SYSTEMATIC MAIN SEQUENCE PHOTOMETRY OF GLOBULAR CLUSTER STARS FOR AGE DETERMINATION

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The individual photometric study of the coeval stars in globular clusters presents one of the best observational tests of the stellar evolution theory. Our own globular cluster system provides fundamental clues to the dynamical and chemical evolutionary history of the galaxy, and the study of their ages give us a lower limit to the age of the galaxy as well as to that of the universe. We have been undertaking a systematic research program, and discuss herewith the ages deduced by fitting main sequence photometry to theoretical isochrones of six galactic globular clusters : M4, M22, M30, NGC 288, NGC 3201 and NGC 6397.

From fits of the isochrones of Ciardullo and Demarque (1977) transformed to the observational plane $|M_V, (B-V)_o|$ of the observed Color Magnitude Diagram (CMD) in the BV system, we deduced the following ages each of which have an uncertainty of 3 or 4 Gys: NGC 6397, $|Fe/H| = -2.0$, age 17 Gys; NGC 288, $|Fe/H| = -1.6$, age 15 Gys; NGC 7099 (M30), $|Fe/H| = -2.16$, age 15 Gys; NGC 3201, $|Fe/H| = -1.4$, age 12 Gys; NGC 6656 (M22), $|Fe/H| = -1.9$, age 15 Gys and NGC 6121 (M4), $|Fe/H| = -1.3$, age 12 Gys, (mean (of 6) = 14.3 Gys. $\sigma_S = 1.97$, $\sigma_{mean} = 0.88$).

The CMD for M4 shown in Figure 1 has been obtained most recently. At a distance of 2 kpc, it is the closest globular cluster to the sun. Adopting $(m-M)_V = 12.52$ ($V_{HB} = 0.9$), $E(B-V) = 0.42$, $Z = 0.001$ ($|Fe/H| = -1.3$), $Y = 0.3$, mixing length parameter $\alpha = 1.6$, and using the improved isochrones of VandenBerg (1983) an excellent fit is produced at 12 Gys. This investigation presents as well the first results of RI main sequence photometry for a globular cluster. The greater baselines provided by the additional pass-bands (i.e., B-I, B-R, V-I) would make possible improved isochrone fittings and points up the urgent need for calculations of synthetic isochrones to be compared with observations. In the figures described below we proceed to show some of the more relevant examples.

Figure 2: the CMD of V vs B-R. The various branches lying above the main sequence are well-defined owing to the greater color baseline provided by B-R (as compared with B-V). The gap between the subgiant (SGB)

A. Maeder and A. Renzini (eds.), Observational Tests of the Stellar Evolution Theory, 153–155.

https://doi.org/10.1017/S0074180900030746 Published online by Cambridge University Press

and the Main Sequence Turn-Off (MSTO) is perhaps more conspicuous. Figure 3: The CMD of V vs B-I. The separation between the SGB and MSTO is dramatic: The bluest SGB stars are redder than the reddest MS stars measured, and an extrapolation of the SGB to fainter magnitudes misses the MSTO by a large margin. Figure 4: The CMD of I vs B-I. The full range of I magnitudes (9.2) and B-I (3.5) are greater than for any other magnitudes and colors. Again, the separation of the SGB and MSTO is dramatic. The sequences are very well defined.

References:

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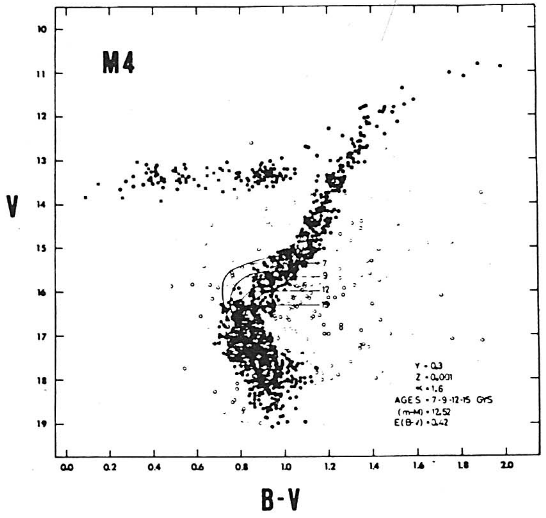

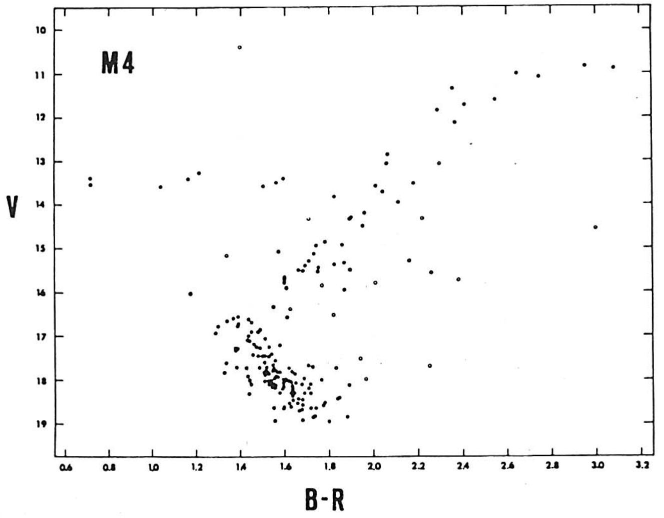

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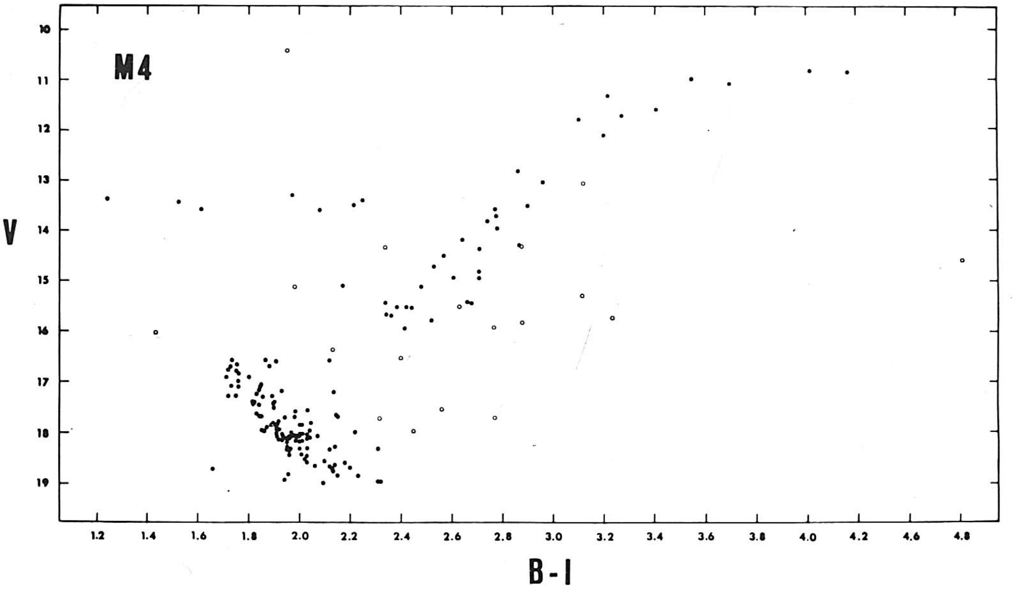

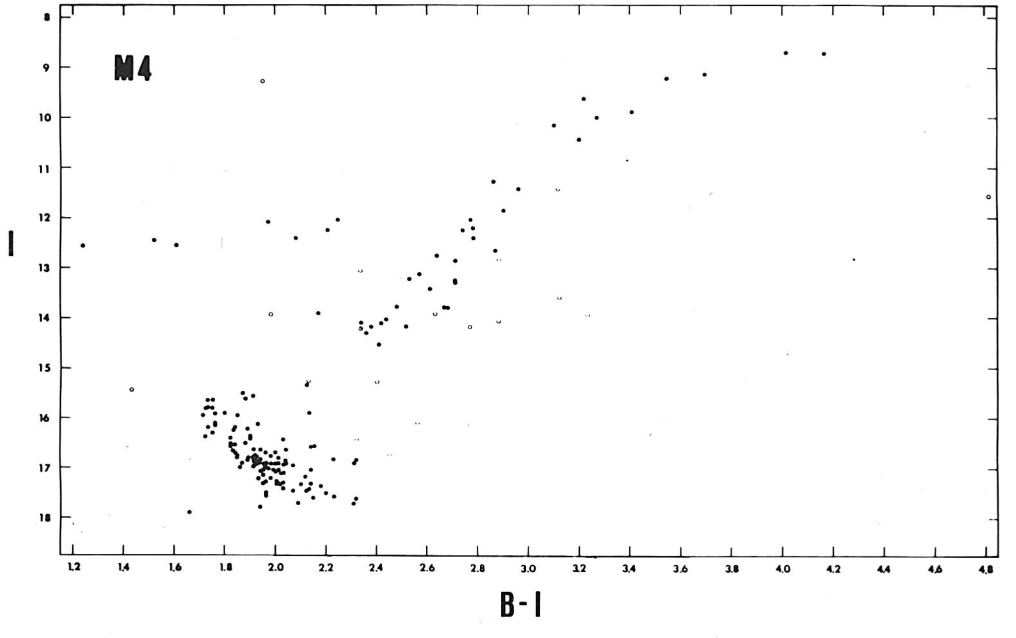

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