MONTE CARLO SIMULATIONS OF GLOBULAR CLUSTER RED GIANT BRANCHES

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ABSTRACT

Simulations of globular cluster luminosity functions have shown that many of the features observed in actual clusters are probably statistical fluctuations. We suggest one new way of looking at the data which may ultimately lead to some information about the physical parameters of clusters.

I. METHOD

Rood (1984) has found that the time dependence of the evolution of a star along the first giant branch can be well approximated by log (L) $= a + b \sinh^{-1} t$, where t is the time before flash in units of 5×10^7 years. The parameters a and b vary with composition and mass, and for a given star have different values above and below the luminosity function bumps predicted to occur when the H burning shell passes through the discontinuity left by the deepest penetration of the convective envelope. Thus uniformly distributed random times before flash yield log L and then log T_e and log g (which can be expressed as functions of log L). Magnitudes and colors with gaussianly distributed random errors are then calculated. Details will be found in Crocker and Rood (1984).

II. RESULTS

(1) The dispersion of only 0.09 m difference between the bolometric magnitude of the brightest giant and the theoretical flash luminosity found by Frogel, et al. (1980) does not require any modification to standard evolution. Simulations with 45 stars in the upper 2.5 m of the RGB show a dispersion of 0.11 m, similar to the observed value. We do not find an increasing dispersion for the second and third brightest star as found by Frogel, et al.

A. Maeder and A. Renzini (eds.), Observational Tests of the Stellar Evolution Theory, 159–161.

(2) Comparison between theoretical models and observation should always be made in the observed quantities. Transforming quantities which contain random errors of measurement causes loss of information.

(3) Determination of Y at a level of $\Delta Y = 0.1$, and Z at a level of $\Delta \log Z = 1$ from luminosity functions requires samples of more than 600 stars in the upper 5 m of the RGB.

(4) Finding a statistically significant bump of the size theoretically expected in the differential luminosity function requires samples of more than 1000 stars.

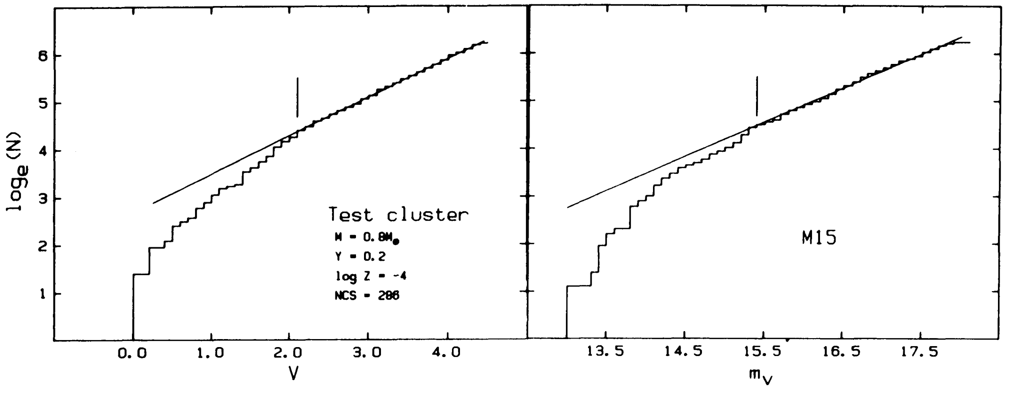

Figure 1. Log of the integrated V luminosity function. The left panel is for a simulated cluster; the right is taken from the data of Buonanno, et al. (1983). The vertical mark shows the theoretical bump location on the left and the hypothesized bump in M15 on the right. On the left V is magnitudes below the brightest star.

(5) It may be possible to locate the bump by using the break in slope of the evolution rate which occurs there. Using the log of the integrated luminosity function and some prejudice about the location of the break, it can be located in samples comparable to the largest cluster surveys (450 stars in upper 5 m). Figure 1 shows that the break in slope is visible in both simulated and real clusters.

REFERENCES

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DISCUSSION

Rood: One of our results shows that the result of Frogel et al who find a dispersion of only 0.1 mag in the difference between M_{bol} (observed) and M_{bol} (theoretical flash) is pretty much what is expected on theoretical grounds. This gives an independent way of getting the distance to globular clusters using the brightest giant which should not be in error by more than 0.1 mag. (1 σ).

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