Lithium Abundance in Interstellar Space

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(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(Li) ~2.7~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' life-time 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