ABSOLUTE MAGNITUDES BY STATISTICAL PARALLAXES

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Our algorithm for stellar luminosity calibrations (based on the principle of maximum likelihood) allows the calibration of relations of the type:

$$M_i = \sum_{j=1}^{N} q_j C_{ij}, \quad i = 1, \ldots, n,$$

where n is the size of the sample at hand,

M_i are the individual absolute magnitudes,

C_{ij} are observational quantities (j = 1, ..., N), and

q_j are the coefficients to be determined.

If we put N = 1 and $C_{iN} = 1$, we have $q_1 = \overline{M}$, the mean absolute magnitude of the sample. As additional output, the algorithm provides us also with the dispersion in magnitude of the sample σ_M, the mean solar motion (U,V,W) and the corresponding velocity ellipsoid (σ_u, σ_v, σ_w).

The necessary input for each star consists in the position (α,δ), the apparent magnitude (m_v), the proper motions and the corresponding errors ($\mu_\alpha, \varepsilon_{\mu\alpha}, \mu_\delta, \varepsilon_{\mu\delta}$), the radial velocity ($v_r$) and the eventual observational quantities. The principle of the method can be defined as follows: Which law of absolute magnitudes, the radial velocities, on one hand, and the tangential velocities, on the other hand, can be considered as resulting from the same assumed kinematical model (here a Schwarzschildian distribution with correction for the galactic rotation)? Technical details are given in Heck (1974, 1976) or in a forthcoming paper in Vistas in Astronomy.

A. G. Davis Philip and D. S. Hayes (eds.), The HR Diagram, 49-52. All Rights Reserved.

The algorithm has been applied to various samples, but we will restrict this paper to a general presentation of the results obtained for RR Lyrae stars and with the indices of the uvby β photometry.

The most recent application of the technique to a sample of about 130 RRab Lyrae stars (Heck and Lakaye, 1977) gave the following relation between luminosity and the ΔS metallicity index introduced by Preston (1959):

$$M_V = 0^m_.12\ (\pm\ 0^m_.04)\ \Delta S - 0^m_.33\ (\pm\ 0^m_.20)$$

with $\sigma_M = 0^m_.51$ ($\pm$ $0^m_.18$), using Parengago's (1940) absorption law. The result for the sample used by Clube and Dawe (1977) is (compare with their paper at this symposium, page 53):

$$M_V = 0^m_.16\ (\pm\ 0^m_.12)\ \Delta S - 0^m_.17\ (\pm\ 0^m_.90)$$

using Bernicki's (1967) absorption law.

From Dr. J. Lub (European Southern Observatory), we received new data concerning Heck and Lakaye's (1977) sample, especially a set of homogeneous reddening values. The derived relation is:

$$M_V = 0^m_.29\ (\pm\ 0^m_.03)\ \Delta S - 1^m_.18\ (\pm\ 0^m_.26),$$

which is slightly different from the previous relations.

The following results were obtained for main-sequence stars, when applying the method to uvby β photometric data:

A0 - A4 type stars (Heck, 1975):

$$M_V = 1.89\ (\pm\ 3.90)\ a_R - 14.52\ (\pm\ 1.93)\ r + 1^m_.62\ (\pm\ 0^m_.25)$$

A4 - F0 type stars (Heck, 1977a):

$$M_V = -12.99\ (\pm\ 4.20)(b-y) - 11.74\ (\pm\ 1.29)\ [c_1] + 13^m_.51\ (\pm 1^m_.29)$$

F-type stars (Heck, 1977b):

$$M_V = 3.13\ (\pm\ 2.84)(b-y) - 4.32\ (\pm\ 1.21)\ [c_1] + 4^m_.27\ (\pm\ 0^m_.25)$$

G-type stars (Heck, 1977c):

$$M_V = -27.29\ (\pm\ 3.36)(b-y) - 33.34\ (\pm\ 6.91)\ [c_1] + 19.66\ (\pm\ 4.52)(b-y)\ [c_1] + 21^m_.60\ (\pm\ 2^m_.07)$$

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where a_r, r, (b-y) and $[c_1]$ are indices derived from the uvby β photometry (see e.g. Strömgren, 1966). The sample of G-type stars contained also stars from other luminosity classes because there were not enough main-sequence stars to get statistically significant results. No conclusive result has been obtained for B-type stars.

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DISCUSSION

CAYREL de STROBEL: How much would your maximum likelihood M_V's change if you also introduced differences in He-content?

HECK: A He-content parameter can be introduced in any calibration as an additional Cij term. The way M_V will change depends upon the sample at hand, but the determination of individual absolute magnitudes will be more precise if this parameter is relevant for the particular calibration.

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