

Interstellar CaII line intensities and the distances of the OB stars

J. Krelowski¹ G. A. Galazutdinov² A. Megier¹ A. Strobel¹
A. Bondar³ F.A. Musae⁴ and I. Han²

¹Center for Astronomy, N. Copernicus University, Gagarina 11, Pl-87-100 Toruń, Poland
emails: Jacek.Krelowski@astri.uni.torun.pl; Andrzej.Megier@astri.uni.torun.pl;
Andrzej.Strobel@astri.uni.torun.pl;

²Korea Astronomy and Space Science Institute, Optical Astronomy Division, 61-1,
Whaam-Dong, Yuseong-Gu, Daejeon, 305-348, Korea
emails: gala@kasi.re.kr; iwhan@kasi.re.kr

³International Centre for Astronomical and Medico-Ecological Research, Terskol, Russia
email: arctur@terskol.com

⁴Special Astrophysical Observatory, Nizhnij Arkhyz, 369167, Russia
email: faig@sao.ru

Abstract. We show that the equivalent widths of the well-known interstellar CaII H and K lines can be used to determine the distances to OB stars in our Galaxy. The equivalent widths, measured in the spectra of 149 early-type stars, exhibit a simple (approximately inverse) relation with Hipparcos parallaxes.

Keywords. ISM:lines and bands — stars:distances — stars:early-type

It was Struve (1928) who first observed the relation between the "detached" Ca II K line and estimated distance. Further work on the subject was published by Sanford (1937), Merrill (1937), Evans (1941), and Beals and Oke (1953). While many later studies have used the Ca II (and other atomic) lines to study both spatial and velocity structure of the interstellar medium, the early results on the intensity – distance relation were for nearly half a century difficult to improve on, because of the problems associated with estimating stellar distances in the appropriate distance range (hundreds of parsecs).

The publication of the Hipparcos Catalogue (ESA 1997) made available a set of parallaxes for 120 thousand stars measured with miliarcsecond accuracy. Using this homogeneous source of parallax data, and a collection of high resolution spectra of 149 OB stars, we investigate the dependence of the equivalent widths of Ca II H and K interstellar lines on parallax. For many stars in our sample, the errors in Hipparcos parallaxes are comparable to the parallaxes themselves. We studied the relations directly in the parallax – equivalent width diagrams, avoiding problems (e.g truncation bias) associated with the inversion (Arenou & Luri 1999, Smith 2003).

We have selected for this project a set of 149 early-type stars (no later than B3), where the influence of possible stellar contamination of H and K lines is negligible. The spectra have been collected using echelle spectrographs of several observatories: MAESTRO (Terskol, Northern Caucasus), Feros (ESO) and BOES (Korea). The spectral resolution varies between 30,000 and 120,000.

Figure 1 presents the parallax vs EW(Ca II H) relation. For clarity, only errorbars for the parallax are drawn; the average errorbar for the equivalent width is close to the filled symbol size. The approximately inverse dependence is conspicuous. The two discrepant stars in the lower left of the diagram are HD 37022 and 37023, situated

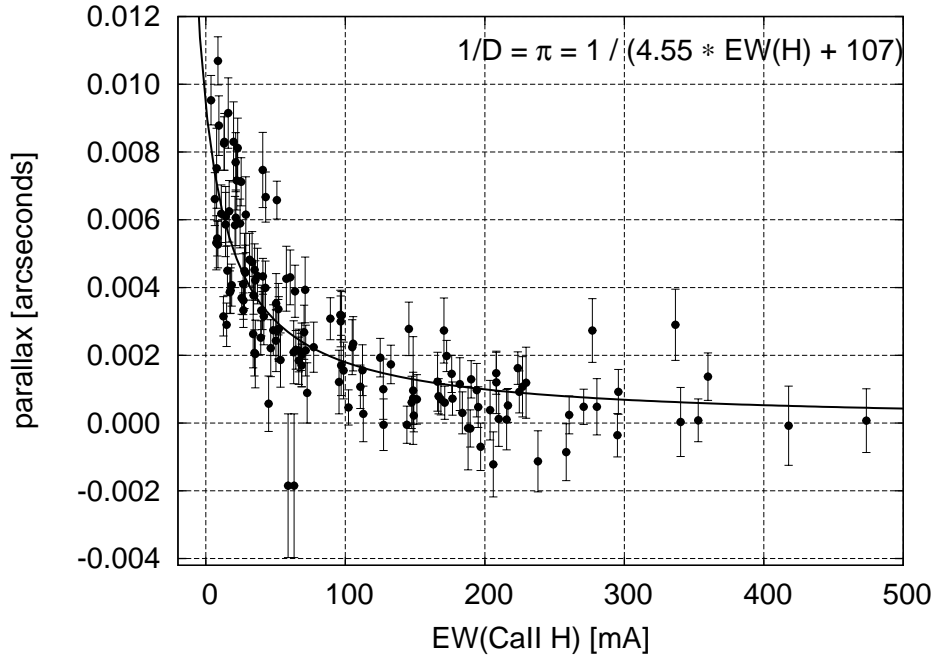


Figure 1. The relation between trigonometric parallax and equivalent width of the Ca II H line. The corresponding formula for the Ca II K line (not shown) is $1/D = \pi = 2.72 \times EW(K) + 102$

13 arcseconds apart. The fitting was done with a weighted least squares algorithm; the resulting formulae are given in Fig. 1. Distances, calculated with the aid of these formulae are given in parsecs if the equivalent widths are in $\text{m}\text{\AA}$. As can be seen, the formulae give nonzero distance ($\approx 100\text{pc}$) even for zero absorption; this corresponds approximately to the radius of the Local Bubble. The proposed method can be used at relatively large distances, i.e. from a few hundred parsecs to, most likely, a few kiloparsecs, not far from Galactic plane ($|z| < 800\text{ pc}$); it should provide reasonably accurate distance estimates for early-type stars beyond the range of individual Hipparcos parallaxes.

Acknowledgements

The authors acknowledge the financial support of the Polish State Committee for Scientific Research (grant 2P03D 019 23) as well as the NATO (linkage grant PST.CLG.980313). G.A.G. is grateful to the Korea MOST (Ministry of Science and Technology) (grant M1-0222-00-0005) and KOFST for providing an opportunity to work at KASI through Brain Pool program.

References

- Arenou, F., Luri, X., 1999, *ASP Conf. Ser.*, 167, 13
- Beals, C.S., Oke J.B., 1953, *MNRAS*, 113, 530
- Evans, J.W., 1941, *ApJ* 93, 275
- ESA. 1997, The Hipparcos and Tycho Catalogues (ESA SP-1200) (Noordwijk: ESA)
- Merrill, P. W., Wilson, O. C., 1937, *ApJ*, 86, 44
- Sanford, R. F., 1937, *ApJ*, 86, 136
- Smith, H, 2003, *MNRAS*, 338, 891
- Struve, O, 1928, *ApJ*, 67, 353