



Lithium Abundance in Interstellar Space

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Why in News

Recently, the researchers at the **Indian Institute of Astrophysics (IIA)** have discovered hundreds of **Lithium (Li) rich giant stars** which indicate that **lithium is being produced in the stars** and **accounts for its abundance** in the interstellar (between stars) medium.

The study was published in the **Astrophysical Journal Letters and Monthly Notices of Royal Astronomical Society (MNRAS)**.

Key Points

- The scientists have discovered a **number of super Li-rich giants** with the **Li quantity equal** to or in some cases, **more than 10 times the present value, $A(\text{Li}) = 3.2$ dex** (measured in logarithmic scale relative to hydrogen).
- Scientists followed a **two-fold strategy** of **systematically searching for high Li among low mass evolved stars** in the Galaxy and **determining the exact evolutionary phase of these high Li abundance stars**.
 - Hundreds of Li-rich giants were discovered by employing data from large scale ground and space missions.
 - However, **Li-rich giants still account for only about 1 in 100 in the Galaxy**.
- The **evolutionary phase** of these giants was determined by **analyzing relative positions of thousands of stars** using their **temperature** and **luminosity** and also **subjecting their independent data set to atmospheric oscillations analysis** using data from **Kepler Space Telescope**.
 - For the first time, it was shown that the **Li enhancement in giants is associated only with central He-burning stars** (also known as the **Red Clump Giants**)
 - This discovery will **help to eliminate or validate many proposed theories** such as **planet engulfment** or **Big Bang Nucleosynthesis (BBN)** during the red giant evolution in which **helium at the center is not burning**.
- **Lithium (Li)**, is one of the **three primordial elements**, apart from **Hydrogen (H)** and **Helium (He)**, produced in the BBN.

This model **predicts primordial Li abundance** [$A(\text{Li}) \sim 2.7 \sim \text{dex}$].

- **Stars** are also proposed as a **likely Li source** in the Galaxy and are considered as **Li sinks**.

The original Li, with which stars are born, only **gets depleted over stars' lifetime as Li burns at relatively very low temperatures** of about **2.5x10⁶ Kelvin** (a range which is easily encountered in stars).

Planetary Engulfment

- In the universe, planets **accompany host stars** (like the Sun is the host star for the planets of the Solar system).
- As the **host star evolves off the main sequence to become a white dwarf**, the planets with **sufficiently close orbits** can be **engulfed** during the giant phase.
- Planetary engulfment events **involve the chemical assimilation of a planet into a star's external layer**.

This can cause a change in the chemical pattern of the stellar atmosphere in a way that mirrors the composition of the rocky object engulfed.

Big Bang Nucleosynthesis

- It is the **leading explanation about how the universe began**. At its simplest, it says that the universe **started with a small singularity** and then **inflated over the next 13.8 billion years** to the cosmos currently observed.
- The **Universe's light-element abundance** is another important criterion by which this theory is verified.

It is now known that the elements observed in the Universe were **created in either of two ways**.

Light elements (namely deuterium, helium, and lithium) **were produced in the first few minutes of the Big Bang**, while elements **heavier than helium** are thought to have their **origins in the interiors of stars which formed much later in the history of the Universe**.

- The theory predicts that **roughly 25% the mass of the Universe consists of Helium**. It also predicts **about 0.01% deuterium**, and **even smaller quantities of lithium**.

Source: PIB