Integrated Near Infrared Spectroscopy of Milky Way Globular Clusters

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Introduction

Simple stellar population models (SSP) predict spectral features for closely homogeneous groups of stars. Such characteristic are presently associated to globular stellar clusters, making their integrated spectra a valuable empirical base for direct comparison with the models. Spectrophotometric data on galactic clusters clusters has recently being obtained and is easily found for the JHK bands and are in general agreement with theoretical predictions. This work presents for the first time integrated spectra of this class of objects on this region. Comparisons with Maraston models are made. Moreover, the molecular and atomic features present in this region provide means of estimating the cluster's abundance. Some of these features have been identified in the spectra of giant stars, providing a test for their correlations with cluster metallicity. The applicability of a similar techique from integrated spectra is discussed

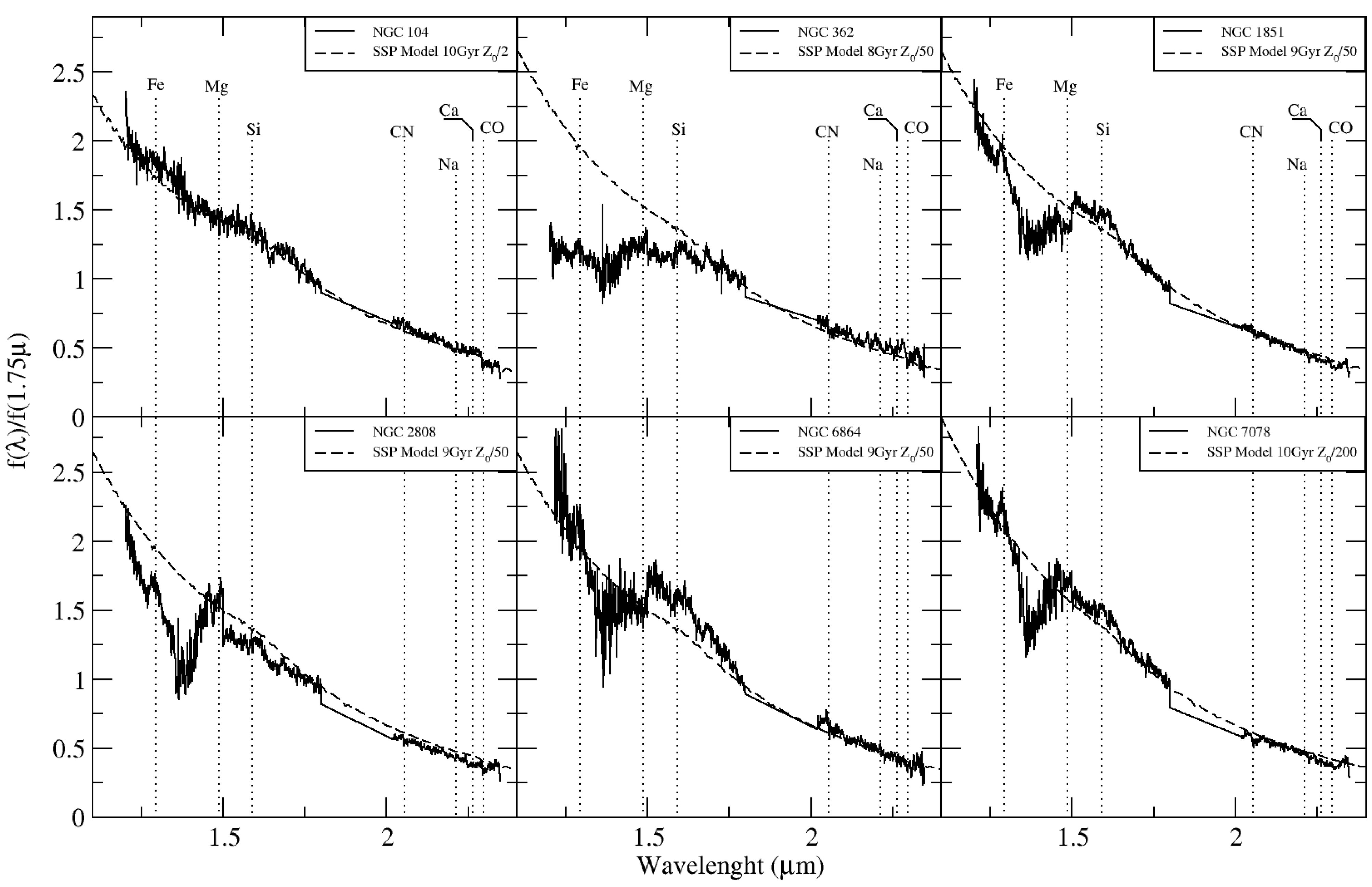

Figure 1: Spectra of the observed globular clusters (solid line) compared to the SSP models of Maraston 2005 (dashed line). The models were chosen to match the ages and metallicities for these clusters given by De Angeli *et al.* 2005 and Zinn and West 1984 (ZW84) respectively. A straight line, in the region between 1.8μm and 2.02μm, replaces the extremely low flux caused by atmospheric absorption, which affects similarly the J band.

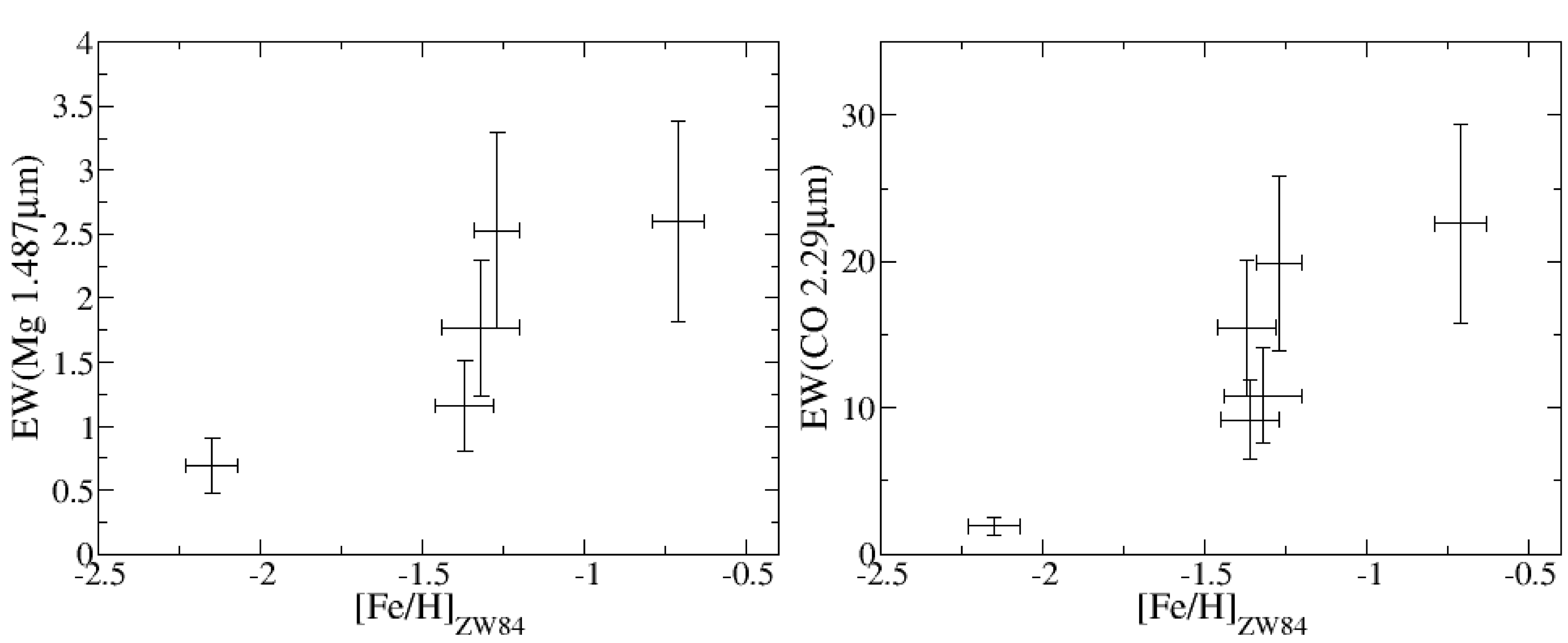

Figure 3: Correlations between atomic and molecular features and metallicity as given by ZW84. The point corresponding to NGC 1851 is absent of the left graph because the Mg feature could not be clearly identified.

Observations

Observations were performed with the OSIRIS spectrograph at the 4.1m SOAR telescope. This instrument is sensitive to the spectral domain from 1.2μm to 2.35μm, with a resolving power of R ~ 1200. Light from the clusters was integrated by defocusing the telescope; this caused some light loss. Recent observations, which are currently under reduction, have achieved better results by adjusting the telescope to a non-sideral tracking, thus combining the light from different parts of the cluster with smaller losses.

Comparison with SSP models

The slope of the spectra is in general agreement with the models, with the exception of the left end of NGC 362. The broad absorption between 1.3μm and 1.5μm has a telluric origin, mostly due to H_2O. CO band heads in 2.29μm and 2.32μm are correctly predicted by the SSP model, as well as their sensibility to the clusters metallicity, clearly seen when NGC 104 is compared to NGC 7078.

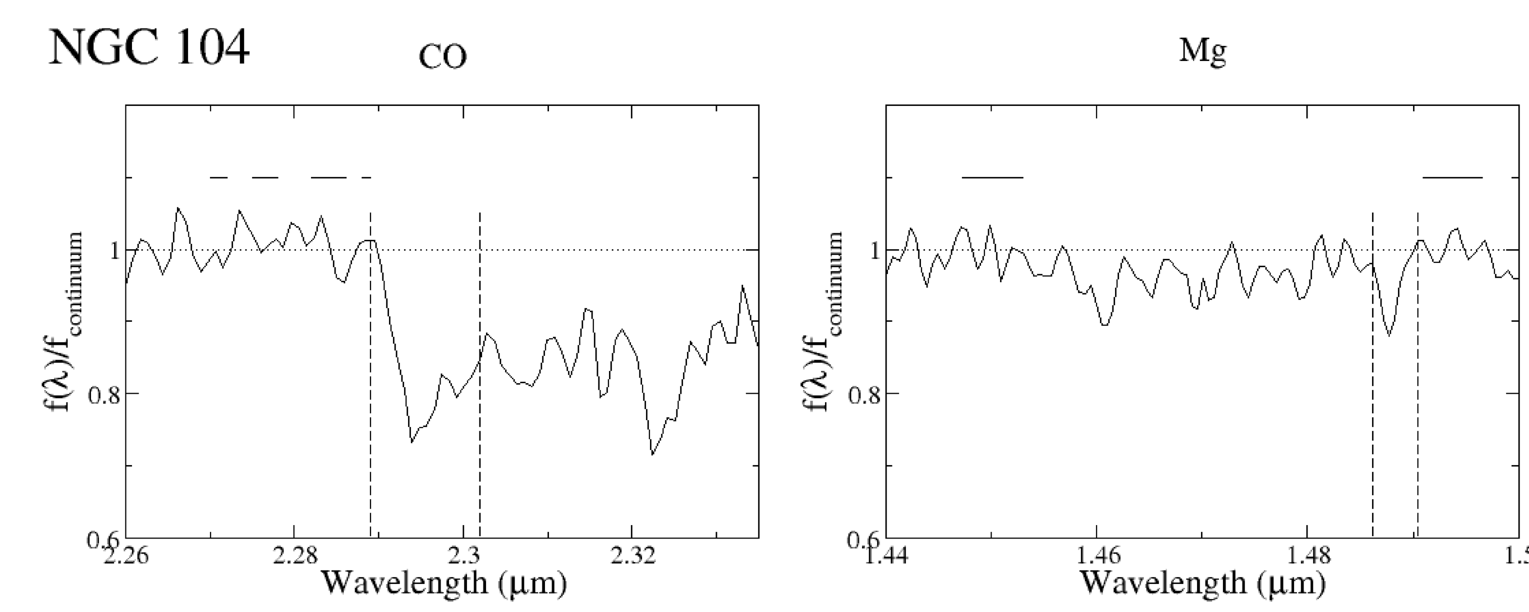

Figure 2: Spectrum of NGC 104 with continuum adjusting intervals and integration limits used for measuring the equivalent widths of CO 2.29μm, and Mg 1.49μm.

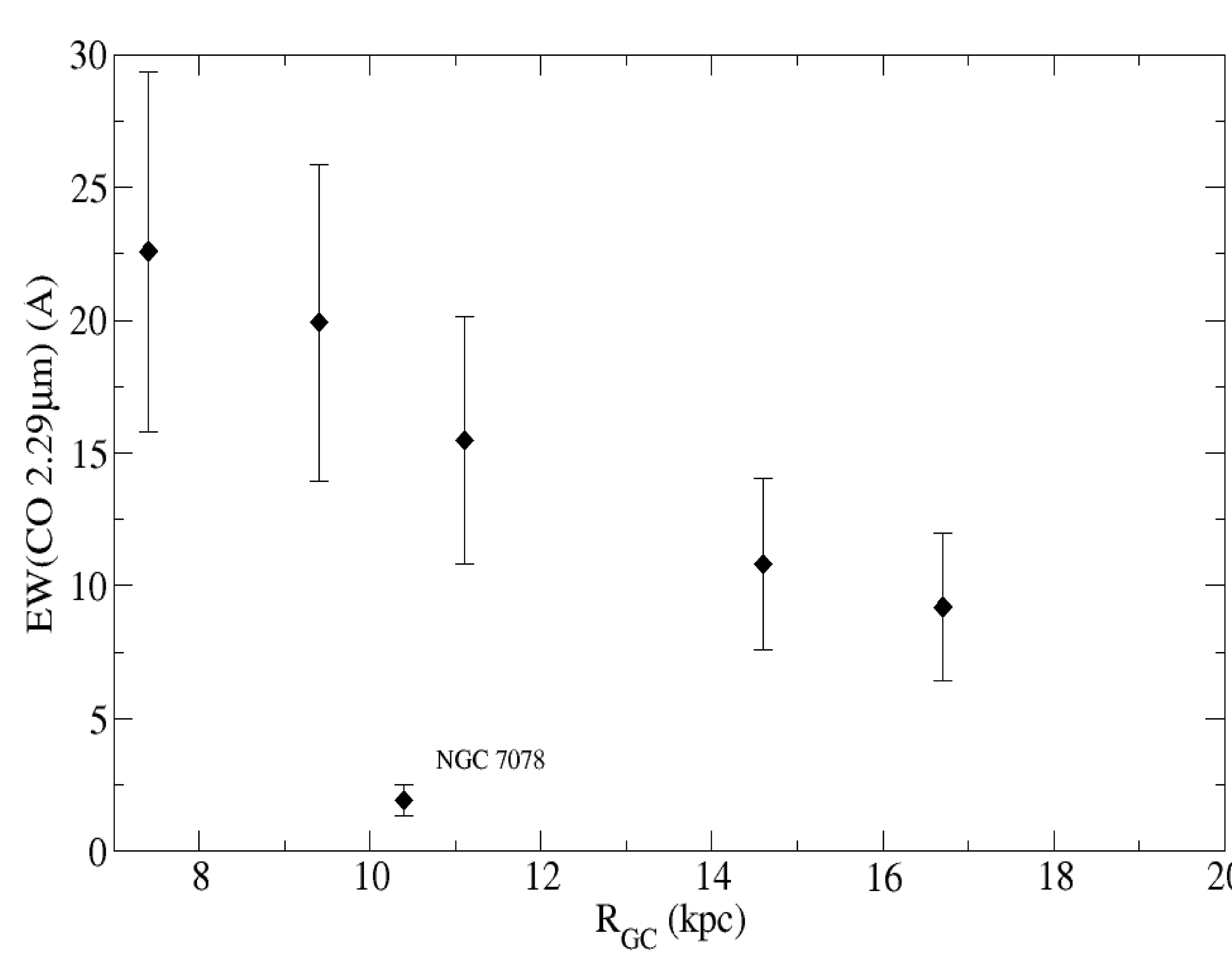

Figure 4: Correlation between the equivalent width of the CO feature at 2.29μm and the galactocentric distance from Harris 1996.

Metallicity

It is known that the CO band head at 2.29μm, present in the spectra of giant stars, provides a good parameter for estimating the metallicity of the cluster. The same reasoning applies to the integrated spectra. This is an expected result, since giant stars are the primary contributors to the integrated light of globular clusters in our galaxy. One of the strongest absorption lines found in the J band was the Mg at 1.487μm. Correlations of this line with metallicity and galactocentric distance, in general, are weaker than those involving CO, although the equivalent width of Mg is more reliable for clusters with very low [Fe/H], such as the NGC 7078.

Conclusions

Physical parameters derived from integrated light spectra of globular clusters achieve similar results to those derived from the spectra of giant stars. For clusters with [Fe/H] > -1.4, the strength of the CO band head at 2.29μm shows an even stronger correlation with galactocentric distance than with metallicity. SSP models are in general agreement with the observations and succeed in predicting the most prominent absorption features.