Physical parameters of NGC6705 (M11) open cluster using Strömgren photometry

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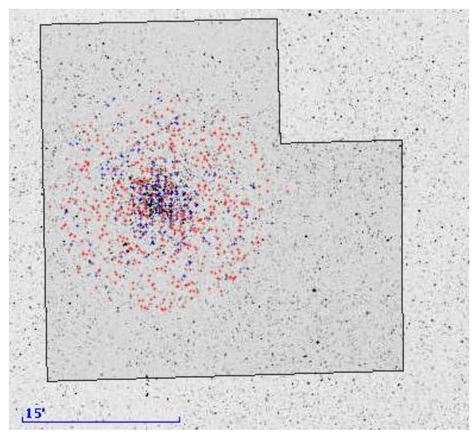
ABSTRACT

NGC 6705 (M11) is a middle-age well-studied open cluster. Its location in an area where the interstellar extinction is relatively low, its exceptional stellar density and richness, and the presence of both early type and evolved stars makes this cluster an interesting target for many scientific issues. Although NGC 6705 has been widely studied, Strömgren photometry was missing. The observations by our team have yielded uvbyHβ photometry for some 50,000 stars in an area of 34'x34' and with V_{lim}~21. All observed stars are classified into photometric regions and their physical parameters determined, using standard relations among color indices for each of the photometric regions of the HR diagram. That allows us to determine reddening, distance, absolute magnitude, spectral type, effective temperature, gravity and metallicity, thus providing an astrophysical characterization. In addition, we discuss the accuracy of the M11 physical parameters through comparison with those recently determined by Beaver et al (2013) with Strömgren photometry. We also compare our results with those from the spectroscopic Gaia ESO Survey to assess the quality of the photometric determinations as well as to give input parameters to the spectral analyses being made by GES.

Our observations

NGC 6705 was observed on 3 - 5 July 2010 with the 2.5 m Isaac Newton Telescope in La Palma. The Wide Field Camera instrument consists of a mosaic of four CCDs that covers a field of 34' x 34'. The cluster was observed once in each Strömgren filter obtaining a total of 51 216 stars up to a limiting magnitude V ~ 21. Stars in the open clusters NGC 6791 and NGC 6633 were used as standard stars. The Strömgren data was taken from Anthony-Twarog et al. (2007) and Schmidt (1976).

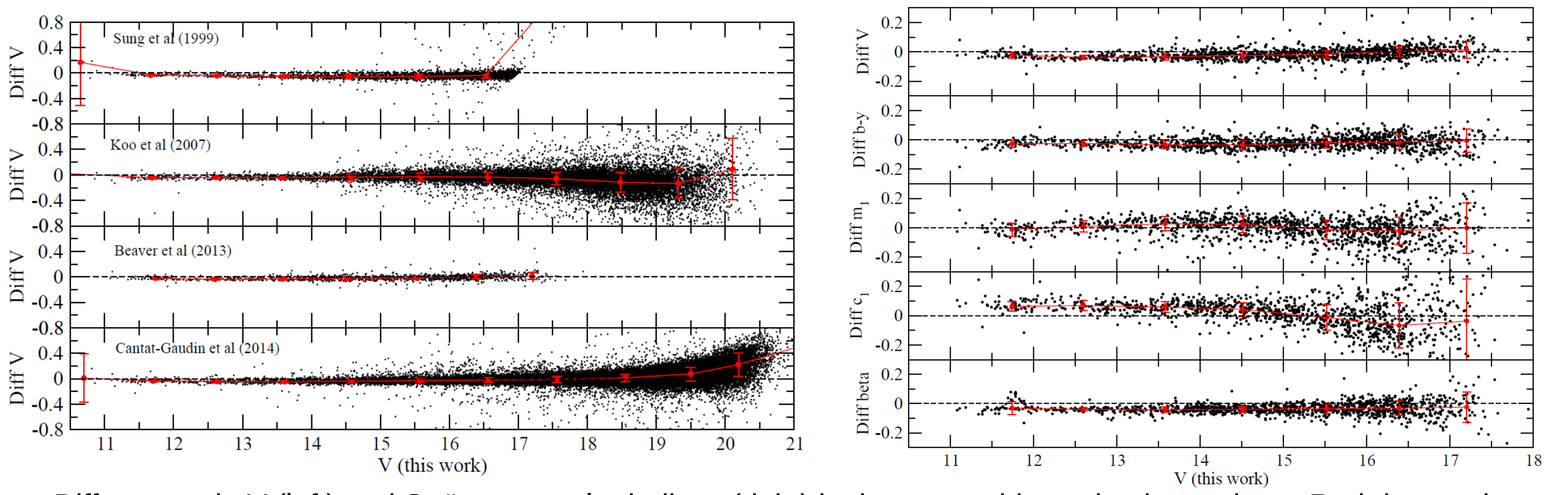


SERC image of the NGC6705 field. Black line delimitates the area covered by our observations. Blue and red dots are UVES and GIRAFFE observations, respectively.

Our photometry in comparison with previous surveys

The plots show the differences between our photometry and previous surveys in the literature. Only those with a significant number of stars, area coverage and deepness in luminosity are considered.

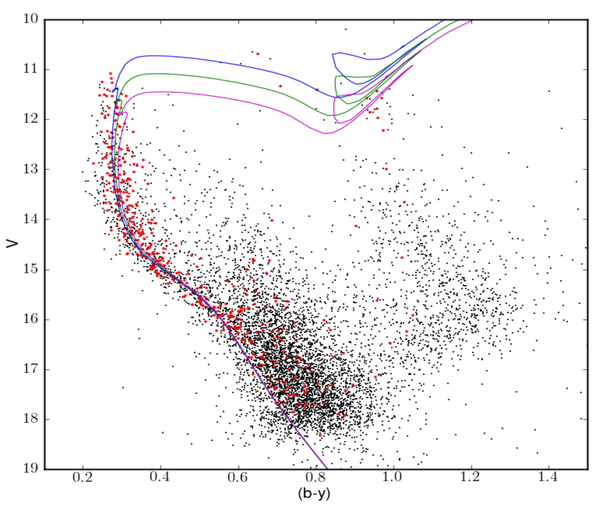
The comparison with the Strömgren data by Beaver et al (2013) for about 1200 stars in common yields small systematic differences caused of: -0.015 0.038 mag in V, -0.017 0.046 mag in b-y, -0.014 0.092 in m_1, +0.014 0.131 mag in c_1 and -0.036 0.042 in β. These are caused by different selection of reference stars for the instrumental-to-standard transformation.



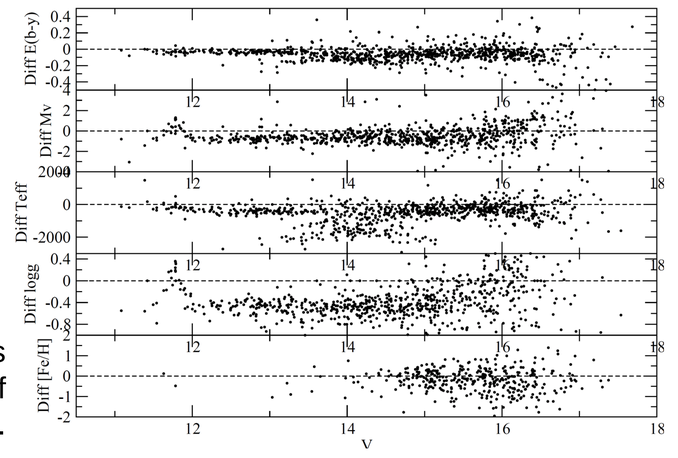
Differences in V (left) and Strömgren color indices (right) in the sense this work minus others. Red dots and error bars are the median and standard deviation of the differences per interval of magnitude.

Results

From a total of 51293 stars observed (only 31341 with Hβ, 21138 with m_1 and 10686 with c_1, 9308 stars with complete photometry), we were able to calculate physical parameters for 6981 stars (1270 stars at a distance closer that 5' from cluster center and 501 stars closer than 2.5'). From these central stars and cluster sequence in the CMD, we found **E(b-y) = 0.31 0.05 (E(B-V) = 0.42); V_0-M_V = 11.9 0.7 (d ≈ 2000pc); [Fe/H] = -0.2 0.4 (Z=0.009).** We have also derived physical parameters with the same methodology but using Beaver et al (2013) photometry. The systematic differences in photometry yield systematic differences in physical parameters, as expected. The differences for stars V<12 are due to non-linearity issues in our photometry.

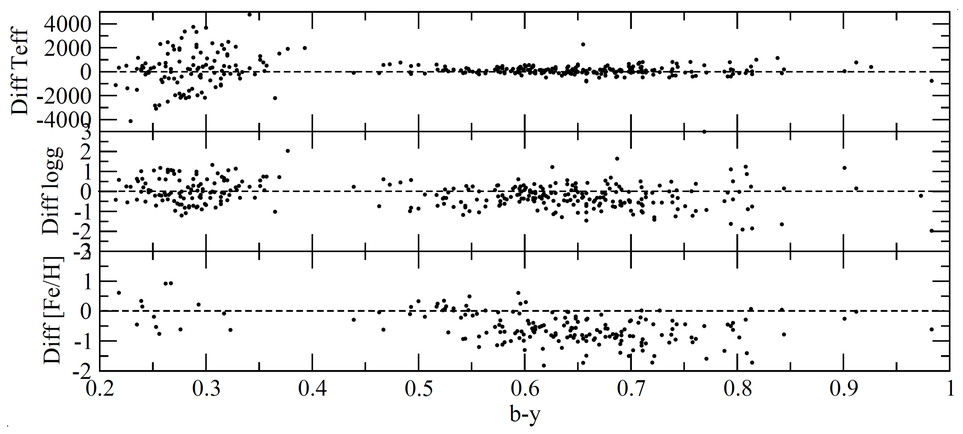


CMD diagram for the 6981 stars with determined physical parameters (black). The stars within a radius of 2.5' are highlighted in red. The isochrones from PARSEC for Z=0.009 and for log age=8.4, 8.5 and 8.6 are overplotted.



Differences in physical parameters as derived from our photometry and that of Beaver et al (2013).

Comparison with Gaia-ESO survey



We have compared our physical parameters with the ones in the **Gaia-ESO Survey** second release for the stars in common and with V>12. There are clear different trends for the stars bluer and redder than b-y=0.4 (T_{eff} ≈ 8000 K), due to the different instrumental setups used by for GIRAFFE observations. The differences have significantly decreased with respect to the first data release.

Our work – Gaia-ESO	b-y<0.4 (HR3)	b-y>0.4 (HR15N)
ΔTeff	220±1580 K	115±345 K
Δlog g	0.08±0.63	-0.31±0.70
Δ[Fe/H]	-0.01±0.59	-0.65±0.58