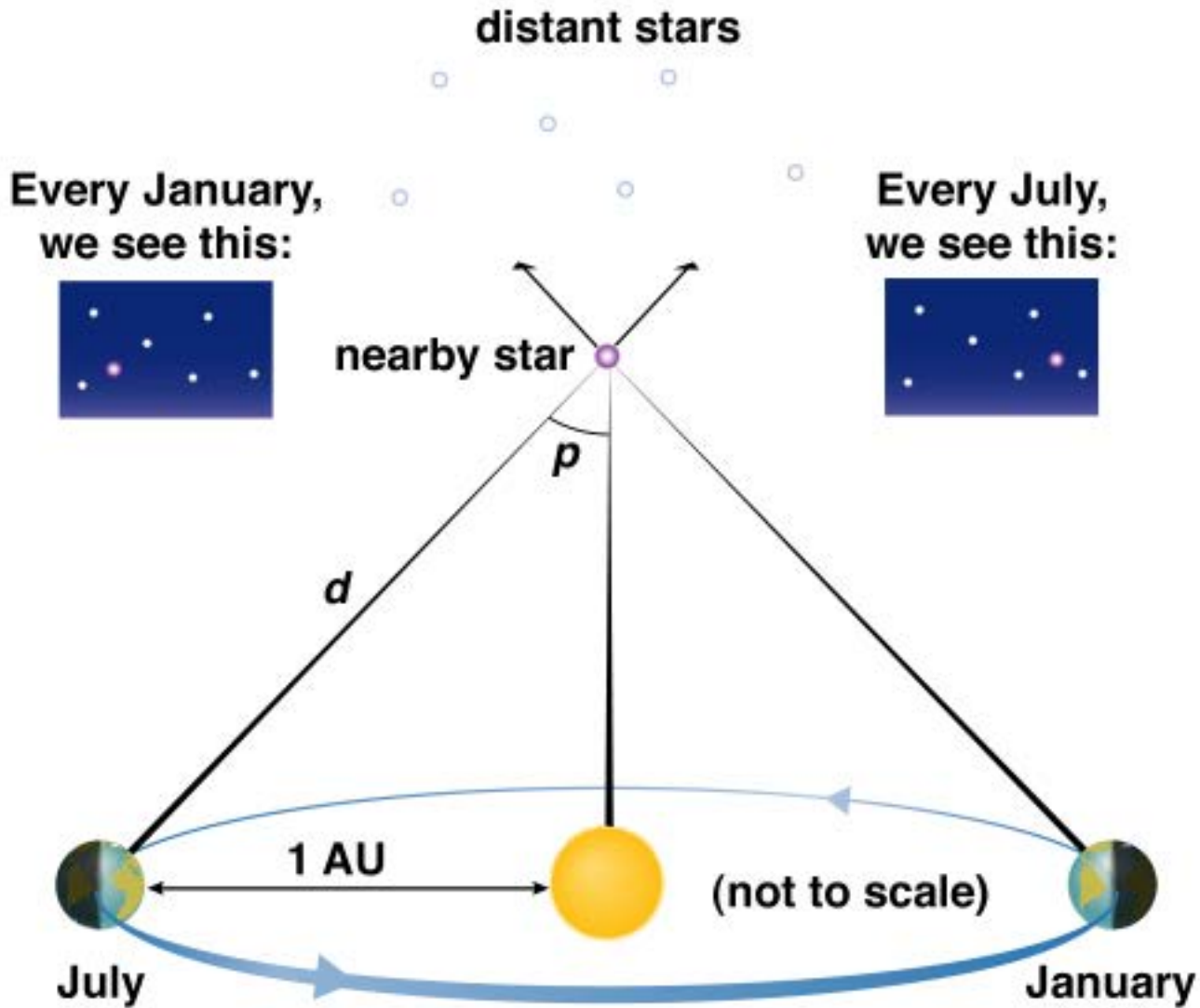


Ερμής: 0.307-0.466 AU
Αφροδίτη: 0.718-0.728 AU
Γη: 0.98-1.1 AU
Άρης: 1.36-1.66 AU
Δίας: 4.95-5.46 AU
Κρόνος: 9.05-10.12 AU
Ουρανός: 18.4-20.1 AU
Ποσειδώνας: 29.8-30.4 AU



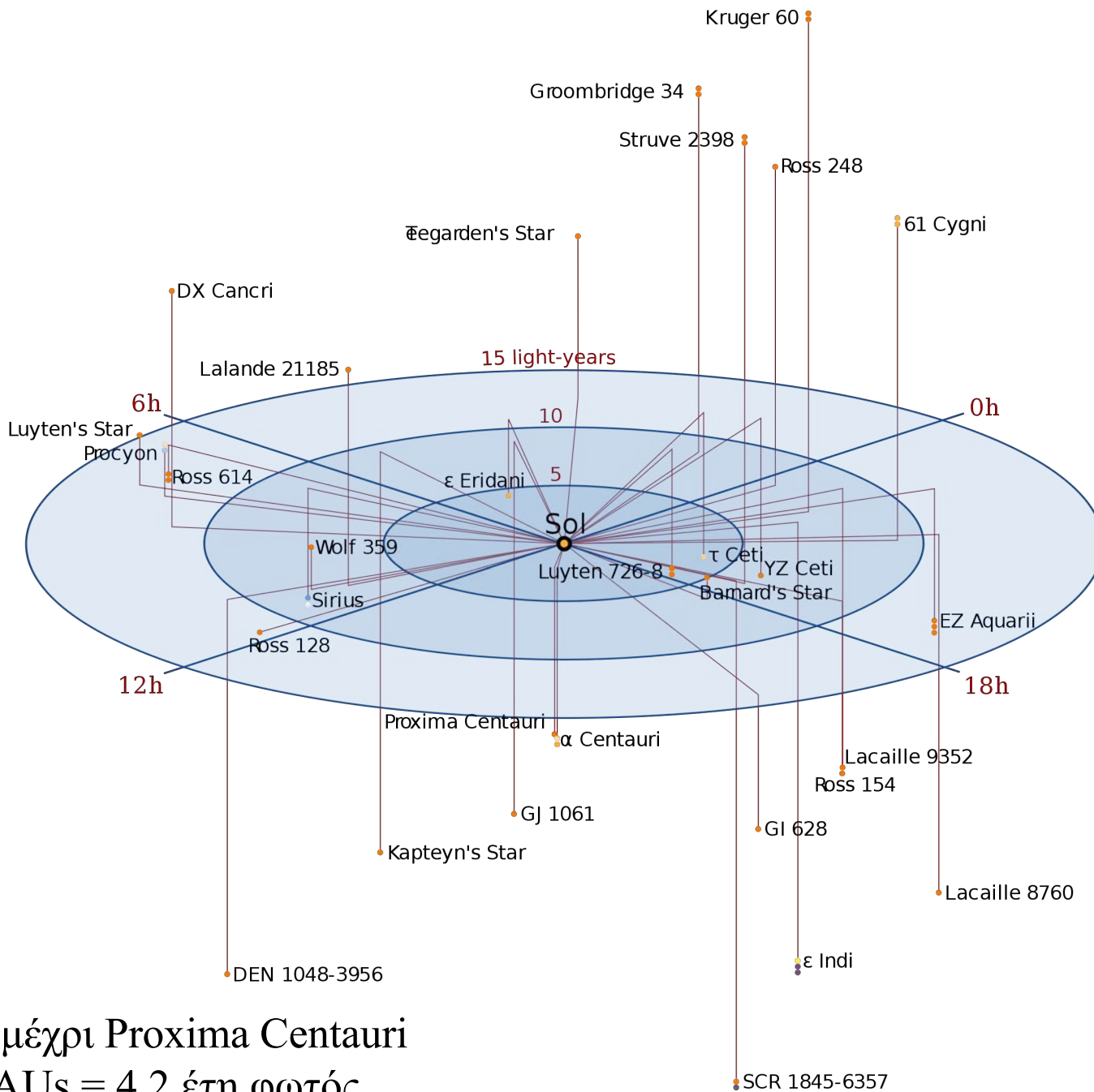
4° Σκαλοπάτι Γειτονικά Άστρα

1838




Copyright © Addison Wesley

From “The Essential Cosmic Perspective”, Bennett et al.

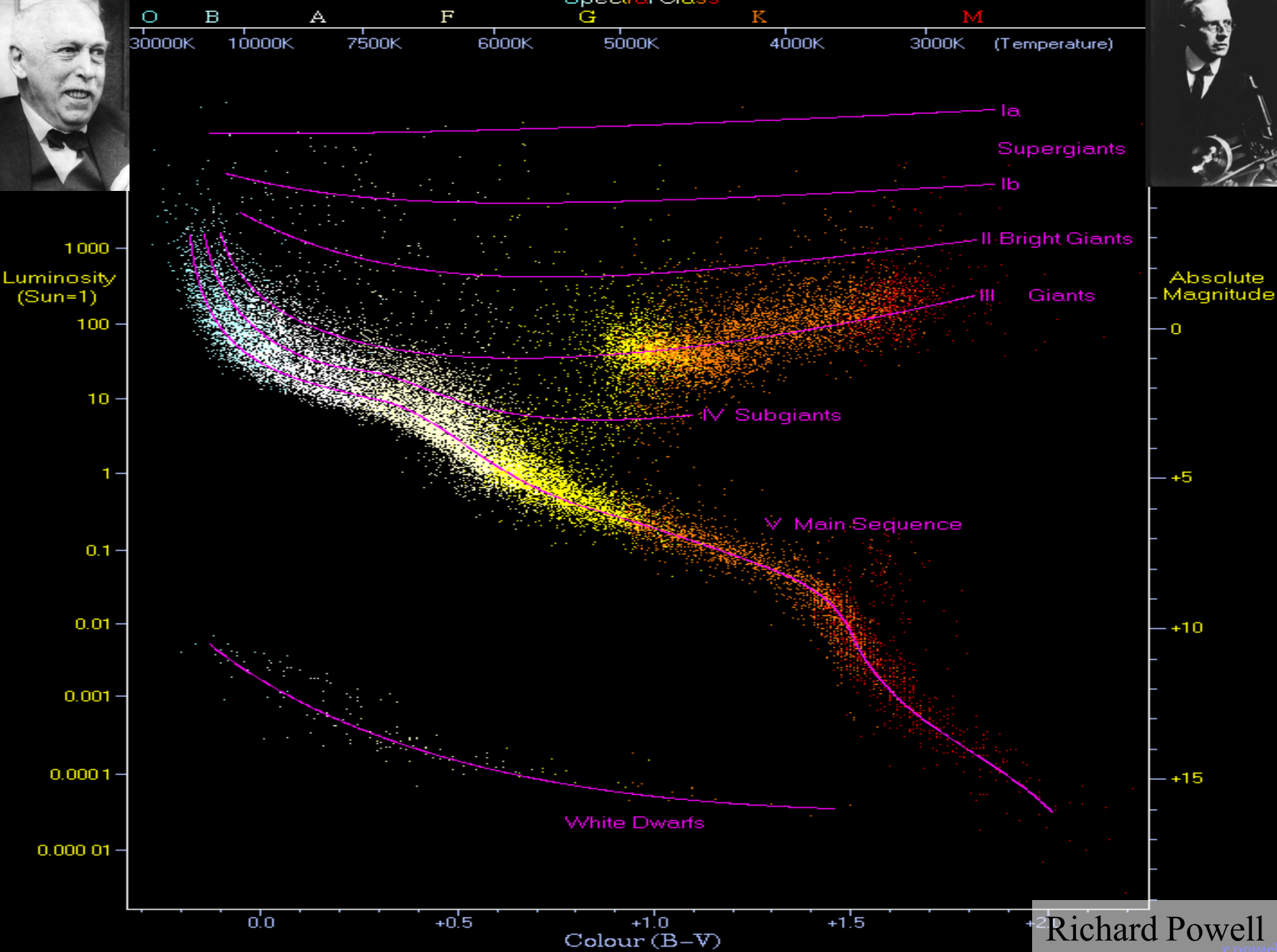


Απόσταση μέχρι Proxima Centauri
= 266,000 AU = 4.2 έτη φωτός

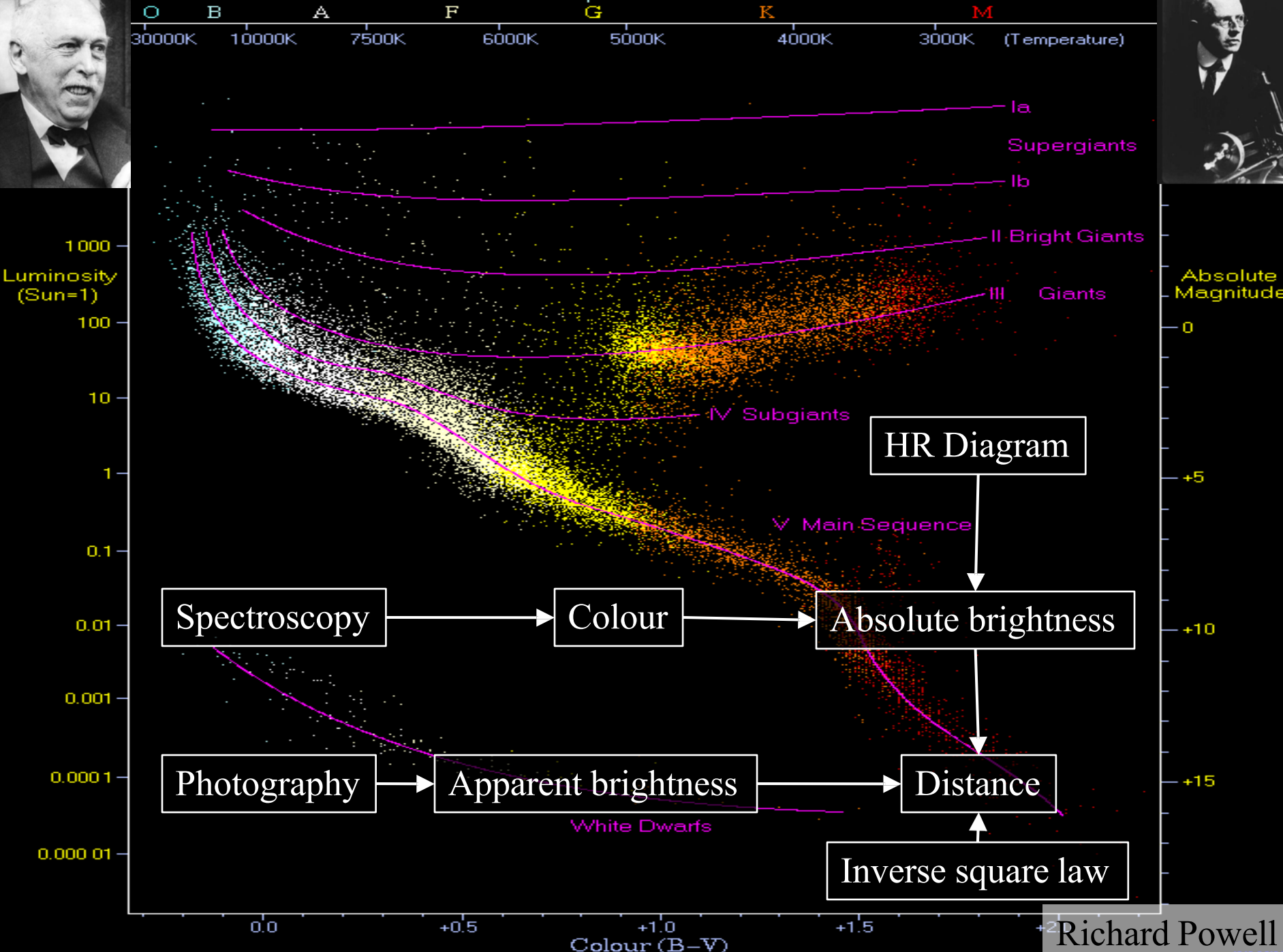
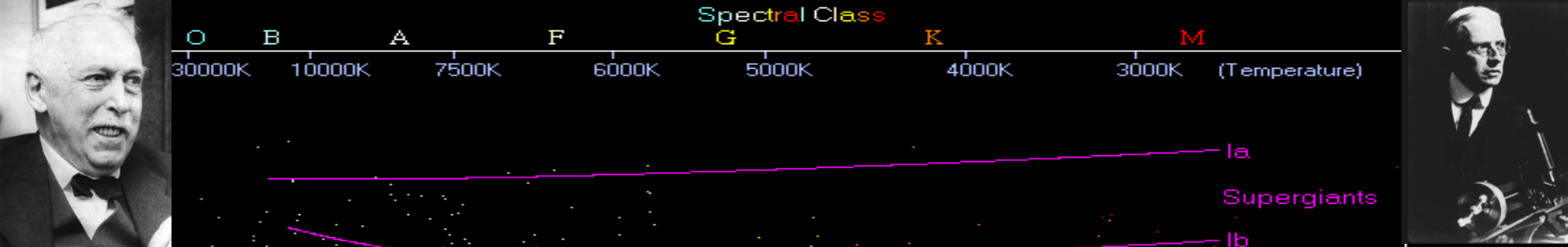



**5^ο Σκαλοπάτι
Ο Γαλαξίας**

1915



Richard Powell
r.powell



A vast field of galaxies, including spiral, elliptical, and irregular shapes, scattered across a dark cosmic background. The galaxies vary in size, color, and orientation, representing a rich population of distant celestial objects.

**6^ο Σκαλοπάτι
Άλλοι Γαλαξίες**

1923

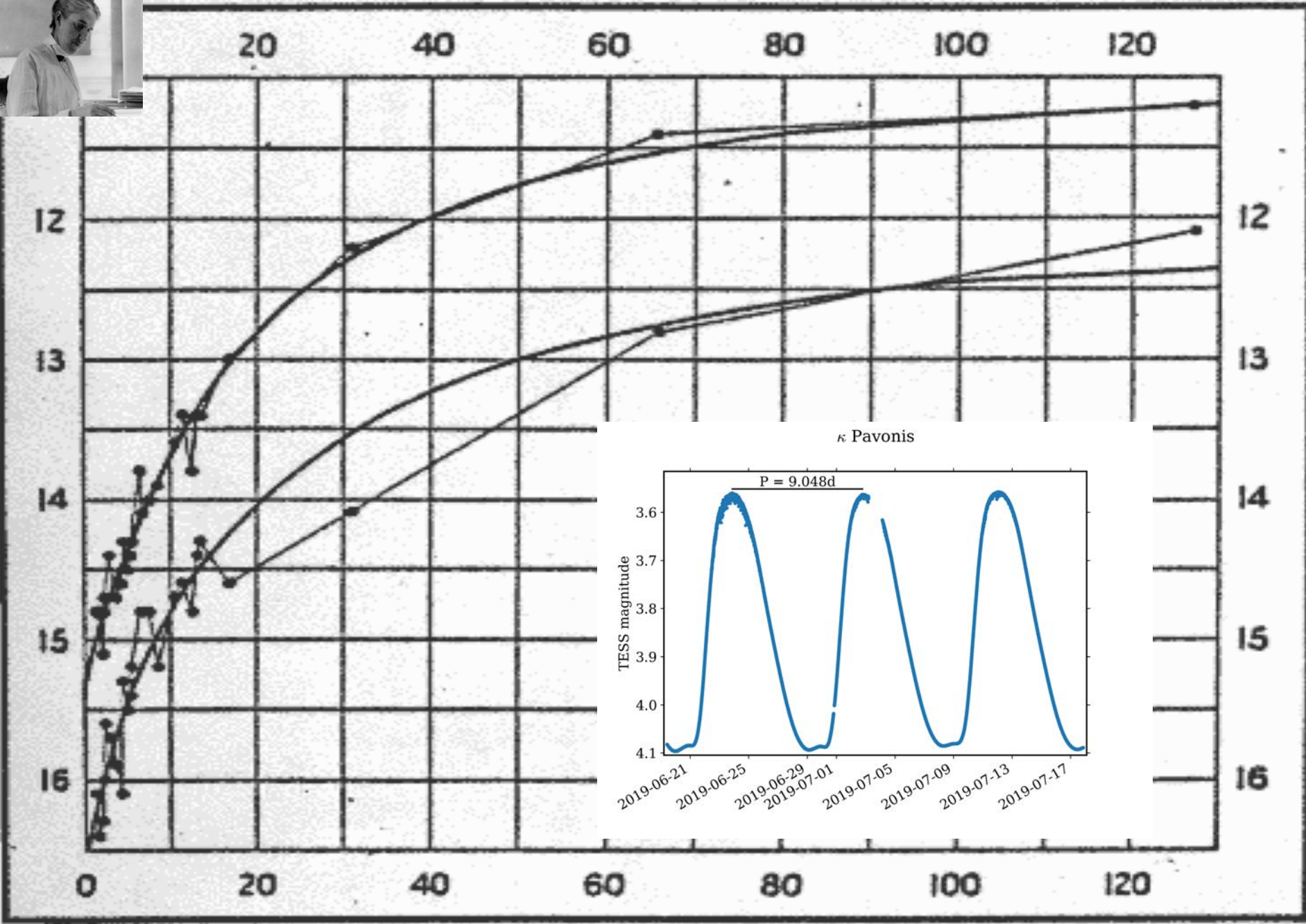
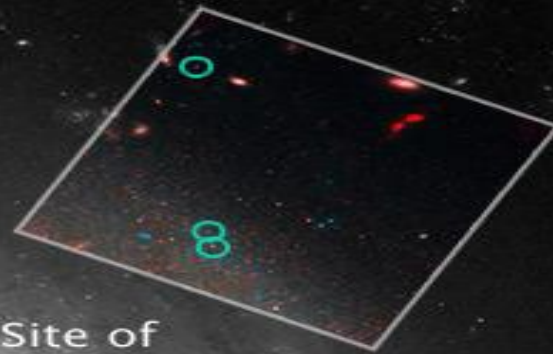
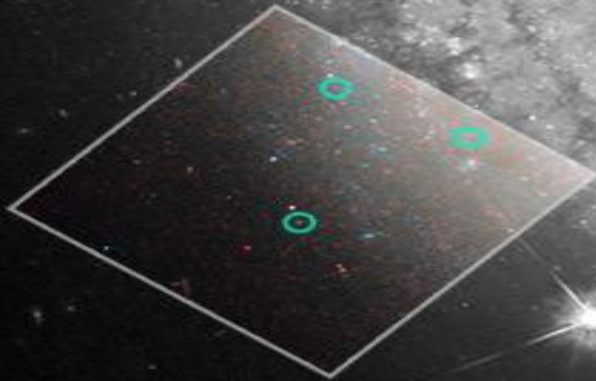


FIG. 1.

Henrietta Swan Leavitt, 1912



Site of
SN 1995al



3 80:2 parts AH ~~final~~ ~~copy~~ of ICM H222 H


~~VAR~~
VAR!

6-Oct
1923

-N

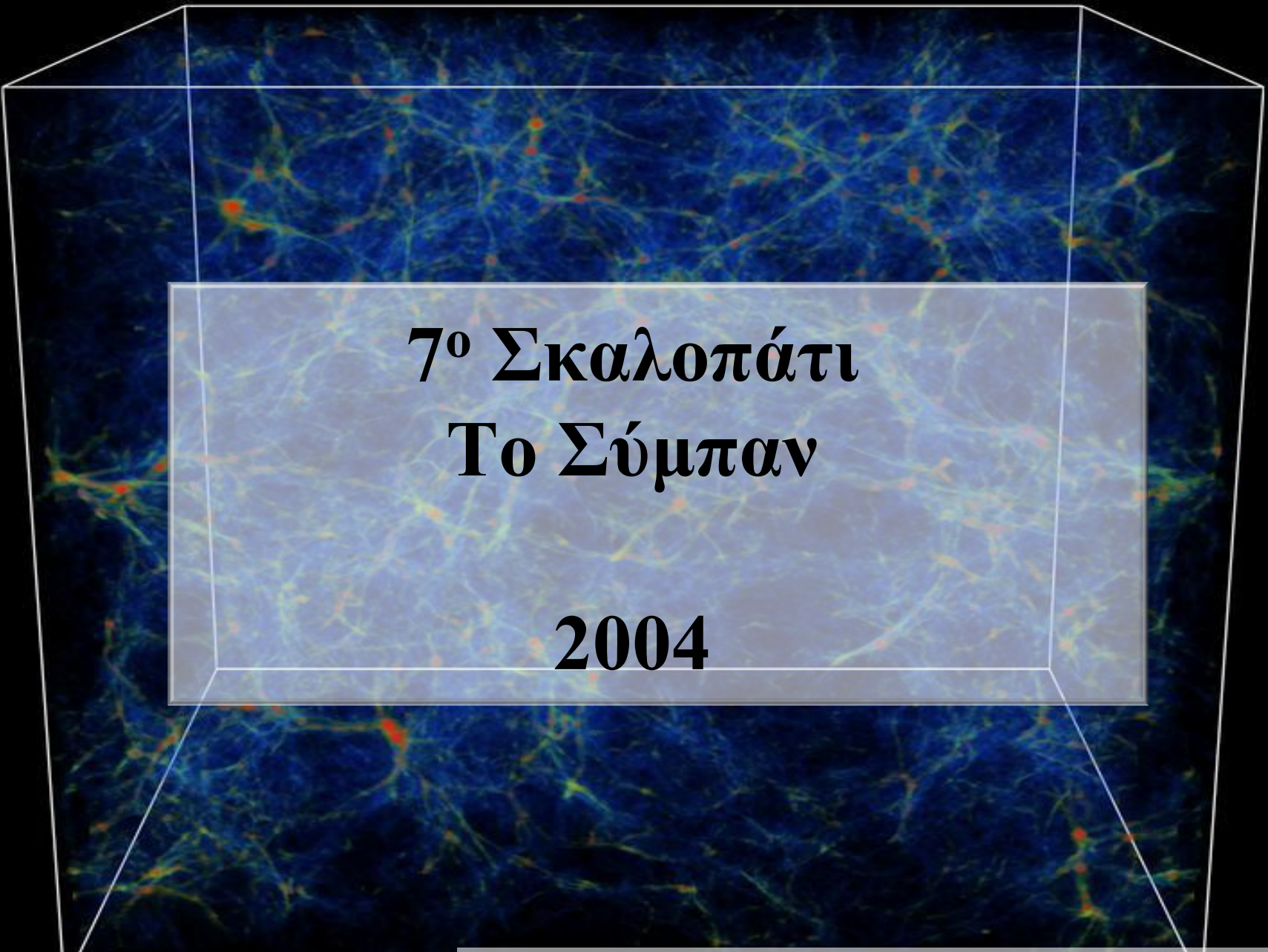
2



A vibrant, multi-colored image of the Orion nebula, showing intricate patterns of red, blue, and white gas clouds against a dark starry background. The nebula's structure is complex, with various filaments and regions of different colors.

Ευχαριστώ!

Orion nebula, NASA, ESA, M. Robberto & Hubble Telescope

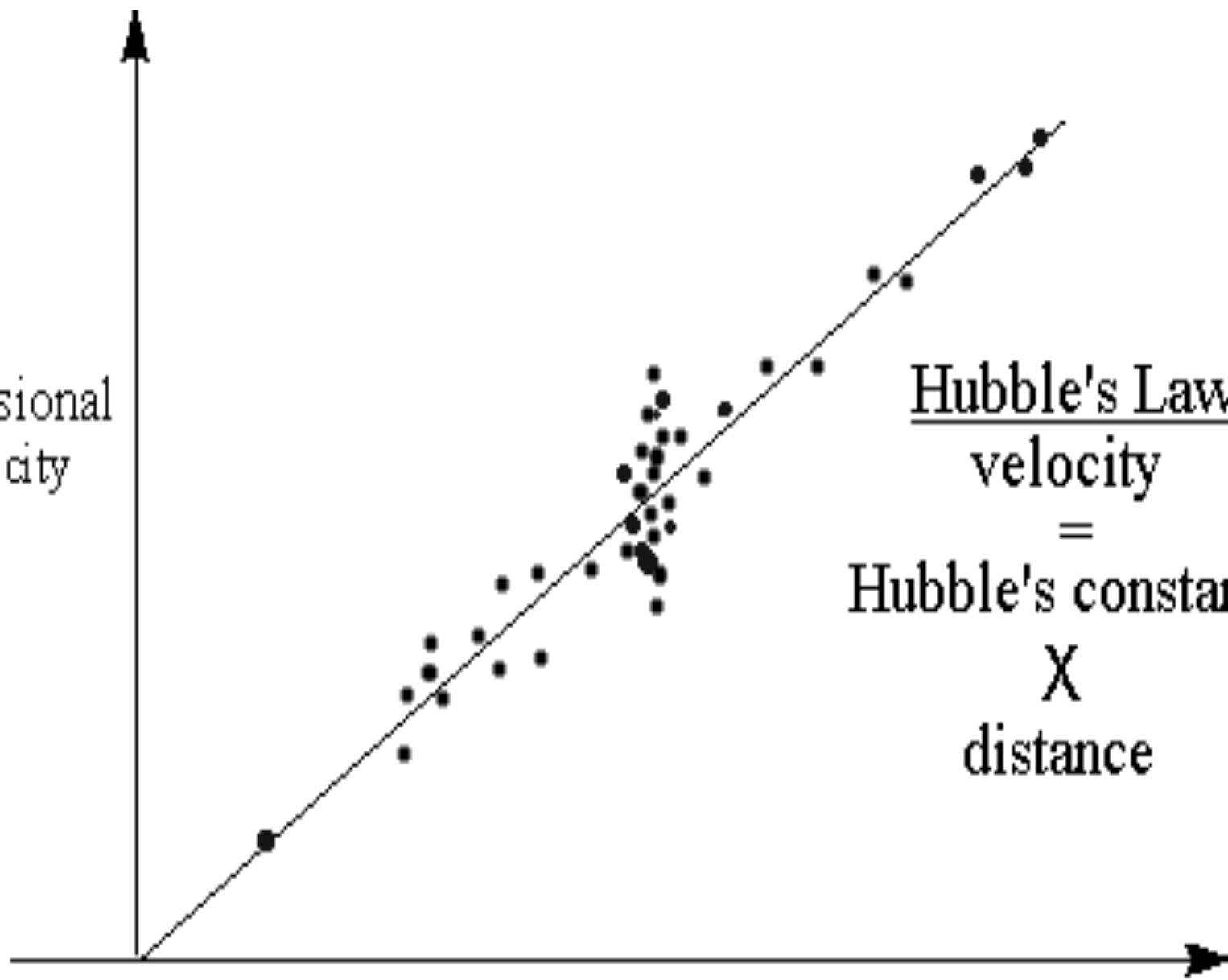


**7^ο Σκαλοπάτι
Το Σύμπαν**

2004

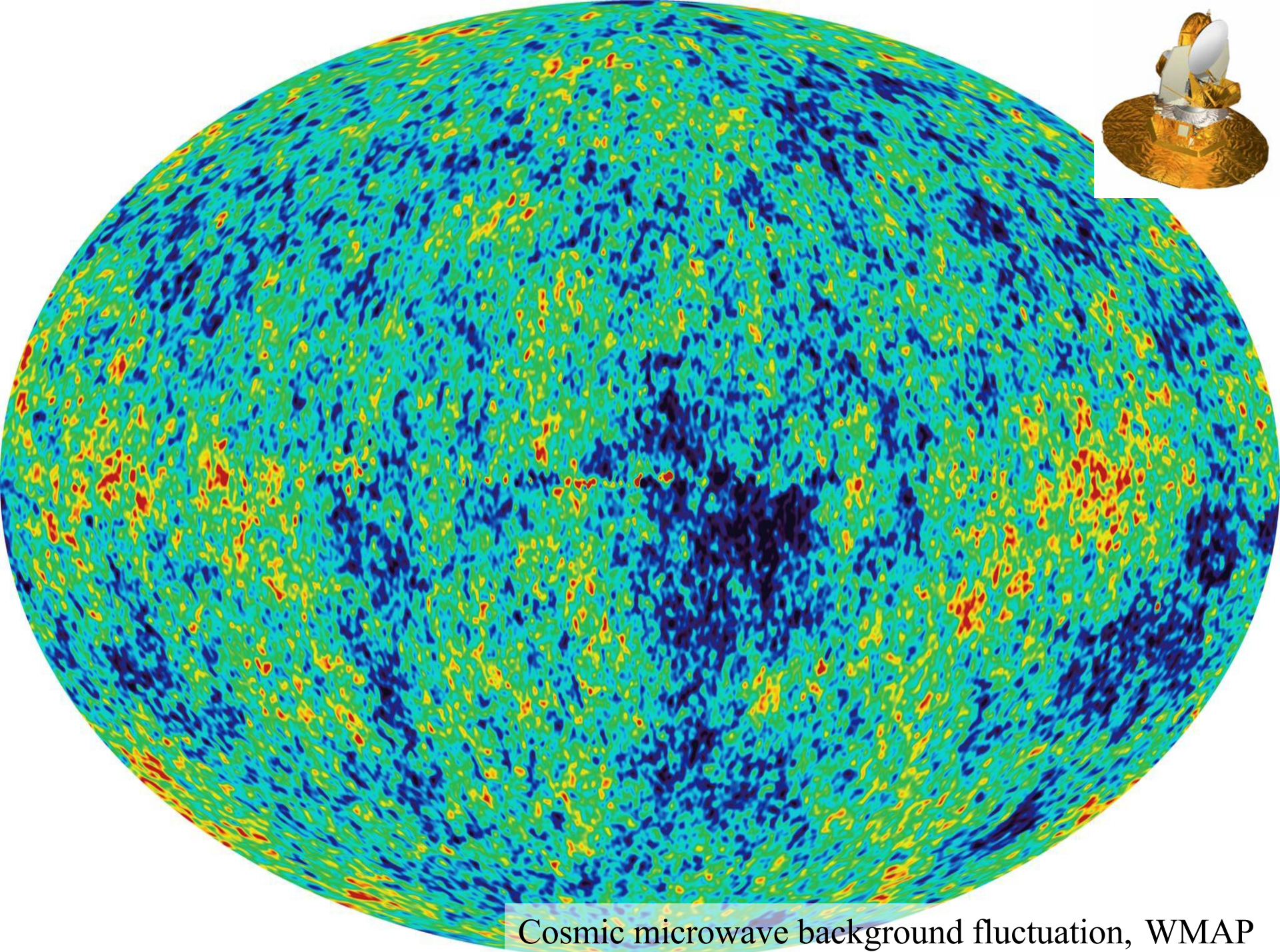


recessional
velocity



Hubble's Law
velocity
=
Hubble's constant
 \times
distance

distance



Celestial object	Distance (metres)	First (relative) measurement
Earth	1.2×10^7 (diameter)	Eratosthenes (~240BCE)
Moon	3.6×10^8	Aristarchus (~270BCE)
Sun	1.5×10^{11}	Aristarchus (~270BCE) Cook etc. (1761,1769)
Mars	2.3×10^{11} (from Sun)	Copernicus (1543)
Saturn	1.5×10^{12} (from Sun)	Copernicus (1543)
Pluto	7.4×10^{12} (from Sun)	Tombaugh (1930)
Proxima Centauri	4.0×10^{16}	Alden (1928)
61 Cygni	1.1×10^{17}	Bessel (1838)
Hyades cluster	1.4×10^{18}	Smart (1939)
Pleiades cluster	4.2×10^{18}	Detweiler et al. (1984)
Galactic center	2.6×10^{20}	Shapley (1914)
Large Magellanic Cloud	1.5×10^{21}	Arp (1967)
Andromeda Galaxy	2.4×10^{22}	Hubble (1923)
NGC 4603	1.0×10^{24}	HST (1999)

Celestial object	Distance (metres)	First (relative) measurement
Sloan Great Wall	1.3×10^{25} (diameter)	Gott et al. (2003)
1997ff Type Ia supernova	1.0×10^{26}	HST (1997)
GRB (Gamma Ray Burst) 090423	1.2×10^{26}	Swift satellite (2009)
UDFy-38135539 (Galaxy)	1.2×10^{26}	Lehnert et al. (2010)
Observable universe	2.8×10^{26} (diameter)	Hubble (1929)
Entire universe	$>7.2 \times 10^{26}$	Cornish et al. (2004)