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ORIGINAL ARTICLE

Globular cluster luminosity function as distance indicator

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Abstract Globular clusters are among the first objects used to establish the distance scale of the Universe. In the 1970-ies it has been recognized that the differential magnitude distribution of old globular clusters is very similar in different galaxies presenting a peak at $M_V \sim -7.5$. This peak magnitude of the so-called Globular Cluster Luminosity Function has been then established as a secondary distance indicator. The intrinsic accuracy of the method has been estimated to be of the order of $\sim$0.2 mag, competitive with other distance determination methods. Lately the study of the Globular Cluster Systems has been used more as a tool for galaxy formation and evolution, and less so for distance determinations. Nevertheless, the collection of homogeneous and large datasets with the ACS on board HST presented new insights on the usefulness of the Globular Cluster Luminosity Function as distance indicator. I discuss here recent results based on observational and theoretical studies, which show that this distance indicator depends on complex physics of the cluster formation and dynamical evolution, and thus can have dependencies on Hubble type, environment and dynamical history of the host galaxy. While the corrections are often relatively small, they can amount to important systematic differences that make the Globular Cluster Luminosity Function a less accurate distance indicator with respect to some other standard candles.

Keywords Globular clusters: general · Galaxies: distances and redshifts

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1 Introduction

Most astrophysics quantities depend critically on accurate distance measurements and globular clusters are among the first objects used to measure distances. The literature on their use as distance indicators is very extensive and cannot be reviewed fully here. I opted therefore to give a summary on the early history of the usage of the globular cluster luminosity function as distance indicator (Sect. 2), before describing the method and discussing the way that globular cluster photometry is used to measure distances (Sect. 3). The main goal of this article is to review the recent observational and theoretical results and provide an assessment on the accuracy and usefulness of the Globular Cluster Luminosity Function (GCLF) as distance determination method.

Many articles and reviews in the past examined the GCLF as distance indicator suggesting the accuracy of the method ranging between 0.1–0.2 mag, at the level comparable to, or sometimes even better than the other methods used for early type galaxies (Hanes 1977a, 1977b; Harris and Racine 1979; van den Bergh 1985; Harris 1991; Jacoby et al. 1992; Ashman et al. 1995; Kohle et al. 1996; Whitmore 1997; Harris 2001; Kissler-Patig 2000). Other works point out more limitations and shortcomings of the method (e.g. Racine and Harris 1992; Tammann and Sandage 1999; Ferrarese et al. 2000b). The recent review of GCLF as distance indicator by Richtler (2003) examines in particular those galaxies that yield discrepant distance measurements when the GCLF distances are compared to those of surface brightness fluctuation method, concluding that discrepant cases are most probably caused by peculiar globular cluster populations that are not uniformly old, and therefore inapplicable for the method. The most recent critical comparison of the relative Virgo vs. Fornax cluster distance as measured using GCLF and other standard candles is presented by Villegas et al. (2010) and is discussed briefly here.