Hyperfine Structure and Abundances of Heavy Elements in 68 Tauri (HD 27962)

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Introduction

HD 27962, also known as 68 Tauri, is a chemically peculiar Am star located in the Hyades Open Cluster in the local arm of the Galaxy. We reduced and model the high resolution SOPHIE (R=75000) spectrum of 68 Tauri. We used model atmosphere and spectrum synthesis to derive chemical abundances in its atmosphere. Furthermore, we have studied the effect of the inclusion of Hyperfine Structure of various Baryum isotopes on the determination of the Baryum abundance. We have also derived new abundances using updated accurate atomic parameters retrieved from the NIST[a] database.

[a]https://www.nist.gov/pml

Model Atmosphere

We used the observed Strömgren photometry of 68 Tauri retrieved from SIMBAD and the UVBYBETA code of T.T.Moon (1985) to determine the effective temperature of 9025 ± 200 K and the surface gravity log(g)=3.95±0.25 dex of 68 Tauri. We used these parameters to compute a 72 layers plane parallel model atmosphere with the ATLAS 9 code (Kurucz, 1992) assuming Local Thermodynamical Equilibrium, Hydrostatic Equilibrium and Radiative Equilibrium.

Spectrum Synthesis

We used Hubeny's code SYNSPEC49 (1992) to compute a grid of synthetic spectra to model the observed spectrum of 68 Tauri. We first computed a synthetic spectrum adopting solar abundances as a first iteration and then altered the abundances in order to reproduce the line profiles of selected lines with accurate atomic parameters.

Conclusion

The abundance analysis yields a distinct underabundance of Sc and a slight underabundance in C, O, Mg, Si and Ca, mild overabundances of the iron-peak elements and large overabundances of the rare-earth elements.
Owing to the improvement of atomic data, we have enlarged and improved the elemental abundances of 68 Tauri. The new results on the rare-earth group confirm the Am peculiarity of 68 Tauri. We stress the importance of taking into account the Hyperfine Structure for all isotopes when available in order to derive accurate abundances.

References

[1] Adelman; Pintado, 2003, The late B and early A stars ξ Octantis, α Sextantis, and 68 Tauri, *Astronomy and Astrophysics*, 406, 987–994

[2] Kurucz, 1992, Model Atmospheres for Population Synthesis, *The Stellar Populations of Galaxies*, 149, 225

[3] McWilliam, 1998, Barium Abundances in Extremely Metal-Poor Stars, *The Astronomical Journal*, 115, 1640–1647

[4] Moon; Dworetsky, 1985, Grids for the determination of effective temperature and surface gravity of B, A and F stars using uvby-beta photometry, *Monthly Notices Roy. Astron. Soc.* 217, 305

Baryum Hyperfine Structure

We replaced the observed line λ 5853.675Å of Ba II extracted from the NIST Atomic Spectra Database with the Hfs of the 5 major isotopes of Baryum as calculated by McWilliam(1998). We used a solar isotopic mixture to compute the grid of synthetic spectra. We find a large difference on the Baryum abundance when including the full hyperfine structure. For the 5853.675Å line shown Figure 1, the inclusion of Hfs yields a Baryum abundance lower of 0.4 dex than when ignoring Hfs.

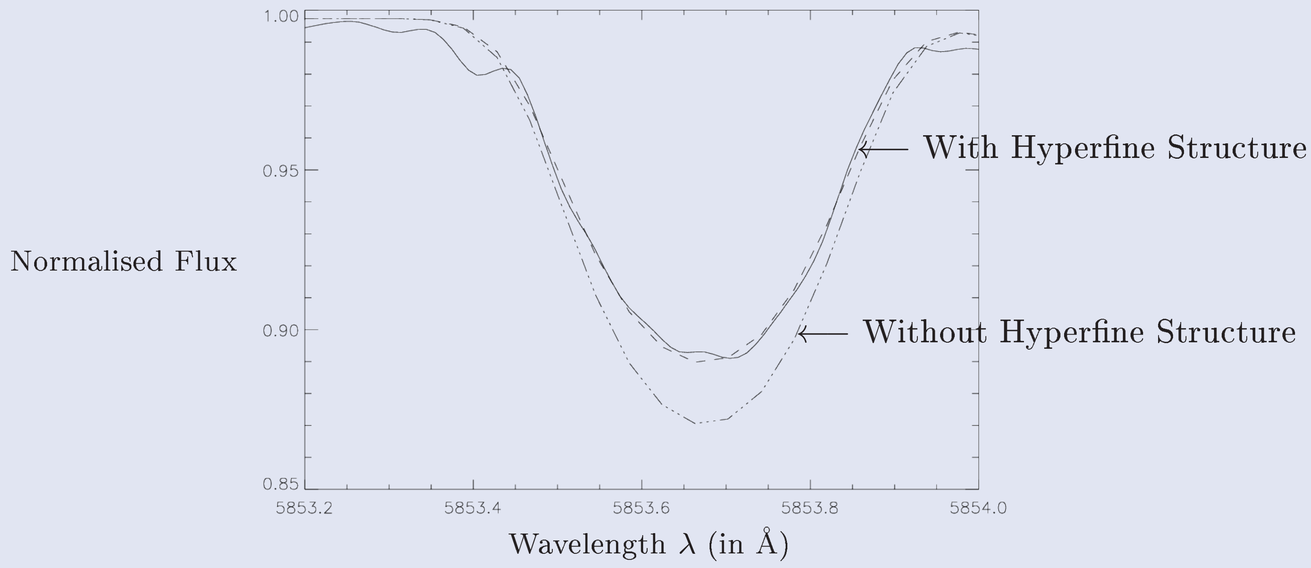

Figure 1: The effect of including Hfs on the line profile of the 5853.675 Å line of Ba II *(observed: thick line, synthetic spectra: dashed line)*

Abundances in the Atmosphere of 68 Tauri

We determined abundances for each lines of Fe II and then computed a weighted mean according to the quality grades assigned to each transition in NIST.

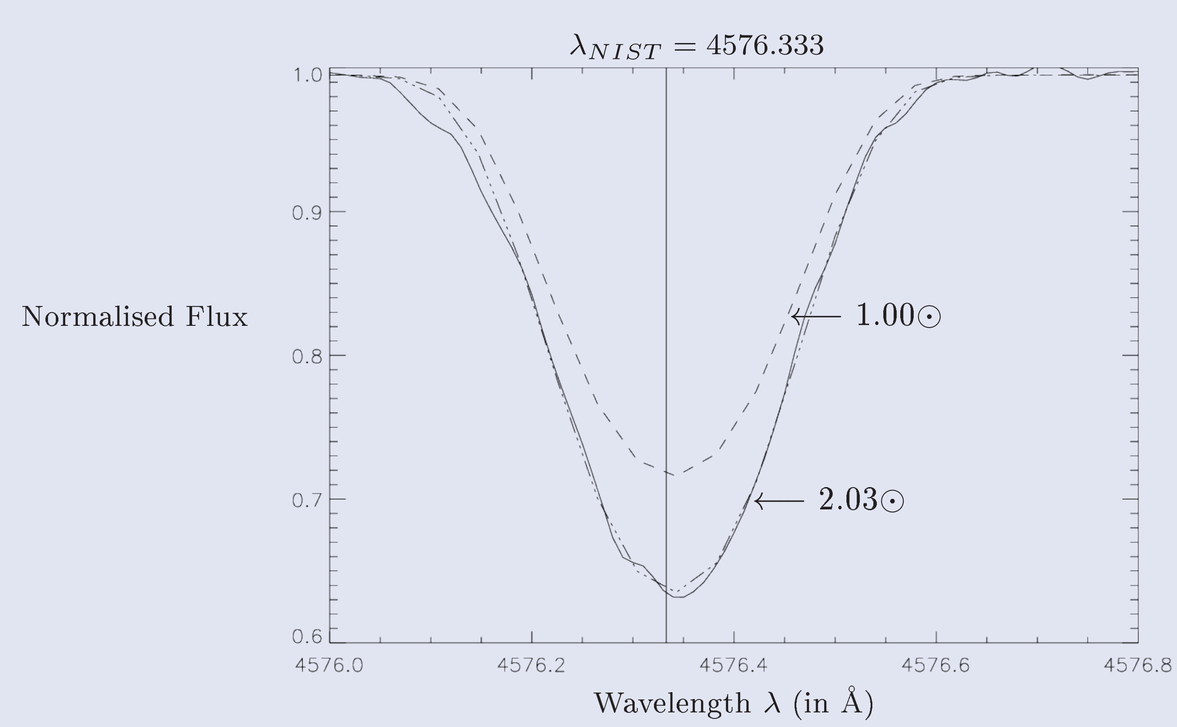

Figure 2: Determination of Iron abundance for the 4576.33Å Fe II line *(observed: thick line, synthetic spectra: dashed line)*

We used this method to determine the abundances of 21 elements. Our determinations are displayed in Figure 3 with error bars, and we compare our results to the abundances previously found by Adelman and al. (2003).

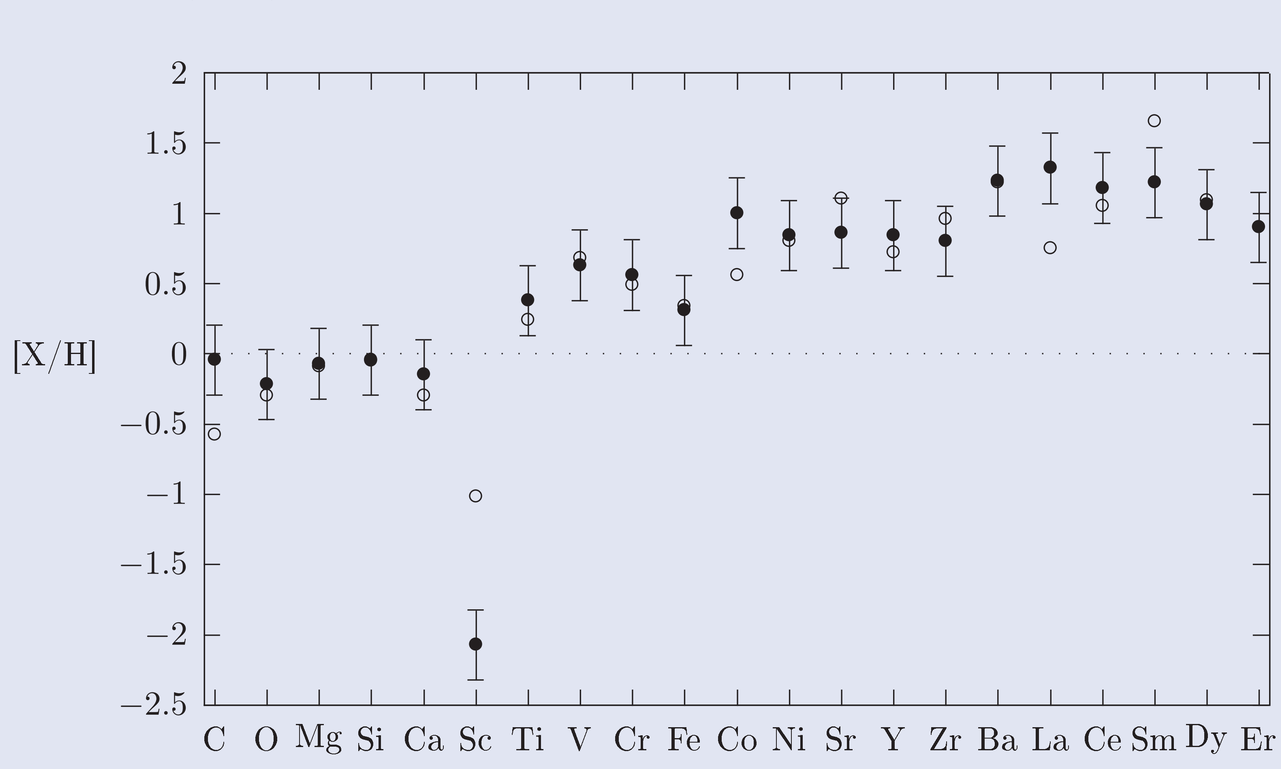

Figure 3: The found abundance pattern in 68 Tauri: *circles (Adelman and al.), dots (this work).*