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ABSTRACT

Just notes, not abstract: I rechecked the V339 Del sl but still can't find any obvious lithium lines in the range of 6680Å-6720Å. Based on Tajitsu et al. (2015), they claimed they detected beryllium, ^{7}Be, in the near-ultraviolet spectra of the classical nova V339 Del from 38 to 48 days after the explosion. Since there is no data in the uv range, I checked the record number (7 and 8) around 90 days after the explosion(record 0) because ^{7}Be decays to form ^{7}Li with a half-life of 53.2 days, but I still can't find any lithium absorption lines. HOWEVER, I did find potential blue-shifted lithium lines only in records 1 and 2.

1. INTRODUCTION

Big Bang Nucleosynthesis(BBN) produced the universe's first lithium within roughly 20 minutes after the Big Bang(see Figure 1.), and according to the models from Cyburt et al. (2015), this same process also made hydrogen and helium (mainly in the forms of deuterium, ^{3}He, and ^{4}He), with only a trace amount of lithium. The Cameron-Fowler mechanism is the process by which stars produce ^{7}Li(Cameron & Fowler 1971), at high temperatures (typically T > 10^7 K), ^{3}He and ^{4}He nuclei fuse via the reaction ^{3}He(α,γ)^{7}Be in the interiors of stars

$$T \rightarrow {}^3He(\alpha,\gamma)^7Be$$

For ^{7}Li to be produced, ^{7}Be must be transported by convection to cooler outer layers (T < 10^6 K) before it is destroyed by proton captures(Ventura & D'Antona 2009), it then will undergo electron capture and produce ^{7}Li via Eqn 1 with the additional formation of 0.86 MeV neutrinos(Izzo et al. 2015).
The lithium seen in very old, metal-poor stars reflects that primordial level and only acts as a baseline for galactic chemical evolution, younger stars show roughly three times more lithium than that value (Fields et al. 2019), which implies that other astrophysical processes must have produced additional lithium, and several sites have been suggested as the main contributors to the lithium abundance.

1.1. *Asymptotic giant branch (AGB) stars*

AGB stars can produce lithium through processes such as proton ingestion events (PIEs) and hot bottom burning. PIEs in low-mass AGB stars (1–3 $M_\odot$) can lead to lithium enrichment with abundances of A(Li) = 3 to 5 while in high-mass AGB stars (>3–4$M_\odot$), the base of the convective envelope causes proton-capture reactions due to high temperature, producing lithium via the same chain as Eqn.1. However, recent observational and chemical evolution studies from Borisov et al. (2024) indicate that AGB stars alone cannot account for the meteoritic lithium abundances, and suggest that other sources such as novae are required to explain the observed lithium abundance in the galaxies.

1.2. *Galactic cosmic-ray spallation*

Lithium is synthesized in the interstellar medium when high-energy protons and cosmic rays collide with C, N, O. These collisions cause the target nuclei to expel nucleons and form light elements like lithium, beryllium(Vangioni-Flam et al. 1998; Laumer et al. 1973), this is a primary non-thermal nucleosynthesis pathway for lithium, especially for the isotope ^{6}Li. In a survey for the Small Magellanic Cloud, 'Ciprijanovi'c (2016) stated that galactic cosmic rays could only produce a very small amount of lithium in the Small Magellanic Cloud, with only 0.16% of the measured abundance explained by this source.

1.3. *Classical Novae*

During a classical nova explosion, extreme temperatures (∼100 to 200 million K during the explosion) enable the nuclear reaction ^{3}He(α,γ)^{7}Be, producing radioactive ^{7}Be. This ^{7}Be is then transported outward in the nova ejecta. As ^{7}Be decays (half-life ∼53 days), it transforms into ^{7}Li(Eqn 1). This process was first proposed by Starrfield et al. (1978) and is now directly supported by the detection of highly blue-shifted ^{7}Be lines in the spectra of several classical novae, including V339 Del(Tajitsu et al. 2015), V5668 Sgr(Molaro et al.

2016), and V2944 Oph(Tajitsu et al. 2015).

$$^3\text{He}(\alpha,\gamma)^7\text{Be} \xrightarrow[53\text{ days}]{e^-} {}^7\text{Li} \quad (1)$$

This reaction chain is the primary pathway for lithium production in nova explosions. ^{3}He captures an alpha particle to form ^{7}Be, which later decays via electron capture into ^{7}Li with a half-life of around 53 days.

A report in 2015 from Izzo et al. (2015) stated that they directly detected the lithium in the early optical spectra of Nova V1369 Cen(see Figure 2.). The measured lithium abundance in the nova ejecta is significantly higher than solar values, with log overabundances of 4.8 relative to sodium, suggesting classical novae are sufficient to explain the observed overabundance of lithium in young stellar populations.

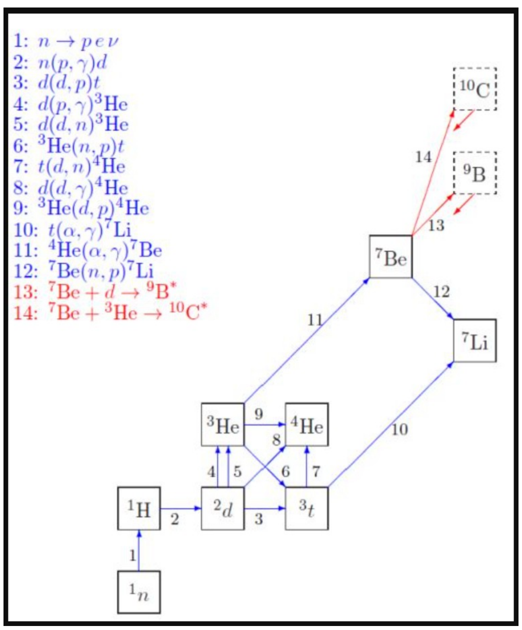

Figure 1. Simplified nucleosynthesis network from Fields (2011), showing pathways for lithium production in both primordial and galactic evolution. The network shows how deuterium starts the reaction chains leading to ^{3}He, ^{4}He, and ultimately to ^{7}Li and ^{7}Be.

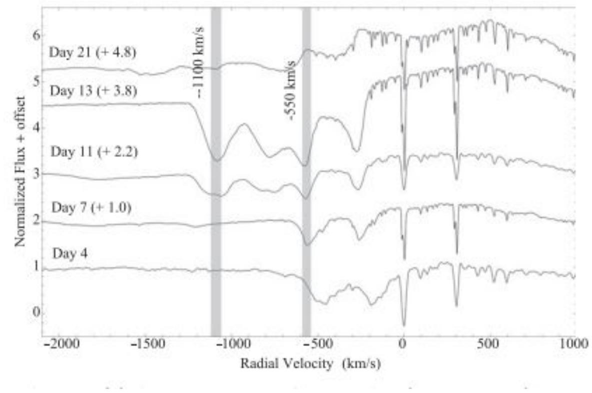

Figure 2. Figure from Izzo et al. (2015), showing identified blueshifted ^{7}Li I λ6708 Å, moving at –550 km/s. Note that the absorption feature is only prominent between days 7 to 13.

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