Beryllium Abundances in Extremely Metal Deficient Stars

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1. Introduction and Background

At very low metallicities, below [Fe/H] = -3, there is evidence that the abundance of Be levels off, forming a plateau (Primas et al. 2000a, 2000b) similar to the Spite plateau for Li. The goal of this project is to determine the relationship between the abundances of Be and Fe at very low Fe, tracing the chemical history of Be. It is also possible to determine the O abundance using OH lines from the same spectra. Boesgaard et al. (1999) determined the relationships: $logN(Be/H) = 1.45\,(\pm 0.04)\,[0/H] - 10.69\,(\pm 0.04)$ and $logN(Be/H) = 0.96\,(\pm 0.04)\,[Fe/H] - 10.59\,(\pm 0.03)$.

The Li plateau in older stars is due to nucleosynthesis of Li during the Big Bang. Some non-homogeneous models of the Big Bang would lead to the synthesis of a large enough amount of Be that a plateau could be detected in the oldest stars. Another possible cause could be the creation of Be through spallation reactions in contained superbubbles created by multiple supernovae (Parizot and Drury 2000) or near hypernovae (Fields et al. 2002, Nakamura et al. 2006). Enrichment of the ISM in Be by such processes could result in a detectable plateau.

The lowest metal stars ([Fe/H] < -3.0) were formed early in the evolution of the Galaxy. By tracing the abundance of beryllium in these old stars, insight can be gained into the chemical history of the Galaxy. Be is formed mainly through spallation reactions. This happens either as the early generations of massive stars eject C and O in supernovae, which then collide with baryons and spall into Be, or as high energy cosmic rays interact with C, N and O atoms in interstellar gas. This means that abundances of Be in old stars provides a way to trace the earliest generations of massive stars.

2. Method

High resolution specra obtained with the Keck HIRES instrument will be used to find the abundance of Be in these stars. The data in hand includes 14 stars with [Fe/H] ranging from -2.9 to -3.7. The arrows in figure 1 show the stars' values for [Fe/H] compared to current available data. Some of the data has been reduced, but data taken during observations in September (for which I was present) and January still needs to be, which will allow me to gain experience working with IRAF.

To analyze the data, I will need to find stellar parameters, make model atmospheres and perform spectrum syntheses. Programs already exist for the creation of model atmospheres and spectrum syntheses. Ann will help me understand, reduce and analyze the data as well as provide a background for the work. There is also a possibility for more data, as Ann has observing time coming up. This would also mean more experience observing, as I would be able to accompany her on runs March 19th and June 18th of this year.

Once abundances have been found, a relationship between [Be/H] and [Fe/H] or [O/H] can be found and the results can be interpreted. If there is evidence of a plateau, a cause will be investigated. The spread in the values of [Be/H] (or lack thereof) will have ramifcations for early star formation, Supernovae and massive stars. The results will allow for better undertsanding of the history of Be and its formation processes, the chemical history of our galaxy, and Big Bang nucleosynthesis.

References

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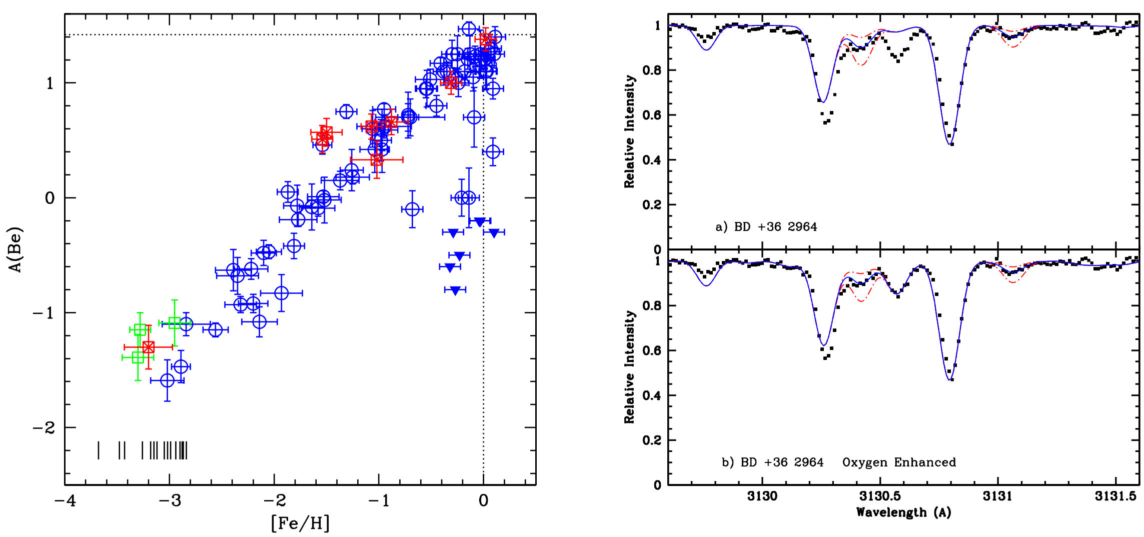

Fig. 1.— Left: Current data for Beryllium abundances. Blue points are data from Boesgaard et al. (1999), Boesgaard et al. (2000), Boesgaard et al. (2004). Green points are from Primas et al. (2000a, 2000b). Red points are from Boesgaard & Novicki (2006). The dotted horizontal line is the meteoritic Be Abundance, A(Be)=1.42. The lines to the lower left represent the metallicities of the stars to be included in my study. Right: Data with model spectral fits superimposed. Red lines show fits for different amounts of Be. Note the contrast between the upper fit and the lower (oxygen enhanced) fit, which accounts for the OH line just longward of the stronger Be line. This could be used to measure O abundances in the data.

Table 1. Beryllium Observations

Star	V	[Fe/H]	Exp. min.	S/N	Star	V	[Fe/H]	Exp. min.	S/N
G 268-32	12.1	−3.50	270	113	LP 651-4	12.0	−2.96	65	86
G 75-56	11.9	−3.01	232	116	BD +3 740	9.8	−2.90	60	167
BD +20 2030	11.2	−2.86	60	122	BD +9 2190	11.2	−2.92	120	110
BD +1 2341p	10.5	−3.14	40	139	G 10-4	11.4	−3.04	120	99
BD -13 3442	10.4	−3.14	80	183	G 64-12	11.5	−3.45	210	121
G 64-37	11.1	−3.28	270	87	G 206-34	11.4	−3.04	105	101
LP 752-17	11.9	−2.87	60	73	LP 815-43	10.9	−3.20	90	91
G 275-4	12.2	−3.70	190	75					