LITHIUM ABUNDANCES IN NORTHERN RS CVN BINARIES

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ABSTRACT  We report the results of a survey of the Lithium 6708 Å line in Northern RS CVn binaries. 37 RS CVn's taken from the list of Strassmeier et al. (1988) were observed at the National Solar Observatory, using the McMath Main Telescope and the Stellar Spectrograph. From a preliminary analysis of the spectra we infer the presence of a moderate, and sometimes strong, Li line in many cool stars in the sample. This confirms what previously found by Pallavicini et al. (1991) for the Southern hemisphere, i.e. that RS CVn binaries tend to have larger Li abundances than typical inactive stars of the same spectral type.

Keywords: RS CVns; Lithium Abundance; Stellar Surveys

INTRODUCTION

It is commonly believed that Lithium should not be present in large amounts in late-type evolved stars. This element, in fact, is destroyed during main sequence lifetime in cool stars, and a subsequent dilution occurs during the giant phase, leaving the star heavily depleted of Li. However, recent observations by Pallavicini et al. (1990, 1991) using the 1.4m CAT telescope and the Coudé Echelle Spectrometer at ESO yielded quite different and unexpected results. Many K-type giants and subgiants in their sample, including a large number of RS CVn binaries, showed an anomalously high Li abundance with respect to typical inactive stars of the same spectral type.

In order to explain such a large amount of Li, Pallavicini et al. considered several possibilities, involving both the evolutionary status of the stars and characteristic properties of RS CVn binaries, like their high level of chromospheric activity and large rotation. However, they could not definitively discriminate between the various alternatives because: i) their sample of Southern stars was rather inhomogeneous; ii) even those objects classified as RS CVn binaries had generally poorly determined parameters (masses, radii, absolute luminosities).

Most well-studied "classical" RS CVn systems are found at Northern declinations and they offer a better opportunity to discriminate between alternative possibilities. For this reason, we have recently carried out a Li survey of Northern RS CVn stars with the purpose of investigating Li in "classical"
RS CVn binaries and testing whether the presence of a strong Li line in several southern active stars could be due to the heterogeneous nature of the sample.

OBSERVATIONS

The observations were carried out at the National Solar Observatory (NSO) using the McMath Main Telescope with the Stellar Spectrograph and CCD detector. Using the 105mm transfer lens the nominal resolution was R=42,000. The covered spectral range was about 70 Å, centered at the Li 6708 Å resonance doublet. 37 RS CVn binaries were observed in two observing runs in February and May 1991. Short period SB2 binaries were monitored at different phases.

Fig. 1: Spectrum of the SB1 RS CVn binary HD 205249.

Several inactive cool giants and subgiants were also observed for comparison as well as a few stars already observed at ESO. The quality of the NSO spectra was similar to that of the ESO data, although the resolution of the latter was slightly higher. This makes us comfortable when comparing the results obtained for the Northern stars to those obtained previously at ESO. An example of the acquired data is shown in Fig. 1 where we plot the spectrum of the K1 III SB1 binary HD 205249. The Li line, though not exceptionally strong, is clearly present with an equivalent width of ~ 100 mÅ of which only ~ 35 mÅ can be attributed to the nearby FeI 6707.44 Å line.

RESULTS

A preliminary analysis of the spectra confirms what previously found for the Southern hemisphere. Lithium is present in more than 50% of the late-type binaries in the sample. The strength of the line is not exceptionally high ($W_\lambda \sim 80 - 120$ mÅ), but significantly larger than typically observed for K-type giants. In a few stars, the Li line appears to be very strong (larger than the
6718 Å Ca I line). A careful spectrum synthesis analysis, however, is required for SB2 binaries, in order to take into account possible contributions to the Li line of one component from Fe lines of the other component.

Approximate Li abundances have been derived from the measured equivalent widths using curves of growth. This has been done, at the moment, for only a few stars in the sample, including RSCVn itself.

![Graph showing Li abundances vs. effective temperature](image)

Fig. 2: Li abundances vs. effective temperature for inactive field stars (open symbols), the active stars from Pallavicini et al. (filled symbols) and the stars in the present survey (asterisks). Inverted triangles indicate upper limits.

The results are summarized in Fig. 2 where Li abundances vs. effective temperature are plotted for inactive field stars (open symbols), the active stars from the sample of Pallavicini et al. (filled symbols) and the stars in the present survey (asterisks). The positions of the Northern RSCVn's in the plot are consistent with those of Southern active stars, i.e. their Li abundances are typically higher than for normal inactive stars of similar spectral type. A more detailed analysis of the data is currently in progress. Besides determining Li abundances for all stars in the sample through spectrum synthesis analysis, we will also determine metallicities and rotation rates. This will allow us to investigate possible relationships between these quantities and Li abundance, in an effort to understand the presence of Li in RSCVn binaries.

REFERENCES