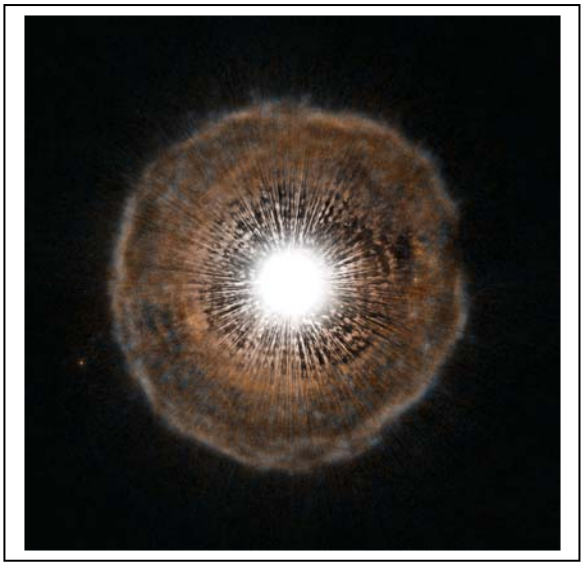
The Expanding Gas Shell of U Camelopardalis



This dramatic image taken by the Hubble Space Telescope reveals details in the shell of gas ejected by the star U Camelopardalis thousands of years ago.

Located 1,400 light years from our sun, the shell is expanding at a speed of about 25 km/sec, and its outer edge is about 500 billion km from the central star, whose image has been greatly over exposed making it seem huge in this image!

Although it looks impressive, the amount of mass in this shell is actually quite small. It is only about 1/10 the mass of our own planet Earth!

Problem 1 - The radius of the shell is 500 billion kilometers, and the estimated speed is about 25 km/sec. How many years did it take for the shell to get this big if 1 year = 31 million seconds?

Problem 2 – The mass of Earth is 6.0×10^{24} kg. The mass of a hydrogen atom is 1.6×10^{-27} kg. If the entire mass of the shell were evenly spread out in a sphere with the shell's radius, how many hydrogen atoms would you expect to find in a cubic meter of this shell to the nearest 10,000 atoms?

Problem 1 - The radius of the shell is 500 billion kilometers, and the estimated speed is about 25 km/sec. How many years did it take for the shell to get this big if 1 year = 31 million seconds?

Answer: Time = distance/speed
= 500 billion km / 25 km/sec
= 20 billion seconds

Since 1 year = 31 million seconds, Time = 20 billion/31 million = **645 years**.

Problem 2 – The mass of Earth is 6.0×10^{24} kg. The mass of a hydrogen atom is 1.6×10^{-27} kg. If the entire mass of the shell were evenly spread out in a sphere with the shell's radius, how many hydrogen atoms would you expect to find in a cubic meter of this shell to the nearest 10 million atoms?

Answer: Convert all lengths to meters: 5×10^{11} km x (1000 m/1km) = 5.0×10^{14} meters.

Volume = $4/3\ \pi\ R^3$ so V = $1.333 \times 3.141 \times (5.0\times10^{14})^3 = 5.2 \times 10^{44}$ meters^3.

Mass of shell is 1/10 Earth = $0.1 \times 6.0\times10^{24}$kg = 6.0×10^{23} kg.

Density = mass/volume
= 6.0×10^{23} kg/5.2×10^{44} m^3
= 1.1×10^{-21} kg/m^3

Since 1 hydrogen atom = 2.0×10^{-27} kg, the density corresponds to

N = 1.1×10^{-21} kg x (1 atom/2.0×10^{-27} kg) = 576,923 atoms/meter^3

Rounded to the nearest 10,000 atoms we get **580,000 atoms**.