Exotic matter in the Solar System
Key Stage 4

Topics covered: Cosmology, dark matter, dark energy, solar system, standard form

Watch the video "How will the Universe end?"
https://vimeo.com/122515139

The Universe contains visible matter such as stars and galaxies and energy in the form of light. The Universe also contains dark matter – this has a gravitational pull on other matter but it does not radiate any light. The largest component of the Universe is dark energy – this behaves as an anti-gravity agent, pushing things away.

Scientists think there is very little dark matter and dark energy in the Solar System.

- Within Saturn's orbit there is less than **1.7×10^{-10} solar masses** of dark matter

- The density of dark energy in the Solar System is **9.5×10^{-27} kg/m³**
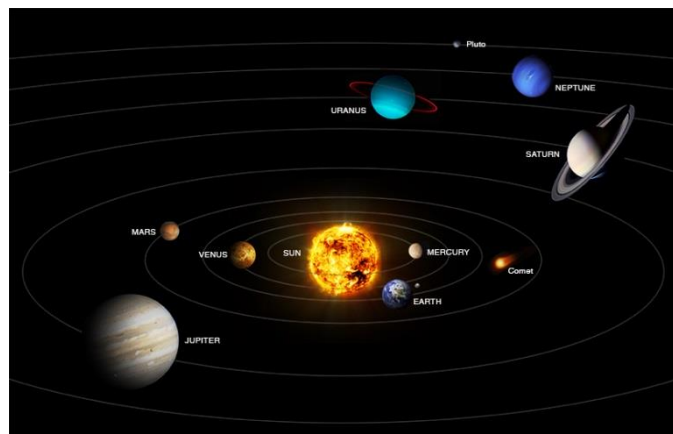
1. Write down all of the different types of light in the electromagnetic spectrum.
2. Calculate the mass of dark matter within Saturn's orbit in kilograms. The mass of the Sun is 1.9 x 10^{30} kg.

$$density = \frac{mass}{volume}$$

3. Use your answer for question 2 to calculate the **density** of dark matter within a sphere extending outwards to Saturn's orbit. The volume of a sphere is:

$$V = \frac{4}{3}\pi r^3$$

Where r is the radius of a sphere.
The average orbital radius of Saturn is 1.4 x 10^9 km (convert this into metres). Use the formulae above to find the density in units of kg/m³.

4. How does the density of dark matter compare to the density of dark energy?

Exotic matter in the Solar System: ANSWERS
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1. Radio, microwave, infrared, visible, ultraviolet, X-ray, gamma-ray
2. Mass of dark matter within Saturn's orbit = 3.23×10^{20} kg
3. Density of dark matter within Saturn's orbit = 2.8×10^{-17} kg/m³
4. 10^{-17} compared to 10^{-27}, there is 10^{10}x more dark matter than dark energy (10 000 million times more)