THE CREATION OF THE ELEMENTS OF THE UNIVERSE

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Have you ever wondered how the elements we find on our planet were created and where they came from? Elements essential to life, such as carbon, oxygen, potassium, sulfur, and phosphorus, the metals that make cars, planes, and ships, or those that we feel have an emotional connection to, such as jewelry from gold, platinum, and diamonds.

During the total solar eclipse on August 18, 1868, several astronomers using spectroscopic instruments detected a new element in the sun, Helium, which turned out to be the second most abundant element in the universe and which is created from Hydrogen under conditions of great pressure and temperatures prevailing in the sun. During this nuclear fusion, huge amounts of energy are released mainly in the form of heat and light.

We now know that over time, Helium also fuses, forming the elements carbon, nitrogen, and oxygen (element No. 8 on the Periodic Table of Elements). In stars more massive than the sun, whose greater gravity creates more pressure and heat, elements other than oxygen can fuse. This process can only continue until iron (element No. 26) is formed at the centre of the giant stars. Fusion is then terminated because to fuse iron into a heavier element, enormous amounts of energy are required, more than what is produced by the nuclear fusion reaction.

Massive stars can transform into various other types, depending on how heavy they are. They can explode into Supernovae, collapse into various types of neutron stars, or even form Black Holes. With the explosions of Supernova stars, large amounts of elements are scattered in space forming nebulae, from which new stars and planets are created.

For more than a millennium, alchemists struggled to transform one element into another. They were looking for the philosopher's stone, which could turn base metals like lead and mercury into gold. Even the great Isaac Newton was fascinated by the idea of transmutation. Indeed, some historians refer to him as "the last great alchemist". However, the enormous forces of nature needed to create these elements were beyond the understanding of the first experimenters.

The origin of heavy elements began to be understood with the publication of Einstein's special theory of relativity in 1905. It was in this seminal work that the equation $E=mc^2$ first appeared. At first it wasn't obvious how important this equation was in the understanding of the universe but applying it to the problem of the sun's massive energy output would have far-reaching implications. Not only did it explain why the sun and other stars could shine for billions of

years, it also helped show how elements heavier than hydrogen form. Hydrogen was the first element created during the Big Bang.

In about 5 billion years, our own star, the sun, which is not big enough to explode into a Supernova, will turn into a Red Giant after all the hydrogen has been consumed. The star's core will shrink, but its outer layers will expand to the orbit of Mars, engulfing and burning up our planet in the process.

Let us not worry. 5 billion years is enough time to continue enjoying our jewelry. Gold is believed to be produced during the nuclear fusion of exploding Supernovae stars, and from colliding neutron stars. Current astrophysical models indicate that this neutron star merger event creates gold equivalent to between 3 and 13 Earth masses!