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ESTIMATING METALLICITIES WITH ISOCHRONE FITS TO PHOTOMETRIC DATA OF OPEN CLUSTERS

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The metallicity is a critical parameter that affects the correct determination of stellar cluster's fundamental characteristics and has important implications in Galactic and Stellar evolution research. Fewer than 10% of the 2174 currently catalogued open clusters have their metallicity determined in the literature. In this work we present a method for estimating the metallicity of open clusters via non-subjective isochrone fitting using the cross-entropy global optimization algorithm applied to UBV photometric data. The free parameters distance, reddening, age, and metallicity are simultaneously determined by the fitting method. The fitting procedure uses weights for the observational data based on the estimation of membership likelihood for each star, which considers the observational magnitude limit, the density profile of stars as a function of radius from the center of the cluster, and the density of stars in multi-dimensional magnitude space.
We present results of [Fe/H] for well-studied open clusters based on distinct UBV data sets. The [Fe/H] values obtained in the ten cases for which spectroscopic determinations were available in the literature agree, indicating that our method provides a good alternative to estimating [Fe/H] by using an objective isochrone fitting. Our results show that the typical precision is about 0.1 dex.

The observational complexity and difficulty in carrying out detailed high-resolution spectroscopy of a large number of stars for a large number of clusters raises the question of alternative methods for estimating their metallicity reliably . The observational complexities account for the very small number of clusters, fewer than 10% in DAML02 catalog, for which good-quality metallicities exist. As commented by Paunzen et al. (2010), the metallicity parameter is set as solar or ignored in most papers that perform some sort of isochrone fitting in CMDs when this parameter is not available from other sources, possibly introducing an unknown bias in the distance, age and reddening estimated.

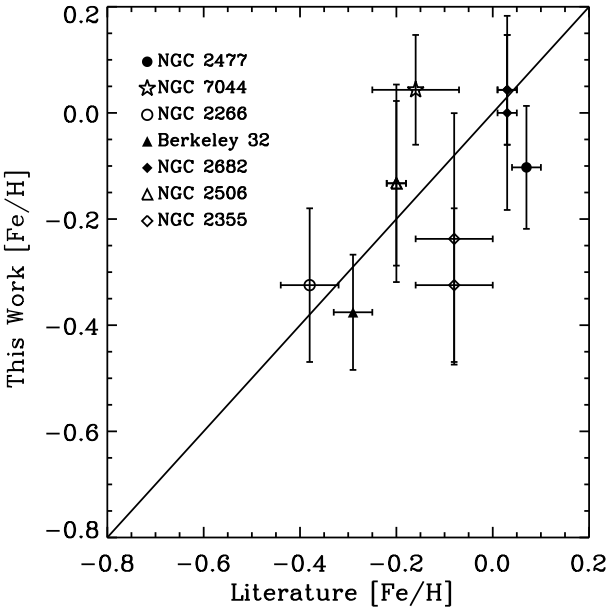

Fig. 1. Comparison of final estimated metallicity values with those from the literature. The [Fe/H] values obtained are compared with those from the DAML02 catalog. The filled symbols indicate [Fe/H] from high-resolution spectra.

In this work we present [Fe/H] estimates obtained with the CE method for nine well-studied open clusters based on 15 distinct UBV data sets. The comparison with [Fe/H] obtained by spectroscopy indicates that our results are adequate for obtaining low-telescope-cost metallicity estimates since most values are consistent withing the 1σ uncertainty. Our bootstrap-estimated errors for [Fe/H] values also show the good agreement between our results and literature [Fe/H] values obtained from photometric as well as spectroscopic data.

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