

Synthetic photometry of globular clusters: understanding the nature of multiple populations

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Abstract:

Color-magnitude diagrams (CMDs) of globular clusters reveal the presence of multiple sequences likely due to populations of stars with different chemical composition (variations in He, C, N, O, Na, Mg, Al). We present synthetic photometry of the globular cluster NGC6752 based on isochrones and atmosphere models both consistently taking into account such variations of chemical composition. Theoretical CMDs based on this photometry are compared to observed CMDs to test the ability of models to infer chemical composition of multiple populations.

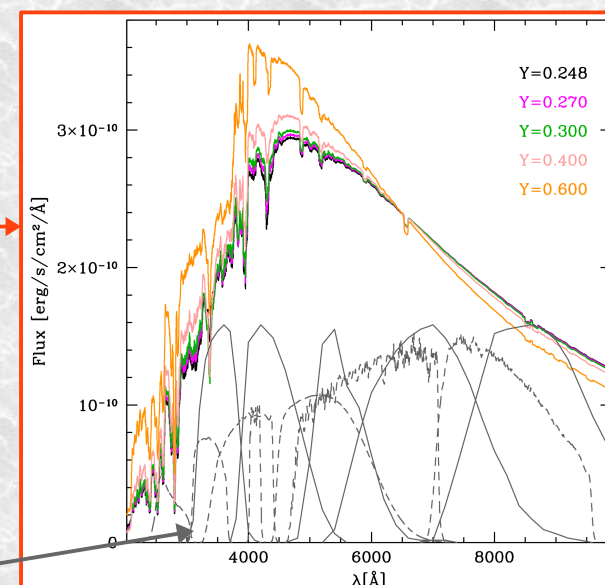
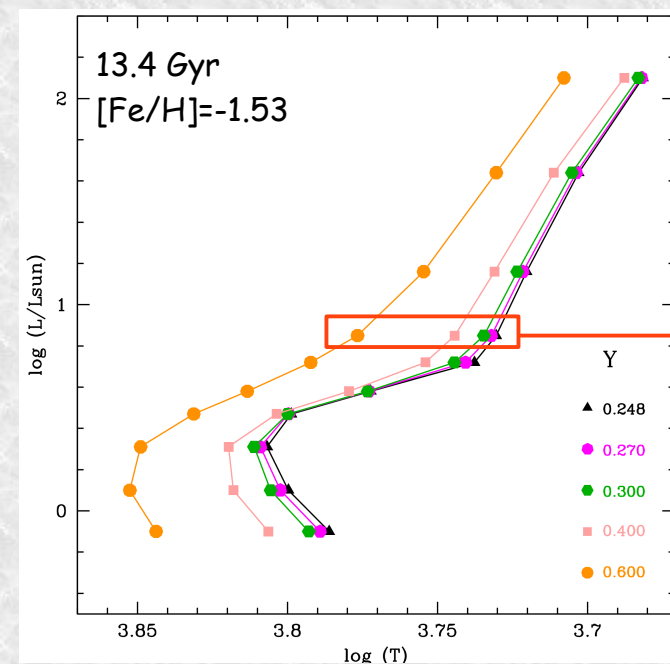
Isochrones computed with the code STAREVOL (*Decressin et al. 2009, Lagarde et al. 2012*)

Each isochrone assumes a different composition according to Chantereau et al. (2015). In particular, the helium mass fraction varies from 0.248 to 0.600.

Abundances of heavier elements also vary:

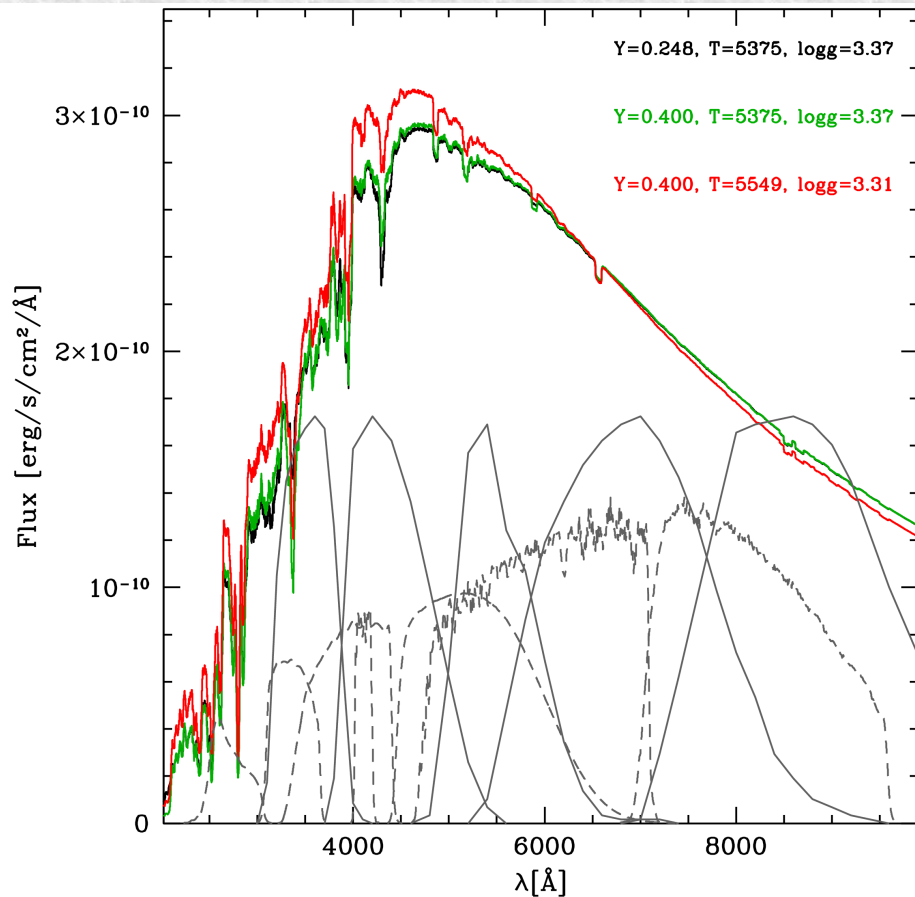
- enrichment in N, Na, Al
- depletion in C, O and Mg.

Synthetic spectra calculated with ATLAS12 (*Kurucz 2014*) and SYNTHE (*Kurucz 2005*) along selected points of each isochrone, used to compute photometry in various filters (Johnson, Stromgren, HST/WFC3, HST/ACS)

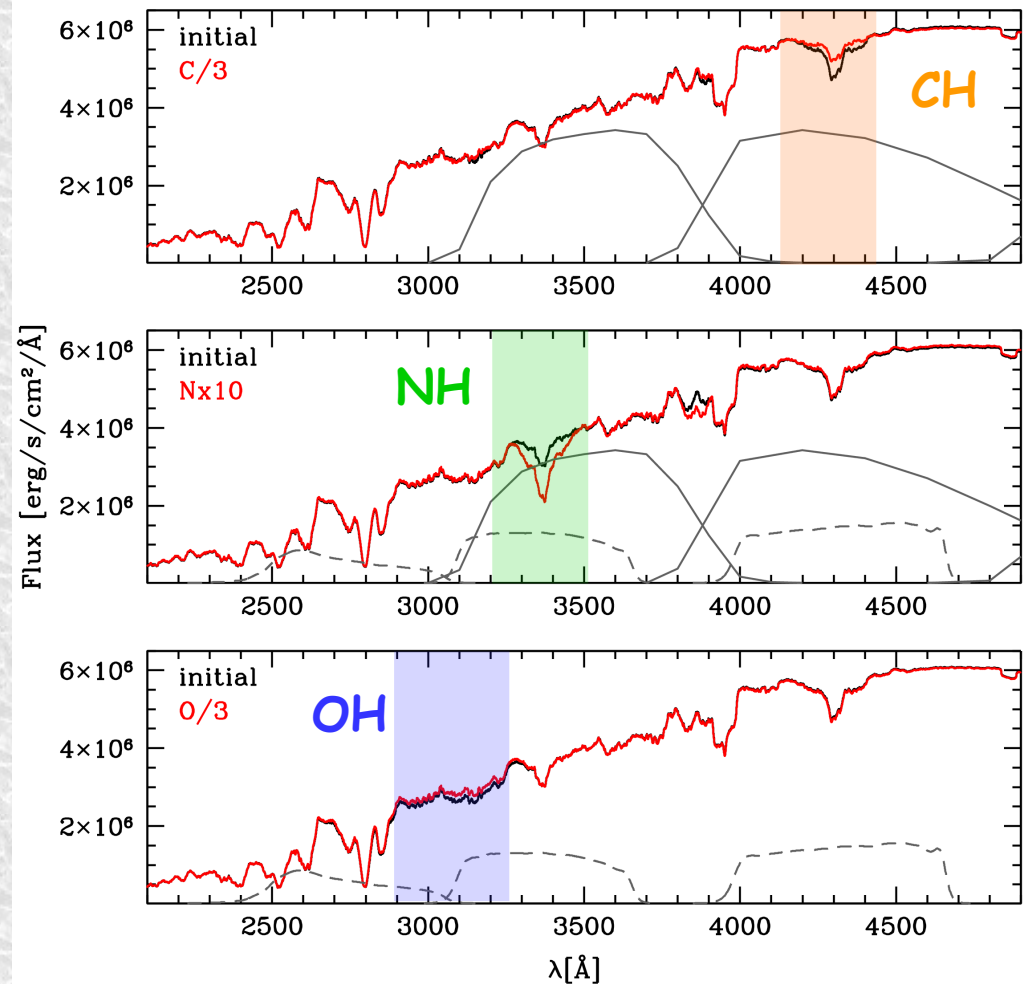


Johnson and some HST filters transmission curves

Effect of chemical species on spectral energy distribution



A change of the helium mass fraction mainly results in a change in effective temperature (through effect on internal structure). SED at a given T_{eff} much less affected by variation of Y .

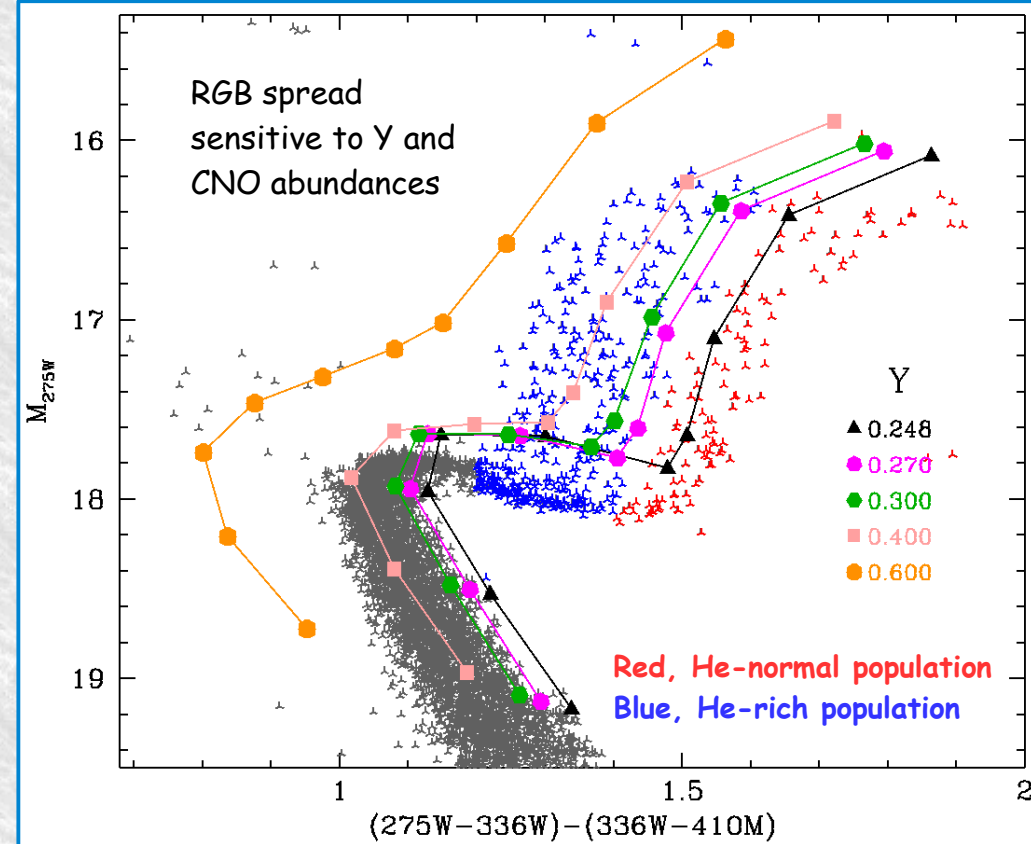
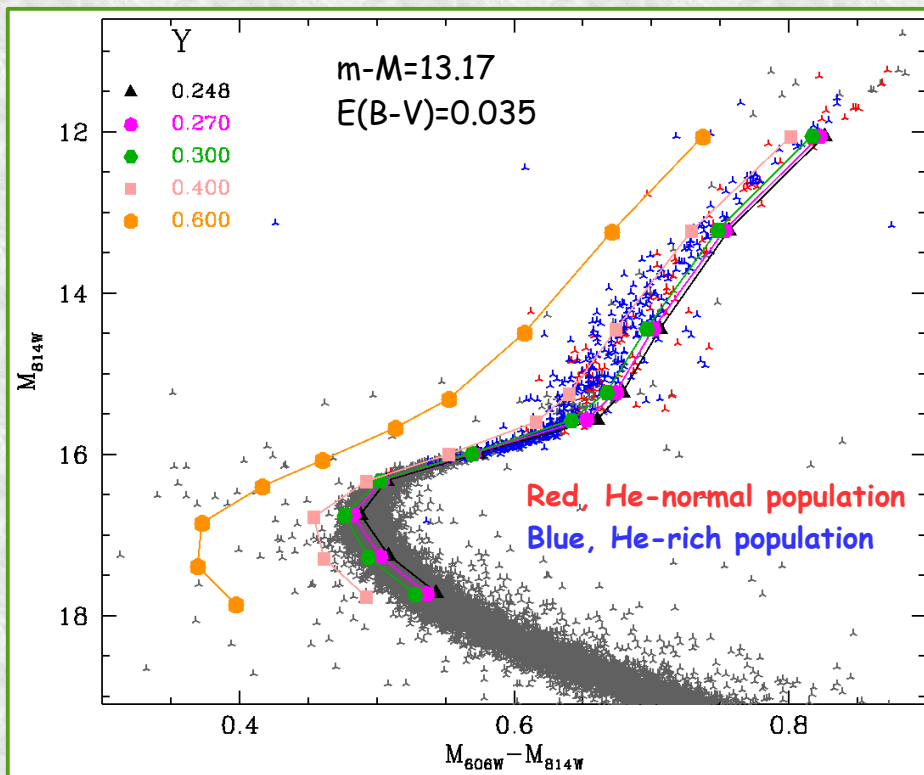


Variation of abundances of carbon, nitrogen and oxygen affect molecular bands at specific wavelengths.

Photometry modified in corresponding bands.

- filter F336W (Johnson U) sensitive to N and O
- filter F438W (Johnson B) sensitive to C
- filter F275W sensitive to O

The case of NGC6752



Data from Milone et al.
(2013)

Synthetic photometry:

- provides a good fit of Main Sequence and Turn-off in CMD based on red filters (Fig green)
- has systematic offsets in blue filters (Fig blue and red)
- does not reproduce quantitatively
 - 1) spread of RGB populations (Fig blue and red)
 - 2) switch with Y of RGB populations in filter 336W (Fig red)

