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Ultra-lithium-deficient halo stars

Lisa M. Elliott[1] **and Sean G. Ryan**[2]

[1]Centre for Stellar and Planetary Astrophysics, School of Mathematical Sciences
Building 28, Monash University, Victoria, 3800, Australia
email: Lisa.Elliott@sci.monash.edu.au

[2]School of Physics, Astronomy and Mathematics, and Centre for Astrophysics Research,
University of Hertfordshire,
College Lane Hatfield AL10 9AB, United Kingdom
email: s.g.ryan@herts.ac.uk

Abstract. While most warm halo dwarfs show lithium abundances at the level of the Spite Plateau, a small number ($\sim 5\%$) have undetectable lithium lines. The existence of these stars has long raised questions when interpreting the plateau abundances: are they an extreme example of a depletion mechanism that has affected the plateau stars, or do they have an entirely different history? We provide an overview of what is currently known about the lithium-poor halo stars and discuss a possible origin for the lithium deficiency in this unique group of stars.

Keywords. stars: abundances, blue stragglers – Galaxy: halo

1. Introduction

The existence of warm halo dwarfs with lithium abundances significantly below the Spite Plateau was first noted by Spite *et al.* (1984). These stars have undetectable lithium lines, with inferred upper limits for A(Li) more than 0.4 dex below the level of the plateau (eg. Hobbs & Mathieu 1991; Thorburn 1992). Previous studies of lithium-deficient halo stars have revealed various abundance anomalies that affect some, although not all, stars (eg. Norris *et al.* 1997; Ryan *et al.* 1998). More recently, many of these objects were found to be deficient in Be (Boesgaard & Novicki 2005; Boesgaard 2007). Ryan *et al.* (2002) discovered that three out of four lithium-poor stars studied showed spectral line broadening and attributed this to rotation. Coupled with a high incidence of binarity, these findings have led to suggestions that the lithium-poor stars may be a product of the same mechanism that is responsible for the formation of field blue-stragglers. Understanding the origin of the lithium-poor stars is crucial for studies of the Spite Plateau: if they do have a different history to normal halo dwarfs they should be ruled out of future studies of lithium depletion in the general halo population.

Following the rotation study of Ryan *et al.* (2002), a further investigation of abundance trends and rotation properties in the lithium-poor stars was undertaken (Elliott & Ryan 2010; Ryan *et al.* 2010). Here we draw on results from these studies, along with previous results, to provide an overview of the observed characteristics of the lithium-poor halo stars.

2. Overview of results

A summary of observed properties for nine lithium-deficient halo stars is presented in Table 1. The key properties are as follows:
Abundances Two cool, metal-poor lithium-poor stars show abundance ratios that differ from the mean trends in the general halo population. This includes enhancements in the

Table 1. Overview of properties of lithium-deficient halo stars

Star	T_{eff}	[Fe/H]	Abundance Anomalies?	Rotation	Binary[1]
HD97916	Warm*	High*	No	Yes	Yes
G202-65	Warm	High	No	Yes	Yes
G66-30	Warm	High	No	Yes	Yes
BD+51°1817	Warm	High	No	Yes[2]	Yes
BD+25°1981	Warm[3]	High[3]	No	Yes?[1]	Yes?
CD-31°19466	Cool	Med	No	No[2]	?
G122-69	Cool	Low	No	Yes	No
G139-8	Cool	Low	Yes	No	No
G186-26	Cool	Low	Yes	No	No

Notes:
$*$ Warm refers to stars with $T_{eff} \gtrsim 6300$ K, high refers to stars with $[Fe/H] \gtrsim -1.50$
[1] From Carney *et al.* 1994; Carney *et al.* 2001; Latham *et al.* 2002 [2] From Ryan *et al.* (2002). [3] From Ryan *et al.* 2001.

neutron-capture element ratios [Sr/Fe], [Y/Fe] and [Ba/Fe] in G186-26 and deficiencies in [Na/Fe], [Mg/Fe], [Al/Fe], [Sr/Fe] and [Ba/Fe] in G139-8.

Rotation At least five stars show evidence of line broadening indicative of rotation rates exceeding that expected in old halo dwarfs. Inferred projected rotation velocities for these five stars are between 4.7 and 10.4 km s^{-1}. At least four of the rotating stars are in binary systems, with periods ranging from 168 to 688 days (Carney *et al.* 1994; Carney *et al.* 2001; Latham *et al.* 2002). Rapid rotation is common in the warm, metal-rich subset of lithium-poor stars while only one of the cooler stars, G122-69, shows mildly enhanced rotation.

3. Conclusions

The high incidence of rotation among the lithium-poor stars suggests that these stars do have a different history to the lithium-normal halo population. Our results, particularly for the warm subset of lithium-poor stars, support a scenario in which mass and angular momentum have been transferred from a now evolved companion, similar to the mechanism that may be responsible for the formation of field blue-stragglers.

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