The metallicity of nearby stars

UPPSALA UNIVERSITET

CASE WESTERN RESERVE UNIVERSITY

Ulrike Heiter

Department of Astronomy and Space Physics, Uppsala University

R. Earle Luck

Department of Astronomy, Case Western Reserve University

Summary

- We present abundance data for **nearby stars**, including a sample of **planet hosts** and comparison stars.
- We find **no difference in the lithium contents** of the hosts versus the non-hosts.
- The mean abundances of **all other elements in the planet hosts are between 0.1 and 0.2 dex higher** than non-hosts. Abundances relative to Fe show no differences in the samples.
- Overall trends in the abundances are dominated by **galactic chemical evolution**.
- The planet-hosts are spread through velocity space – they are not exclusively stars of the thin disk.
- The abundances and astrophysical parameters are based on high resolution, high signal-to-noise optical spectra.

Stellar samples

- 217 dwarf stars in total, all north of declination $-30°$
- 115 F, G, K dwarfs from the *Hipparcos* catalog, within 15 pc from the Sun, brighter than 7.5 absolute magnitudes
- 55 planetary host stars, discovered before mid-2003 (84% within 50 pc)
- 53 additional comparison stars (from Heiter & Luck 2003, 89% within 50 pc)

Observations

- Echelle spectroscopy with 2.1m telescope at McDonald Observatory
- Spectral range 475 to 685 nm, R≈60,000, S/N > 150
- Data available at **http://bifrost.cwru.edu/NStars/**
- Solar flux spectrum using Callisto as the reflector
- Equivalent widths measured to better than 15 – 5% for all unblended lines from 10 to 200 mÅ

Methods

- Line by line differential abundance analysis based on synthetic line profiles for Li I 670.7 nm, C I 505.2, 538.0, 658.7 nm, C_2 513.5 nm, [O I] 630.0 nm and synthetic equivalent widths for all other elements
- Model atmospheres computed with prior generation MARCS code (Gustafsson et al. 1975)
- Excitation and ionization equilibrium for Fe lines used to determine astrophysical parameters
- For details see Luck & Heiter (2005, 2006) and Heiter & Luck (2003)

Results

- The mean difference between planet hosts and comparison stars in [Fe/H] is 0.18 dex. The range in [Fe/H] values is comparable.
- There is no difference in Li abundances between planet hosts and comparison stars (see **Figure 1**). All other elements show abundance differences similar to [Fe/H].

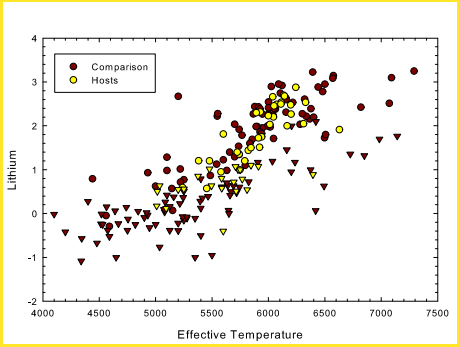

Figure 1 - *Lithium abundances vs. effective temperature.*

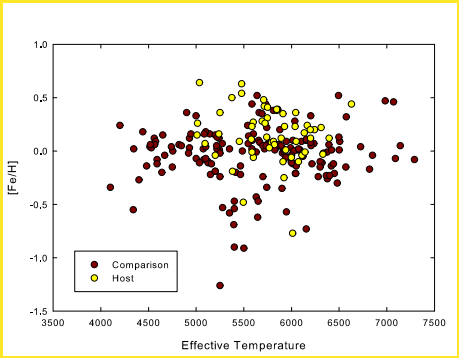

Figure 2 - *[Fe/H] vs. effective temperature.*

References

Luck, R. E. & Heiter, U. 2006, AJ, 131, 3069
Luck, R. E. & Heiter, U. 2005, AJ, 129, 1063
Allende Prieto et al. 2004, A&A 420, 183
Heiter, U. & Luck, R. E. 2003, AJ, 126, 2015
Gustafsson, B. et al. 1975, A&A, 42, 407

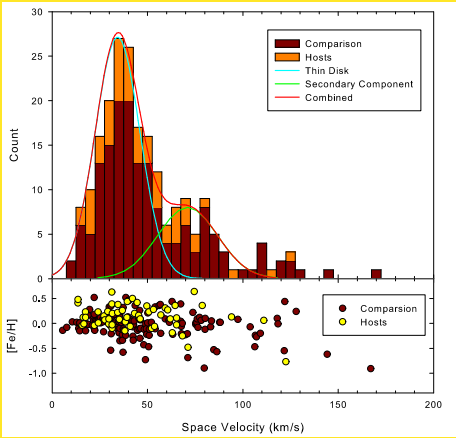

Figure 3 - *Space velocity distribution.*

- [C/Fe] and [O/Fe] abundances for all stars do not depend on $T_{\rm eff}$. They show well-known dependencies on [Fe/H], which can be explained by galactic chemical evolution.
- Dependencies of other elements on [Fe/H] are as expected from chemical evolution models.
- [Fe/H] values do not depend on $T_{\rm eff}$, except that metal-poor dwarfs are at $T_{\rm eff} \geq 5400$ K (see **Figure 2**, cf. Fig. 12 of Allende Prieto et al. 2004).
- Planet hosts concentrate at $T_{\rm eff}$ range 5400–6000 K. This indicates a preference in planet formation (CGP) for metal-rich stars with mass around one solar mass.
- The space velocity distribution shows two peaks (thin/thick disk) and a high-velocity tail (see **Figure 3**). Planet hosts are found over the whole velocity range.
- There is no trend of metallicity with space velocity.
- For velocities > 50 km s^{-1}, there is no difference in [Fe/H] between planet hosts and comparison stars.
- Future studies of the local region should consider a spectroscopic sampling of an extended region (e.g. nearest 100 pc), as well as a similar sized adjacent volume.