XXVIII Sankt-Peterburg astronomical Olympics

January 31 2021

Theoretical part

7-8th class

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1. We assume that most of the milky Way stars are located in the disk with a characteristic diameter of 100 thousand light-years and a thickness of about 3 thousand light-years. The total mass of the disk is about $4 \cdot 10^{10}$ the mass of the Sun. How many times is the average concentration of disk stars less than the average concentration of stars in a globular cluster with a diameter of 150 light years and a total mass of $4 \cdot 10^{6}$ the mass of the Sun?

$2r_1 = 100000 = 2.50000$

$L = 3000.$

$M_1 = 4 \cdot 10^{10}$

$r_2 = 150$

$M_2 = 4 \cdot 10^{6}$

$\rho_1 = \frac{M_1}{V_1} = \frac{M_1}{\pi \cdot r^2 \cdot L}$

$\rho_2 = \frac{M_2}{4\frac{\pi r_2^3}{3}}$

$\frac{\rho_1}{\rho_2} = \frac{\left(\frac{M_1}{\pi r_1^2 L}\right)}{\left(\frac{M_2}{4\frac{\pi r_2^3}{3}}\right)} = \frac{M_1}{M_2} \cdot \frac{4\pi r_2^3}{3\pi r_1^2 \cdot L} =$

$= \left(\frac{4 \cdot 10^{10}}{4 \cdot 10^{6}}\right) \cdot \frac{4 r_2^3}{3 r_1^2 \cdot L} = 10^4 \cdot \frac{4}{3} \cdot \frac{(15 \cdot 10)^3}{(50000)^2 \cdot 3000} =$

$= 10^4 \cdot \frac{4}{3} \cdot \frac{3^3 \cdot 5^3 \cdot 10^3}{3 \cdot 10^3 \cdot 5^2 \cdot (10^4)^2} = \frac{4 \cdot 3 \cdot 5}{10^4} = 0{,}006$

Average concentration of disk stars is 0,006x less than the average concentration of stars in globular cluster.

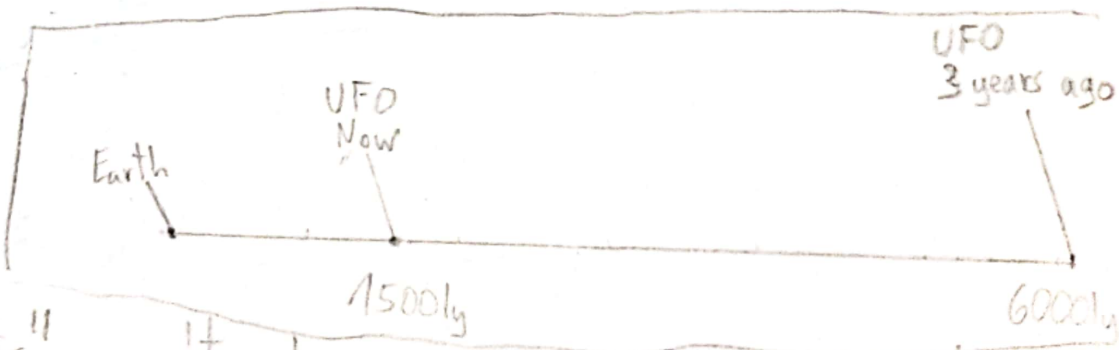
2. Find an extra item in the list based on two different criteria: Sirius, Arcturus, Aldebaran, and Pollux. Explain your choice.

Sirius has double spectral class, while others have just one. Sirius is closest to earth, and has the largest magnitude.

3. Ufologists are sounding the alarm: "Mysterious radio signal detected again!" But if three years ago the distance to its source was six thousand light-years, now the source is only fifteen hundred light-years away. "An invasion guests from deep space, it is inevitable and inescapable!" Assuming that the source of the signals is indeed the same and that it is moving towards the Earth in a straight line at a constant speed, determine how much time is left for humanity to organize a meeting for a new "guests".

$6000_{ly} - 1500_{ly} = 4500_{ly}$

$4500_{ly} : 3 \text{ years} = 1500_{ly}$ per year



Assuming "guests" won't have any tehnical problems, they will arrive in 1 year.

Luka Izak Tasič

4. On the night of September 17th – 18th, the St. Peterburg astronomer should observe the four stars: α Eagle, α Bootes, ζ Taurus, θ Aquarius. In what order is it more convenient to observe them at the moments of their best visibility on this night and why?

We first observe α Eagle, than θ Aquarius and than ζ Taurus, because they are already visible. We observe α Eagle first because it's on the west side of our point view and it's going to set before θ Aquarius and ζ Taurus (both easteren). Second is θ Aquarius, than ζ Taurs and last α Bootes, because he rises last.

5. To get a *Hubble Deep Field South (HDFS)* image on the *Wide Field and Planetary Camera 2 (WFPC2)*, a total exposure time of 99300 seconds was required when the sky area of 2.5′ × 2.5′ (angular minutes) was observed at a wavelength of 606 nanometers. How many years will it take to shoot the whole sky?

$\frac{180 \cdot 60}{2,5} \cdot \frac{180 \cdot 60}{2,5} = 4320 \cdot 4320$

$\frac{4320 \cdot 4320}{365 \cdot 24 \cdot 3600} \cdot 99300 =$

$= \frac{18662400}{31536000} \cdot 99300 = 5,8 \cdot 10^4$

180·60
10800

10800 : 2,5
10800 : 25 = 4320
90
50
00

365·24
730
+1460
8760

8760·3600
26280
+ 1 5256 00
31536000

4320·4320
12285
+ 12966 24000