Origin of Isotopic Variations

The Big Bang and all that stuff

Formation of the Solar System

- New stars and planetary systems form from the debris Supernova. It is possible that the material in the solar system had been cycled through several supernovae since the big bang. The Sun formed from a cosmic cloud about 6 billion years ago. Gas gradually moved together under the influence of gravity. As the gas moved together, it became hotter and denser and eventually was pressed together so closely that nuclear fusion ensued. Surrounding the new sun was a flattened disk of gas and dust.

The Sun
**Mass (kg):** $1.989 \times 10^{30}$

**Mass (Earth = 1):** 332.820

**Equatorial radius (km):** 695,000

**Equatorial radius (Earth = 1):** 108.97

**Mean density (gm/cm^3):** 1.41

**Rotational period (days):** 25-36°

**Escape velocity (km/sec):** 618.02

**Luminosity (ergs/sec):** $3.827 \times 10^{33}$

**Magnitude (V):** 26.5

**Mean surface temperature:** 6,000°C

**Age (billion years):** 4.5

**Principal chemistry:**
- Hydrogen: 92.1
- Helium: 7.8
- Oxygen: 0.004
- Carbon: 0.03
- Nitrogen: 0.0086
- Neon: 0.0076
- Iron: 0.0017
- Silicon: 0.0031
- Magnesium: 0.0024
- Sulfur: 0.0015

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**Sun Stats**

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H burning – He production

P-P chain I:  
H → H → e → H → H → e → H
H → H → He
He → He → He → 2H

P-P chain II:  
H → H → e → H → H → e → H
H → H → He
He → He → He → Be
Be → e → Li
Li → H → 2He

69%  31%
Nomenclature

\[ \delta = \left( \frac{^{13}\text{C}/^{12}\text{C}}{^{13}\text{C}/^{12}\text{C}}_{\text{Standard}} \right) - 1 \times 1000 \]

\[ \delta \text{ values are positive or said to be heavy} \]

\[ \delta \text{ values are negative or said to be light} \]

Less \(^{13}\text{C}\), \(\delta\) values are negative or said to be light

Standard is PDB (Pee Dee Belemnite)

V-PDB (Vienna Pee Dee Belemnite)
Mass (kg) \( \approx 1.989 \times 10^{30} \)
Mass (Earth = 1) \( 332,830 \)
Equatorial radius (km) \( 695,000 \)
Equatorial radius (Earth = 1) \( 108.97 \)
Mean density (g/cm³) \( 1.41 \)
Mean surface temperature \( 15,000,000°C \)
Mean surface temperature \( 6,000°C \)
Age (billion years) \( 4.5 \)

The Origin of Carbon Isotopic Variations

Principal chemistry

Hydrogen 92.1
Helium 7.6
Oxygen 0.001
Carbon 0.03
Nitrogen 0.0084
Iron 0.0007
Silicon 0.001
Magnesium 0.0024
Sulfur 0.0018

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**Intermediate Carbon in Vegetables**

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**SCIENCE**

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Methodology/Terminology