From Lithium to Uranium: Elemental Tracers of Early Cosmic Evolution
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Germanium Abundances in Field Stars

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Abstract. From Ge I lines in the near-ultraviolet, germanium abundances are deduced for the Sun, one metal-poor subgiant, and nine turnoff stars spanning a range of metallicities. The abundance of germanium with respect to iron varies widely among the stars, and is always at or below its solar proportion. In four stars, one mildly and the rest extremely metal-poor, Ge is deficient by $\geqslant 0.5$ dex. The nearby elements Zn and Zr show nearly scaled-solar abundances. The Ge deficiency persists when heavy r-process elements such as platinum are extremely enhanced. Among this small sample, Ge deficiency correlates with Al deficiency, of similar size.

Keywords. Astrochemistry, stars: abundances, stars: Population II

Ge abundances are derived in this work from the near-ultraviolet Ge I lines in ten stars plus the Sun. All are dwarfs except one, BD +17 3248, an r-process-rich subgiant.

The temperature and gravity were redetermined for each star as described by Peterson, Dorman, & Rood (2001) from the ultraviolet spectral flux level, the breadth of Balmer line wings, strengths of strong metallic-line wings, and the dependence of abundances on line excitation and ionization. Accord with Cowan *et al.* (2005) is fair for BD +17 3248.

The observed data were taken with the Hubble Space Telescope Imaging Spectrograph (STIS) echelle. The sole exception is HD 179949, whose ground-based echelle spectrum was provided by Steven Vogt of UCO/Lick Observatories. The resolution varies because of different gratings and the rotation of hotter stars, with V sin(i) $\leqslant 9$ km s^{-1}.

To obtain abundances, spectra were calculated from first principles using the program SYNTHE by R. L. Kurucz, and models of Castelli & Kurucz (2004). A revised list of atomic and molecular line parameters (Peterson *et al.* 2004) helped to disentangle blends.

The figure shows the results for the region including the Ge I line at 3039.067 Å. Each panel compares the theoretical spectra (light line) with the echelle observations (heavy black line) for six stars, offset vertically for visibility. Wavelength in Å appears at the bottom, and y-axis ticks represent 10% of the full intensity scale. The same log gf values were adopted in each stellar calculation. Model parameters appear after the star name (in bold). Calculations in color include only lines of a single element: orange is Zn (atomic number Z=30) and Ge (32), and red is Zr (40). A scaled-solar Ge abundance was assumed. For HD 140283 only, a second calculation is shown with Ge reduced by 0.8 dex.

The plot shows that Ge is generally deficient in stars more metal-poor than [Fe/H] = −1.3, but is also deficient in HD 128167 at [Fe/H] = −0.4. The Ge abundance is most closely related to the Al abundance, which is about as deficient as Ge in all stars plotted. This sample must be increased, and a larger variety of elemental abundances determined in each star, to better constrain the process(es) producing germanium.

References

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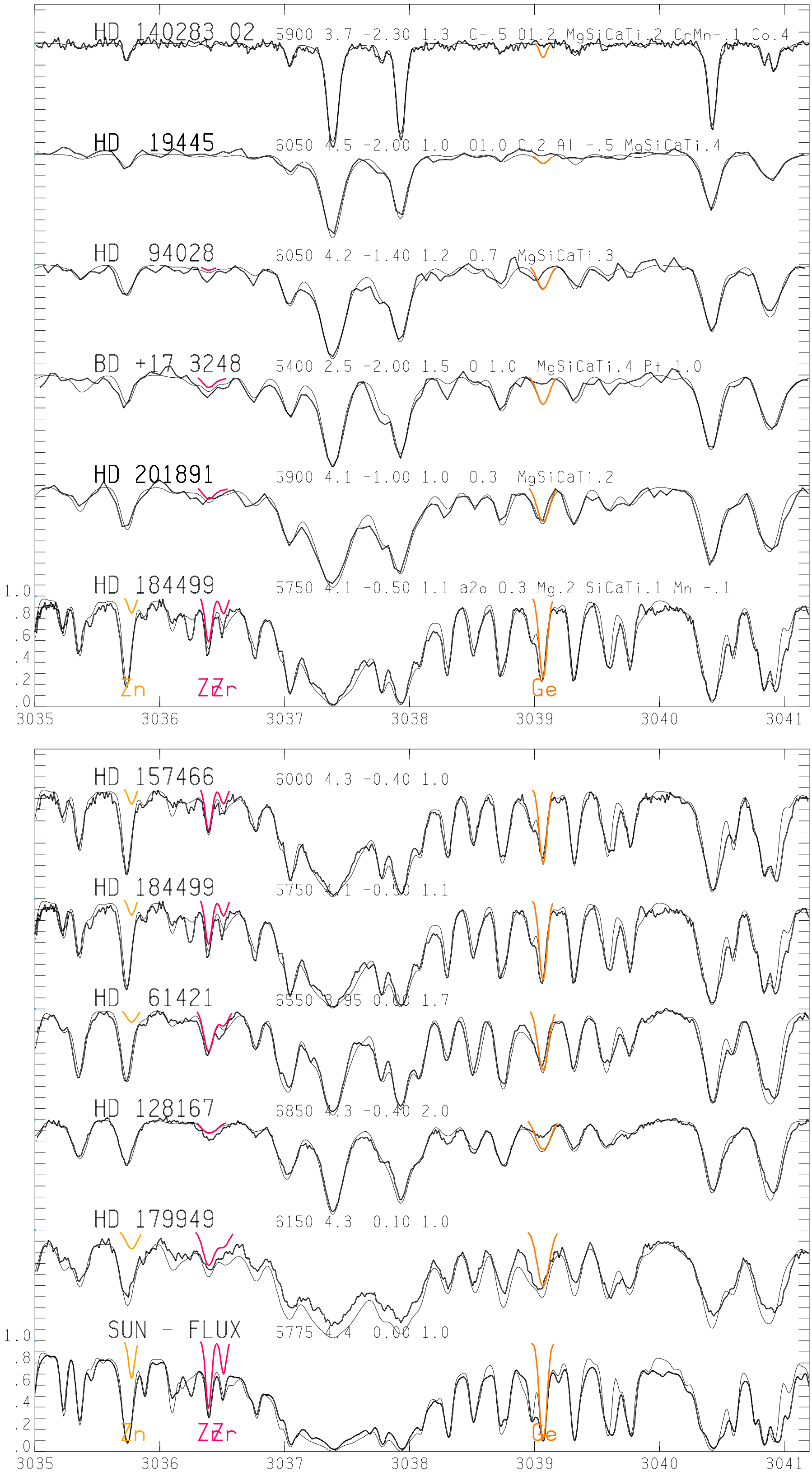

Figure 1. The two panels show theoretical (thin line) spectra compared to echelle (heavy line) spectra for six stars.

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