A MODEL-ATMOSPHERE ANALYSIS OF THE SPECTRUM OF ARCTURUS

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Abstract. We have analysed the spectrum of Arcturus (K2 III) relatively to the Sun, using a differential technique employing empirical models for both stars. We derive an effective temperature of 4260 ± 50K and a surface gravity log g = +0.90 ±0.35; these in turn lead to a very low mass, in the range 0.1 to 0.6 $M_{\odot}$. Elements are found to be underabundant by an average factor of 4 compared with the Sun. The abundance patterns in the two stars are significantly different, in keeping with the belief that Arcturus is a star of an older generation than the Sun. The carbon isotope ratio, which is as small as 5 or 6, shows that the atmospheric material of Arcturus has been processed through the CNO cycle, and theoretical arguments also indicate that Arcturus is somewhat evolved.

Reference

Mäckle, R., Holweger, H., and Griffin, R. and R.: 1975, *Astron. Astrophys.* 38, 239.

DISCUSSION

Walborn: If the '*p*' were dropped from the spectral type, then Mme Cayrel would complain about the classification! *Some* designation must be attached to indicate that the spectrum shows a significant difference from that of the standard star.

Keenan: The designation *p* can be dropped from the classification if we add the designation CN-1 to indicate that the star is moderately deficient in CN.

Bidelman: What deficiencies did you get for C, N, and O? This is useful in judging how deficient in C and N a star must be to be termed CN-weak on classification plates, for Arcturus is a relatively mild case of CN deficiency.

Griffin: Carbon, nitrogen and oxygen were found to be deficient by 0.7, 0.9 and 0.6 in the logarithm, respectively, relative to the Sun.

Nissen: You mentioned that you have used empirical models for the Sun and Arcturus. Does that mean that you have used a scaled solar $T(\tau)$-relation in the model of Arcturus?

Griffin: Yes – to construct a preliminary model. The model underwent considerable modification and refinement in the light of various published photometries, etc.

Osborn: I am interested in the gravity you determined. I believe the preliminary curve-of-growth analysis gave log g of about 1.7 and the model atmosphere analysis gave a value about 0.9. Is this a typical error range for the determination of gravities from high dispersion spectra?

Griffin: Gravities determined from curve-of-growth analysis are inaccurate parameters; I have no hesitation in preferring the result for log g given by the empirical model analysis.

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Spinrad: Can you pinpoint the difference in metal abundances between the present determination (about −0.6) and the older curve-of-growth determination?

Griffin: It is difficult to make suitable allowance for the varying degrees of ionization in a curve-of-growth analysis, and in Arcturus elements such as Fe are only partially ionized in the line-forming region. Their treatment *should* be more reliably handled by a stratified model analysis.

Spinrad: The derived (low) spectroscopic mass of α Boo is very exciting, puzzling and important. It will have an impact on mass loss and white dwarf mass and radius computations.

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