THE ABSOLUTE MAGNITUDES OF THE NEARBY STARS: CALIBRATIONS OF MEAN LUMINOSITY RELATIONS

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The nearby stars are most favored for determining precise absolute magnitudes and for calibrating spectral-type, luminosity relations and color, luminosity relations. To demonstrate the main problems we discuss the (M_V,B-V) relation since (B-V) data are available for most of our candidates. At Yale Observatory van Altena is compiling a new catalog of trigonometric parallaxes. We feel deeply indebted to van Altena for making available to us a preliminary version of this catalog.

Based on these new data Figs. 1-3 show (M_V,B-V) diagrams of the stars nearer than 25 pc. The stars with the best-determined absolute magnitudes (s.e. $\leq 0^m.20$ and $\leq 0^m.30$) are plotted in Figs. 1 and 2 resp.; in Fig. 3 all the stars with $\sigma_\pi/\pi \geq 0.14$ are given. In addition we have plotted the Zero-Age Main Sequence in the upper part of the diagrams; for B-V > +0.40 the mean main sequence, as derived from the nearby stars, data available in 1982 was marked.

Fig. 3 points out that a sample of stars with large accidental errors shifts the mean main sequence to lower luminosities; such effects could be eliminated by statistical corrections ("Lutz-Kelker corrections") if the observational material fulfils certain conditions. However, if the number of stars available for calibration is sufficiently large it is recommended that the sample of objects be restricted to those with accurately determined absolute magnitudes as shown in Figs. 1 and 2 where the Lutz-Kelker correction is smaller than a tenth of a mag.

In Fig. 2 the mean curve fits the data fairly well whereas the best determined stars (Fig. 1) in the region $+8^m < M_V < +10^m.5$ are significantly brighter. Obviously, this deviation is not caused by a change in the trigonometric parallax system. For 42 stars in this region with s.e. of $M_V < 0^m.3$ the mean difference $\langle M_V\rangle_{new} - \langle M_V\rangle_{old}$ is only $-0^m.02 \pm 0^m.02$. Also an incompletely applied Lutz-Kelker correction cannot account for it. However there is a slight dependence of the mean absolute magnitudes on the tangential velocities. A least squares analysis yields $\Delta M_V = +0^m.003(\pm 0^m.001)$ per km s^{-1}. In the 1982 sample the portion of stars with large tangential velocities was relatively high, producing a shift to lower luminosities.

At M_V of about $+10^m$ these effects are strengthened by a phenomenon

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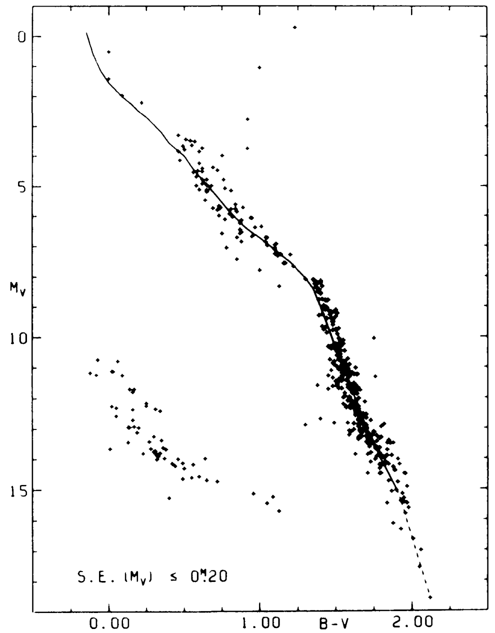

Fig.1 CM - Diagram of the stars within 25 pc; s.e.(M_V) ≤ $0^m.20$.

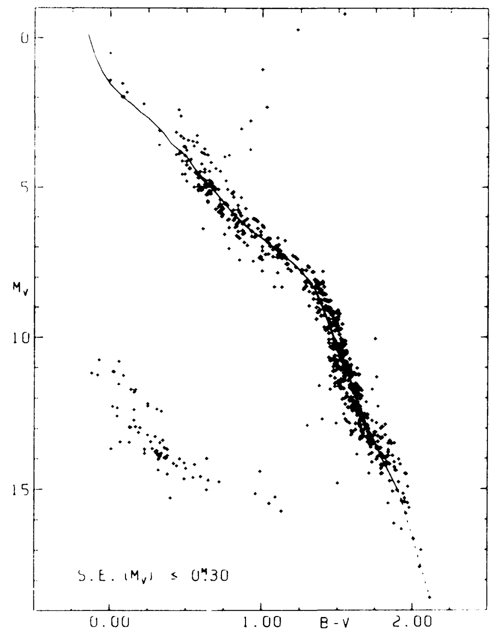

Fig.2 CM - Diagram of the stars within 25 pc; s.e.(M_V) ≤ $0^m.30$.

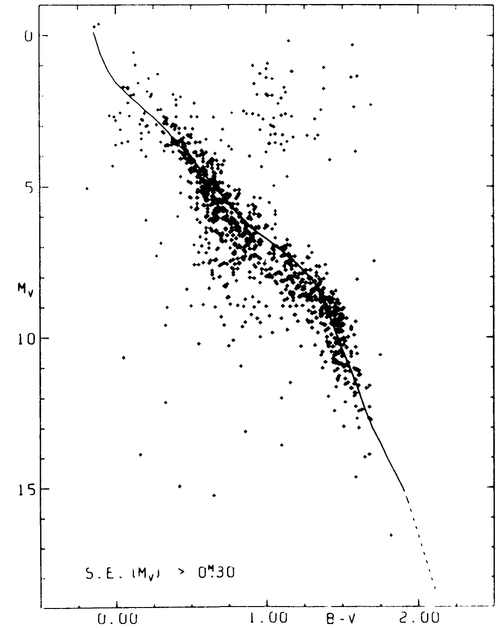

Fig.3 CM - Diagram of the stars within 25 pc; s.e.(M_V) > $0^m.30$.

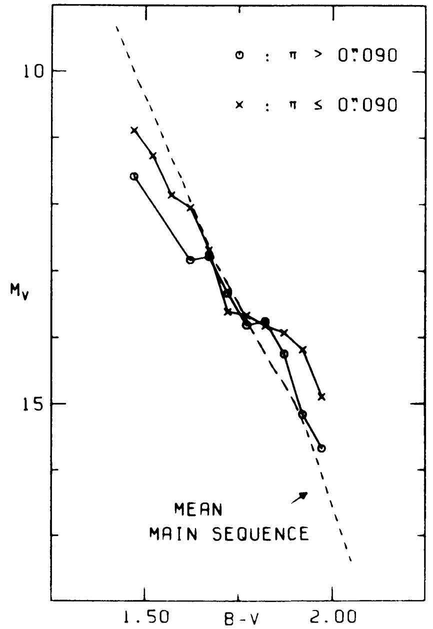

Fig.4 <M_V> for faint stars with π_t published 1969 to 1978.

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represented in Fig. 4. This diagram gives mean values of M_V in (B-V)-intervals of $0\overset{m}{.}05$ for faint stars with precise trigonometric parallaxes published from 1969 to 1978 ("GJ stars"). This sample has not only a faint limit in apparent magnitude but also a bright one at about $V = 10^m$. A bright limit implies that in a certain color range the absolutely brighter dwarfs were not observed and the derived mean main sequence proves to be too faint. On the other hand, near the faint limit the observed mean main séquence will be too bright ("Malmquist bias").

These effects vary with the distance modulus M-m. The nearest stars in such a series define a mean main sequence somewhat fainter than that of the more distant objects. Our sample was subdivided into very nearby stars ($\pi \geq 0\overset{''}{.}090$) and those with parallaxes between $0\overset{''}{.}040$ and $0\overset{''}{.}090$. Unfortunately the numbers of objects per interval are very small (1 to 13) but even so we see that the expected deviations are observable. In the region $+1.45 < B-V < +1.60$ such stars of lower luminosities may have shifted the mean curve in the 1982 derivation which, however, is no longer confirmed by the new parallax data.

We may conclude that a mean main sequence, even if derived from the best determined trigonometric parallaxes, should be used only with caution for different samples of dwarf stars. A mean curve depends on the limits (whether in magnitude or in volume) of the observational series used for calibration; furthermore the luminosities are affected by the ages which are correlated with the velocities and/or the chemical compositions of the stars.

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DISCUSSION

MILLWARD: In your Figure 2, it looks as if the upper envelope of your main sequence at (B-V)= 0.3 - 0.7 may be composed of undetected binaries. They all lie about half a magnitude above the main locus of stars.

GLIESE: You are right. In this region the majority of our stars lie above the curve given. Maybe some of these objects are binaries but for (B-V) < 0.4 the ZAMS is plotted and it is connected to our curve at 0.4. Obviously, in this region evolutionary effects may occur among our field stars.

JASCHEK: Have you compared with open cluster results?

GLIESE: Not yet!

LYNGÅ: How much does your new calibration differ from the earlier calibrations made for similar, apparent magnitude-limited, samples?

GLIESE: In 1971 I used all good M_V's of nearby stars available at that time. The material was a mixture of various observational series which had different magnitude limits. In 1982 I used Eggen's data for stars with large proper motions. From stars with a transverse velocities < 80 km/sec. I derived a mean main sequence which deviated from the 1971 sequence in the range $8 < M_V < 13$ by 0.2 to 0,3 mag. But from $M_V = 4$ to 8 the differences were insignificant (< 0.1 mag.)

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