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LETTER

Letter to the Editor

IUE observations of Beryllium II lines in Lithium-rich giant stars⋆

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Abstract. IUE spectra of the Beryllium II region are presented for two Lithium-rich giant stars, HD 9746 and HD 112127. In either spectrum there is no sign of significant Beryllium features at the Be II lines 3130.416 Å or 3131.064 Å, which seems to indicate that Be was depleted in these two Lithium-rich giants. This suggests that some additional Lithium was produced in their stellar interiors during the evolution along the giant branch.

Key words: stars: abundances – stars: giant – stars: late-type

1. Introduction

The unusually high Lithium abundances found in Lithium-rich giants are not explained within the framework of the normal stellar evolution. According to this scheme, Lithium is predicted to be depleted in main-sequence stars with deep subphotospheric convective envelope, and is further depleted on the ascent of the red giant branch due to dilution in a deepening convective zone (e. g., Iben, 1965). About twenty of such Lithium-rich giants have been discovered up to now, some of them possessing surface Lithium abundances approaching the cosmic value of Logn(Li) = 3.0 (Brown et al., 1989; Gratton and D'Antona, 1989; Fekel and Balachandran, 1993; Gregorio-Hetem at al., 1992; De La Reza and Da Silva, 1995).

This excess of Lithium is frequently proposed to be fresh Lithium synthesized in the stellar interior, or to originate from a preserved Lithium content, or else to result from an external process such as pollution from debris of nova explosions, or a brown dwarf or giant planet engulfing in the atmosphere of an evolving star (e. g. Brown at al., 1989; Gratton and D'Antona, 1989; Fekel and Balachandran, 1993).

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⋆ Based on observations by the International Ultraviolet Explorer (IUE)

Beryllium and Lithium are fragile elements, destroyed by (p, α) nuclear reactions at moderately low temperatures in the stellar interiors. Lithium is destroyed at $\approx 2.5\ X\ 10^6$ K, whereas Beryllium is destroyed at $\approx 3.5\ X\ 10^6$ K. Therefore, Beryllium will be depleted by a deeper convective mixing than the one needed to deplete Lithium. Such a scenario is a powerful tool for the knowledge of stellar structure, providing substantial help for the analysis of the intriguing problem of the excess of Lithium in the so called Lithium-rich giant stars. If this Li content is preserved during evolution off the main sequence, one should expect an additional excess of Beryllium content in these stars. If, on the contrary, this Lithium excess results from fresh Lithium synthesized in the stellar interior, one should not expect for enhanced Be abundances in the stellar atmosphere. Let us recall that the Hyades giant stars are shown to be deficient in Be relative to the dwarfs by a factor of at least 30 (Boesgaard et al., 1977). Beryllium abundances in the Hyades dwarfs is close to the solar value (Boesgaard et al., 1977; Garcia López et al., 1995). Moreover, Hyades dwarf stars presenting high (normal) Li abundances, also show normal Be abundances (e.g.: Garcia López et al., 1995).

The above reasoning motivated us to look for Be features in the Lithium-rich giant stars. In this letter we present IUE observations of the Beryllium region for two such stars, namely HD 9746 and HD 112127.

2. Results

In Figure 1 we present the IUE spectra for HD 9746, a Lithium-rich giant with Logn(Li)=2.7, V sin i=8.7 km.s^{-1}, and V_r=−43.31 km.s^{-1}, and for HD 112127, a Lithium-rich giant with Logn(Li)=2.7, V sin i=1.7 km.s^{-1}, and V_r=5.16 km.s^{-1}. The K1III giant HD 9746 shows a rotational velocity enhanced with respect to typical Lithium-normal giants of the same spectral type, whereas HD 112127, with a spectral type K2.5III, shows normal rotational velocity (De Medeiros et al., 1996). It

Table 1. Journal of the observations (HD 28307 is used as a reference spectrum.)

	HD 9746	HD 112127	HD 28307
Image	LWP 29647	LWP 29909	LWP 17067
Date	Dec. 5, 1994	Feb. 5, 1995	Jan. 2, 1990
Julian date[1]	9691.885	9753.292	7893.634
Exposure time	150 minutes	137 minutes	25 minutes

should be noted that these authors have found no sign of binarity for these stars.

For HD 9746 and HD 112127, we obtained spectra with the International Ultraviolet Explorer (IUE) from the Vilspa Ground station. We observed the 1900 to 3200 Å UV region in high–resolution mode (Large aperture) with the Long Wavelength Prime camera (LWP). The log of observations is given in Table 1. We also display, for comparative purpose, the IUE spectrum of HD 28307, a K0III single giant in the Hyades with V sin i=1.5 km.s^{-1} and V_r=36.36 km.s^{-1}. This spectrum was taken from the IUE data archives.

In the IUE spectrum displayed in Fig. 1 for both Lithium-rich giants, HD 9746 and HD 112127, the lines of Be at 3130.416 Å and 3131.064 Å are weak or absent in relation to the comparison spectrum of the giant HD 28307. In this Figure the wavelength scale was transformed into the stellar rest frame. As shown by Boesgaard et al. (1977) both Be and Li are deficient in the Hyades giants compared to their abundances in the dwarfs, with a Be mean dilution factor greater than 32.

The present results for HD 9746 and HD 112127 seem to indicate that such stars are as Be deficient as the Hyades giant HD 28307, suggesting strongly that Beryllium was also depleted in these two Lithium-rich giants. This Beryllium deficient behavior for the Lithium-rich giants HD 9746 and HD 112127 would be a strong evidence that, at least for these two stars, the unusual high Lithium content is not primordial. This implies that, in principle, some Lithium may have been produced in their interiors during evolution along the red giant branch.

More accurate observations of the Be II region, with higher signal-to-noise ratio, and a study of the CNO abundances, would serve as powerful tools for a more solid discussion about the origin of the Lithium excess in the Lithium-rich giant stars.

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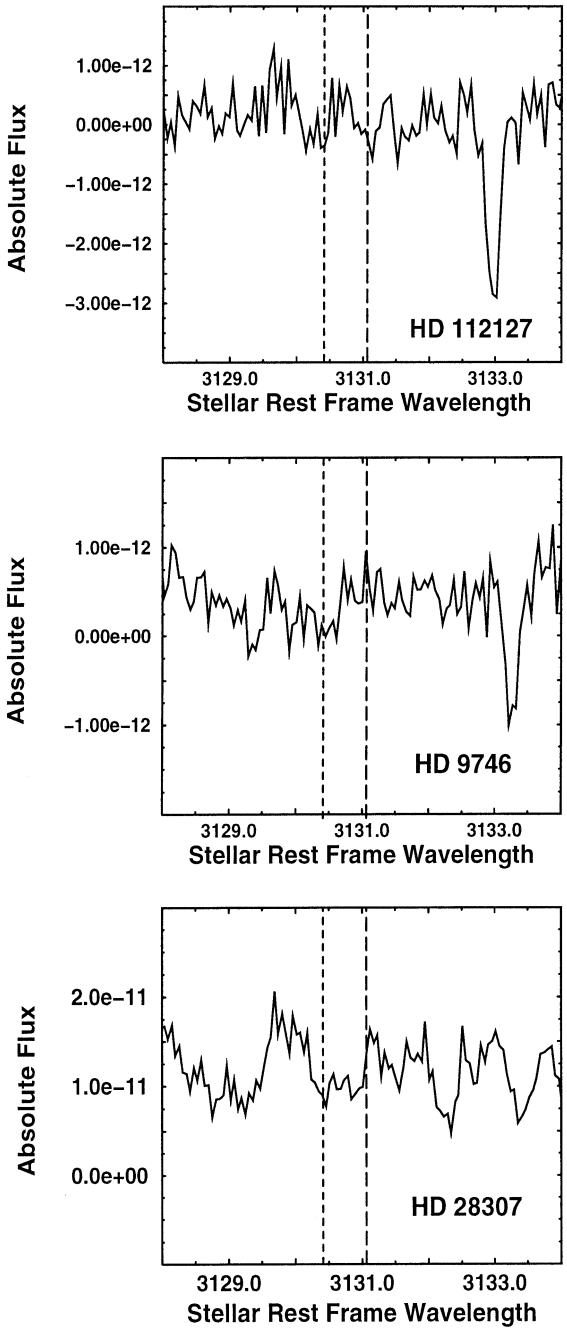

Fig. 1. IUE observations: the Beryllium spectral region. The Be II laboratory wavelengths (3130.416 Å and 3131.064 Å) are indicated with dashed lines. The wavelength scale has been transformed to the stellar rest frame and the absolute flux is given in erg.s.$^{-1}$cm.$^{-2}$Å.$^{-1}$

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