GLOBULAR CLUSTERS AS EXTRAGALACTIC DISTANCE INDICATORS: MAXIMUM LIKELIHOOD METHODS

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ABSTRACT

We have explored the use of maximum likelihood estimation techniques in the use of globular cluster luminosity functions (LFs) as distance indicators. In particular, we have tested size-of-sample effects through the analysis of Monte Carlo simulations of LFs drawn from an assumed universal population like that characterizing the globular clusters in the Local Group. Our working assumption, following others before us, is that the underlying LF is adequately well described by a Gaussian normal in a number vs. absolute magnitude representation.

For typically observable sample sizes in studies which are limited to the bright half of the LF, statistical limitations preclude a precise determination of the attributes which fully describe the LF, even in the absence of field object contamination. In particular, the intrinsic dispersion (the shape parameter of the LF) must be taken to be a universal constant, independent of galaxy type; only then may the turnover magnitude (which contains the distance information) be derived with good precision. Some data exist for nearby galaxies (including ellipticals) which permit an assessment of the universality of the intrinsic dispersion: they are not inconsistent with the hypothesis. However, it will be important to test this point in future as more data are secured.

Real globular clusters in remote galaxies are unresolved, and the samples are contaminated with foreground field stars and remote background objects. This contamination necessitates corrections which are statistical in nature, applicable to binned LFs. Through numerical simulations, we have tested the limitations imposed by realistic numbers of field objects in globular cluster LFs in remote galaxies, testing for systematic biases and assessing the attainable precision in derived distance as a function of the sample size and the limiting magnitude.

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Our findings are that maximum likelihood methods are very robust. Distances precise to ± 10% are routinely derived (even in the presence of field object contamination) for moderately populous globular cluster samples within which photometry reaches nearly to the turnover: there is no need to strive for much deeper levels through extraordinary investments of telescope time. (Of course several very deep such studies will be wanted to test further the universality of the LF, which is also of interest as a diagnostic of cluster formation and disruption; thereafter, if our working assumption is indeed borne out, much more modest programs will yield the desired precision.) The implication is that globular clusters are potentially more far-reaching distance indicators than has previously been realized. Moreover, their previously-noted advantages make them doubly attractive: the method is insensitive to the Population I distance scale and calibrators, and permits the study of extremely remote systems in but a single step from the Milky Way.

Our complete results are in a paper submitted to the Astronomical Journal.

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