III IYNT 2015

Problem № 9
«Space Distances»

Team *«MG 12»*

Problem 9

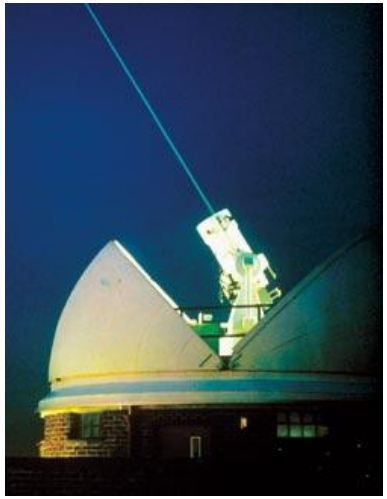
How do astronomers measure distances between the planets of the Solar System, between the stars in our Galaxy, or between the galaxies? Determine the distance between the two space objects of your choice.

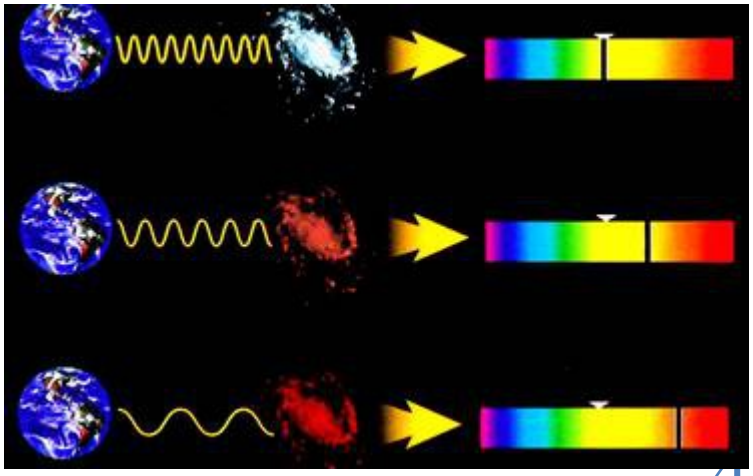
Hypothesis

The most efficient way to determine the distance between space objects in school conditions is to use the Titius-Bode formula or the method of parallax.

The measurement of space distances can be conducted by:

- Radio telescopes
- Laser ranging method
- Method of redshift
- Titius-Bode formula
- method of parallax



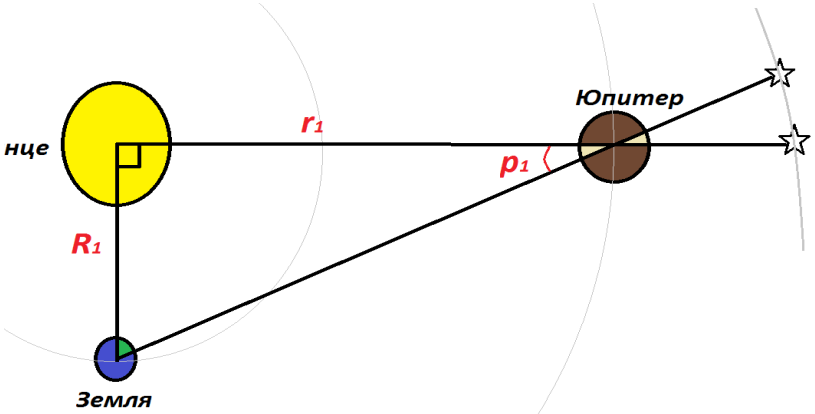


Space distances

In the process of solving the problem we decided to measure the distance between Jupiter and Saturn using two methods:

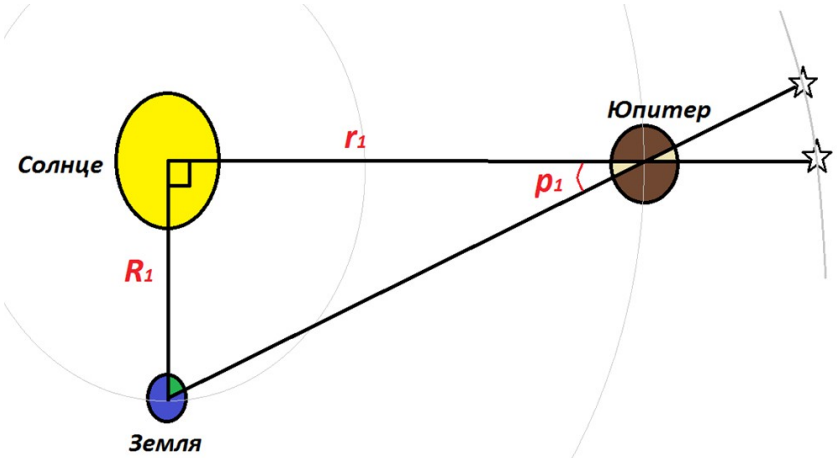
- parallax
- Titius-Bode formula.

Solution №1. Jupiter



- $R = 150'000'000\ km;$ $R = 150'000'000\ km;\ tgp_1 \approx \frac{1}{5}$

Solution №1. Jupiter

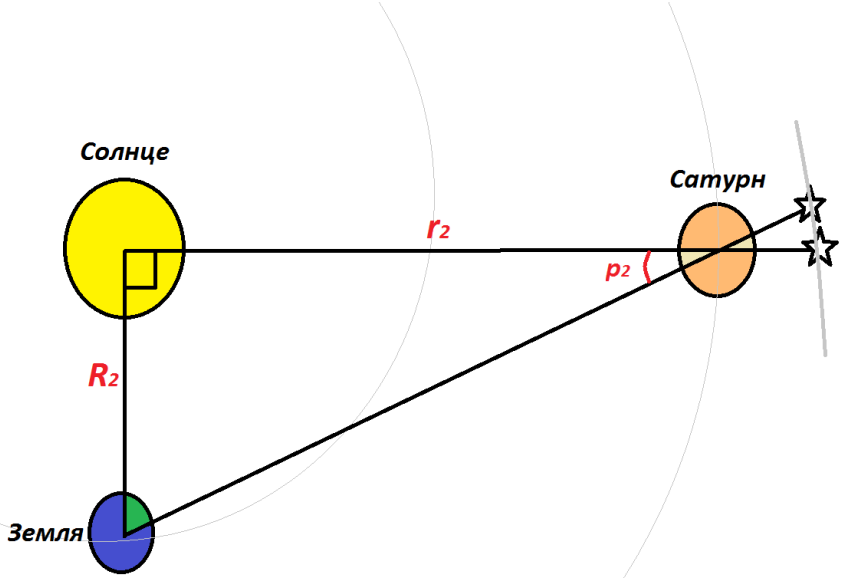


- $tgp_1 = p_1$

$$p_1 = \frac{R_1}{r_1};\ r_1 = \frac{R_1}{p_1}$$

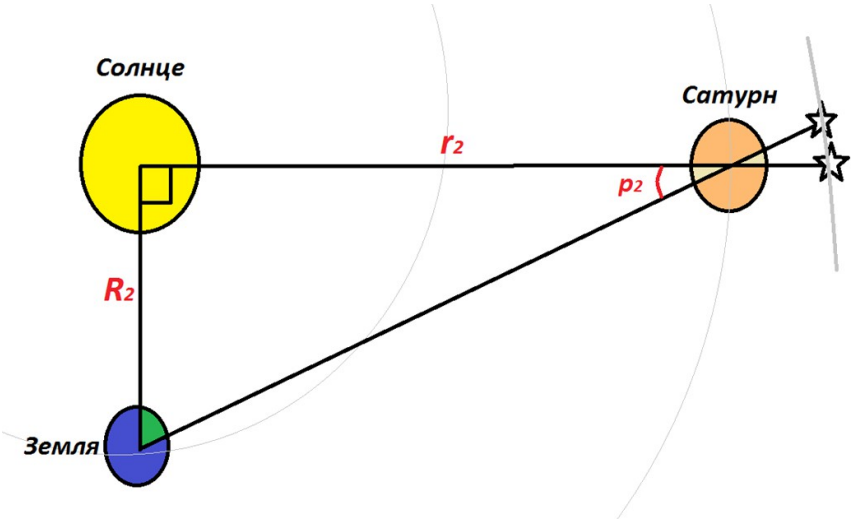
$$r_1 = \frac{150'000'000}{0,2} = 750'000'000\ \text{km}$$

Solution №1. Saturn



- $R_2 = 150'000'000\ km;\ tgp_2 \approx \frac{1}{10}$

Solution №1. Saturn.



- $tgp_2 = p_2$

$$\therefore p_2 = \frac{R_2}{r_2}\ ;\ r_2 = \frac{R_2}{p_2}$$

$$r_2 = \frac{150'000'000}{0{,}1} = 1'500'000'000\ \text{km}$$

Solution №1

- The distance between Jupiter and Saturn is:

$$\mathbf{r_2 - r_1 = r}$$

$$\mathbf{1'500'000'000}\ \text{km} - \mathbf{750'000'000}\ \text{km} = \mathbf{750'000'000}\ \text{km}$$

Solution №2

- The second way of solving the problem – Titius-Bode formula:

$$r = 0,4 + 0,3 \times 2^i$$

In which r is the distance between Earth and a celestial object, and i is the number of a celestial object starting from Earth (the asteroid belt is counted)

r is expressed in au (astronomical unit).

Solution №2

1. Distance between Earth and Jupiter :

$$r_1 = 0,4 + 0,3 \times 2^4$$

$$r_1 = 5,2 \text{ au}$$

2. Distance between Earth and Saturn:

$$r_2 = 0,4 + 0,3 \times 2^5$$

$$r_2 = 10 \text{ au}$$

3. Distance between Jupiter and Saturn:

$$r_2 - r_1 = r$$

$$10 \text{ au} - 5,2 \text{ au} = 4,8 \text{ au}$$

Solution №2

- au=**150 000 000** km

4,8 au×**150 000 000** km=**720′000′000** km

According to our calculations, the distance between Jupiter and Saturn is 720′000′000 km or 4,8 au

Conclusion

Distance between Jupiter and Saturn	
According to resources	655′000′000 km
Method of parallax	750′000′000 km
Titius-Bode formula	720′000′000 km

Information resources

1. https://en.wikipedia.org/wiki/Titius_-_Bode_law
2. https://en.wikipedia.org/wiki/Saturn
3. https://en.wikipedia.org/wiki/Jupiter
4. http://en.wikipedia.org/wiki/Parallax
5. Zasov A.V., Kononovich E.V. Astronomy. Moscow: Fizmatlit, 2011, 255pg.