National Aeronautics and Space Administration

Star Explosion Sends Chemical Elements Flying Through Space

got calcium?

The Milky Way galaxy doesn't contain any milk, but it sure does have a lot of calcium. There's enough calcium floating between the stars to fortify trillions upon trillions of gallons of milk.

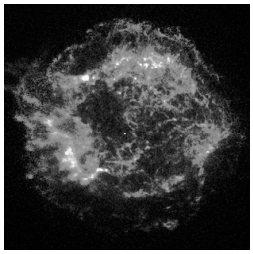
Calcium comes from stars. In fact, all of the elements that make up your body and the planet Earth itself other than hydrogen and helium were made in stars or during star explosions.

Stars are like mighty chemical factories. They burn hydrogen and helium through a process of nuclear fusion, which produces tremendous energy. The nuclear ash — the products of fused hydrogen and helium — are carbon, nitrogen, and other atoms as heavy as iron. Eventually a star runs out of fuel to burn. At this point, the star explodes, sending all those atoms racing into space. Some atoms bump into each other in the fury, fusing to create even heavier atoms such as gold, silver and uranium. These atoms spread across the galaxy over the course of billions of years.

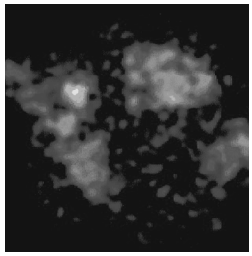
Cassiopeia A is a star that exploded about 320 years ago. No astronomer recorded the explosion at the time, but we can still see the remains of the explosion today in the form of a colorful supernova remnant.

The Michigan-Dartmouth-Massachusetts Institute of Technology Observatory in Kitt Peak, Arizona, captured a beautiful image of Cassiopeia A in visible light (above, top). The Chandra X-ray Observatory, an earth-orbiting satellite, saw the hot X-ray-emitting gas from the explosion (on front, and middle image, this page). This gas is hotter than the surface of the sun. Chandra was also able to see the individual elements within the explosion. For example, researchers at NASA's Goddard Space Flight Center created an image showing only the element calcium (bottom image).

Visible light image of Cassiopeia A (from telescope on Earth)



X-ray image of Cassiopeia A (from Chandra X-ray Observatory, in Earth orbit)



X-ray image showing only the calcium present in Cassiopeia A (also from Chandra X-ray Observatory)

For the classroom:

How much calcium is in Cassiopeia A? That's what astronomers are trying to find out. Maybe you can help.

- Stars that produce supernova remnants like Cassiopeia A are about 20 times more massive than the Sun. They are largely made up of hydrogen but also contain some calcium and other elements.

- When the star explodes, the hydrogen, calcium, and other elements fly off into space, and the explosion creates even more. The total amount of calcium is equal to 0.0165% the mass of the original star.

How many kilograms of calcium are in a typical supernova remnant, like Cassiopeia A? How many 8-ounce glasses of milk would this equal? How does the total amount of calcium compare to the mass of the Earth? To answer these questions, use the following facts:

- The sun has a mass of 2.0×10^{30} kg.
- One glass of milk (8 fluid oz. or 237 ml) contains approximately 300 mg of calcium.
- The earth has a mass of 6.0×10^{24} kg.

For more information on space science and the Chandra mission, see:

http://imagine.gsfc.nasa.gov/
http://chandra.harvard.edu/pub.html

Answers:

Kg of Ca in SN remnant = (20 x 2.0 x 10^{30} kg) x 0.000165 = 6.6 x 10^{27} kg of Ca in remnant

Glasses of milk = total Ca in remnant / Ca in 1 glass = (6.6 x 10^{27} kg) / (300 mg x 1kg/10^{6}mg) = 2.2 x 10^{31} glasses of milk!

Total Ca in remnant compared to mass of Earth = (6.6 x 10^{27} kg) / (6.0 x 10^{24} kg) = 1,100 times mass of Earth

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