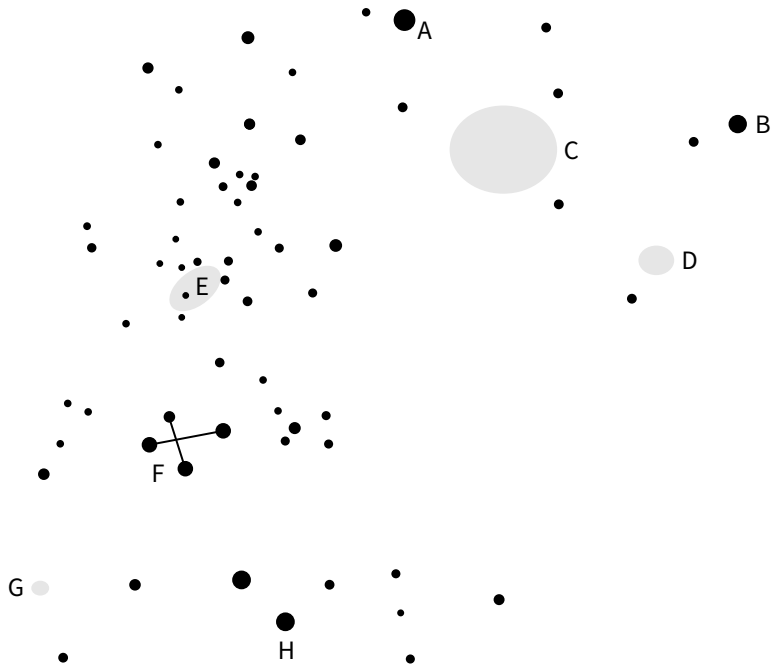
International Astronomy and Astrophysics Competition
Qualification Round 2024

Problem A : The Southern Hemisphere (5 Points)

Most people live in the northern hemisphere of the Earth and observe the northern night sky. However, the night sky in the southern hemisphere is different and features many interesting & important astronomical objects that cannot be seen in the northern hemisphere.

Below, you see a sketch of a particular section of the southern hemisphere night sky. Find the correct names of the objects tagged with the letters A to H.

Note: A,B,H refer to stars; F refers to a constellation; C,D,E,G refer to other objects.



(A) _____ (B) _____ (C) _____ (D) _____

(E) _____ (F) _____ (G) _____ (H) _____

Problem B : Stars in the Milky Way (5 Points)

Our Sun is one star among billions of stars in the Milky Way. However, it is difficult to determine the exact number of stars. By observing the nearby stars around us, you find that the local density of stars is 0.05 stars/(light-year)^3. For simplicity, assume that the Milky Way has a cylindrical shape with a diameter of 100,000 light-years and a thickness of 1,000 light-years.

Use this information to estimate the total number of stars in the Milky Way.

Problem C : Gravity at the ISS (5 Points)

The International Space Station (ISS) orbits the Earth at an altitude of around 410 km. The ISS does not fall towards the Earth, and the astronauts & objects are floating weightlessly. On Earth's surface, objects fall with a gravitational acceleration of approximately 9.81 m/s^2.

(a) Show that the following equation gives the percentage P of how much the grav. acceleration decreases between Earth's surface (R: Earth's radius, 6371 km) and an object at altitude z:

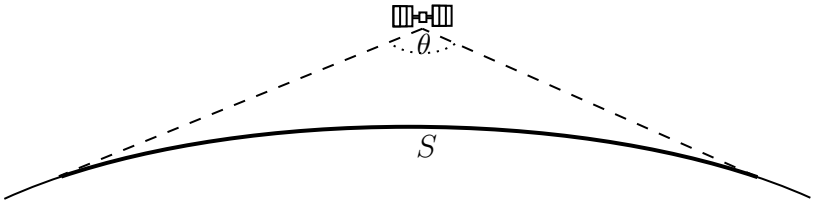
$$P(z) = 1 - \left(\frac{1}{1+\frac{z}{R}}\right)^2$$

(b) What is $P(z)$ for the altitude of the ISS, and why are objects weightless nevertheless?
(c) At what distance does the grav. acceleration become only 1% of that on Earth's surface?

Problem D : Field of View of the ISS (5 Points)

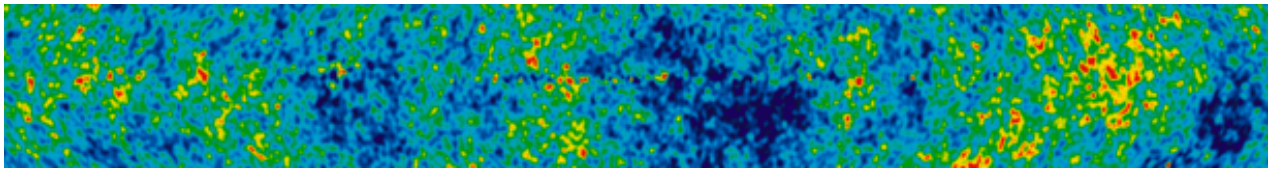
The astronauts living on the ISS have a spectacular view of Earth. However, they see only a certain part of the Earth at a given time, and the planet's curvature limits their view.

Use geometry to determine (a) the field of view angle θ, (b) the total distance S visible, and (c) the percentage of Earth's surface that astronauts can see.



Problem E : Microwave Background (5 Points)

Looking into the universe around us reveals billions of galaxies across all directions. However, when looking past them into the empty space, we detect something called the *cosmic microwave background* (CMB). It was discovered by accident and is immensely important for cosmology.



Explain what the CMB is and how it was discovered.

General Information and Submission

You can write the solution by hand or type it on a computer. To qualify for the pre-final round, you must get at least 15 points (Junior, under 18 years) or 20 points (Youth, over 18 years). Make sure to submit your solution by *Friday 26. April 2024 23:59 UTC+0* online at www.iaac.space/submission. If you have questions or comments, please feel free to contact us via email: info@iaac.space. Good luck!