RevMexAA (Serie de Conferencias), **44**, 58–58 (2014)

XIV Latin American Regional IAU Meeting (Florianópolis/SC, Brazil, 25-30 November 2013)
Editors: A. Mateus, J. Gregorio-Hetem & R. Cid Fernandes

METALLICITY EFFECTS ON GLOBULAR CLUSTERS: SIZE AND COLOUR

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Globular clusters generally appear in two subpopulations: a blue, metal-poor and a red, metal-rich one, with the blue clusters ≈ 20% larger than their red counterparts. We discuss that this size difference can at least partially be attributed to an *apparent* effect caused by a combination of mass segregation and stellar evolution.

Given that three-dimensional distances are not known, it is difficult to distinguish between structural (mass) and apparent (light) effects using observations. Hence it has long been debated if the observed size difference between red and blue clusters could be caused by projection effects (Larsen et al. 2001), mass segregation and metallicity (Jordán 2004) or possibly different formation mechanisms (Harris 2009), to name a few.

To answer this question, we evolved direct N-body models of globular clusters (GCs) with the code `NBODY6` (Aarseth 1999, 2003) with different metallicities covering the whole range found in our galaxy: low ($Z = 0.0001$ or [Fe/H]≈ −2.3), intermediate ($Z = 0.001$ or [Fe/H]≈ −1.3) and high ($Z = 0.01$ or [Fe/H]≈ −0.3). In a nutshell, lower metallicity implies a longer mean free path for photons escaping the star, which in turn leads to a brighter star exhausting its fuel faster (see Clayton 1968).

The simulations are started using 95 000 single stars and 5 000 binary systems. Stellar and binary evolution is included (Hurley et al. 2000, 2002) as well is an external tidal field (see Sippel et al. 2012 for a detailed description of the model setup). The direct nature of the code implies that stellar collisions are possible.

We find no size differences for the half-mass radius, a structural parameter commonly used to quantify cluster sizes in theoretical studies. This indicates that the clusters are structurally identical, and is further confirmed by identical surface density profiles when weighted by mass.

However when taking the stellar *light* (Fig. 1) into account, the metal-rich clusters are found to be ≈ 17% smaller on average (at an age range of $10 - 13\,$Gyr). This is due to a combined effect of stellar evolution and mass segregation and implies that metallicity does not affect the cluster structure, while it can produce an apparent size difference as observed.

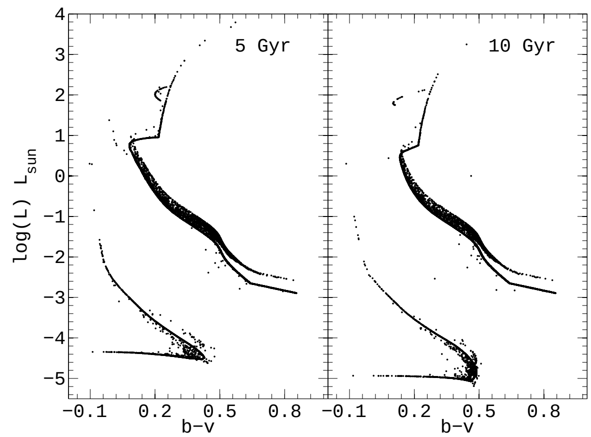

Fig. 1. Herzsprung-Russell diagram for a cluster with intermediate metallicity evolved to $t = 5\,$Gyr (left panel) and $t = 10\,$Gyr (right panel). No error is added to the data, the double main sequence is caused by the binary population included in the model. Blue stragglers are visible left to the main sequence turnoff, especially in the younger snapshot.

In addition, we can trace the evolution of colour with time, which enables us to follow the evolution of a dynamically evolved single stellar population (see Fig. 1).

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