

# Detailed studies of three open clusters from Gaia ESO Survey (GES)

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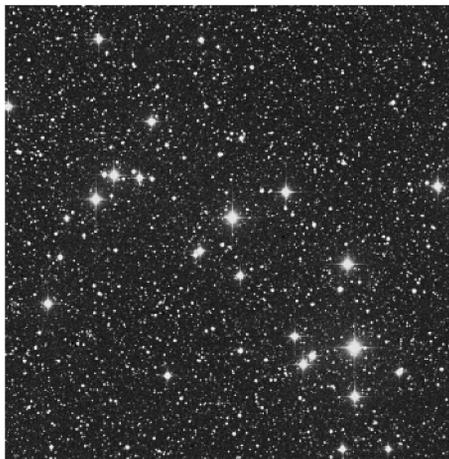
## ABSTRACT

We present results for the intermediate-age and old open clusters NGC6633, NGC6705 (M11) and NGC2682 (M67). We have used new Strömgren-Crawford photometry, proper motions from ROA observations and spectral information from Gaia-ESO Survey (GES), to study the physical parameters of the stars in the three cluster's areas. The astrometric studies cover an area of about  $1\text{deg}^2$  and down to  $r \sim 17$  while our INT-WFC CCD intermediate-band photometry covers an area of about  $40' \times 40'$  down to  $V \sim 19$ . The stars of those areas selected as cluster members from their proper motions, are classified into photometric regions and their physical parameters determined, using  $uvbyH\beta$  photometry and standard relations among colour indices for each of the photometric regions of the HR diagram. That allows us to determine reddening, distances, absolute magnitudes, spectral types, effective temperatures, gravities and metallicities, thus providing an astrophysical characterization of the clusters. These results are compared with the physical parameters obtained from GES spectral data as well as radial velocities to confirm membership. All these data lead us to a comparison of photometric and spectroscopic physical parameters.

NGC 6705 (M11)



NGC 6633



NGC 2682 (M67)

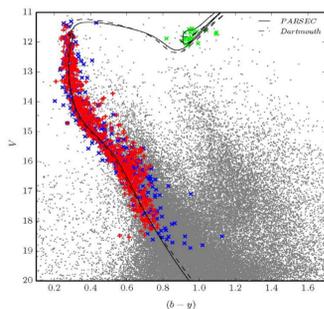


## Our observations

Observations taken with the Wide Field Camera (WFC) of the 2.5 m Isaac Newton Telescope in La Palma. The WFC consists of a mosaic of 4 CCDs that covers a field of  $34' \times 34'$ . The clusters were observed in each Strömgren filter up to a limiting magnitude  $V \sim 19$ .

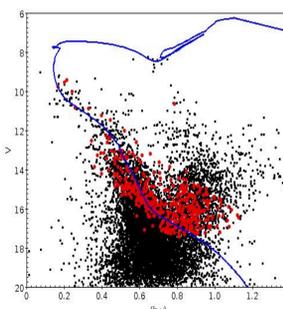
### NGC 6705 (M11)

$\alpha = 18:51:05$   
 $\delta = -06:16:12$   
 $l = 27.307^\circ$   
 $b = -2.776^\circ$   
 $\log \text{age} = 8.45$   
 $E(b-y) = 0.30 \pm 0.02$   
 $\text{dist} = 2512 \pm 800 \text{ pc}$   
 $[\text{Fe}/\text{H}] = -0.3 \pm 0.3$



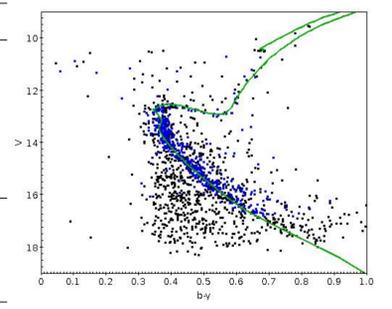
### NGC 6633

$\alpha = 18:27:15$   
 $\delta = +06:30:30$   
 $l = 36.011^\circ$   
 $b = 8.328^\circ$   
 $\log \text{age} = 8.629$   
 $E(b-y) = 0.17 \pm 0.08$   
 $\text{dist} = 417 \pm 15 \text{ pc}$   
 $[\text{Fe}/\text{H}] = -0.2 \pm 0.3$



### NGC 2682 (M67)

$\alpha = 08:51:18$   
 $\delta = +11:48:00$   
 $l = 215.696^\circ$   
 $b = 31.896^\circ$   
 $\log \text{age} = 9.97$   
 $E(b-y) = 0.03 \pm 0.03$   
 $\text{dist} = 830 \pm 60 \text{ pc}$   
 $[\text{Fe}/\text{H}] = 0.0 \pm 0.3$

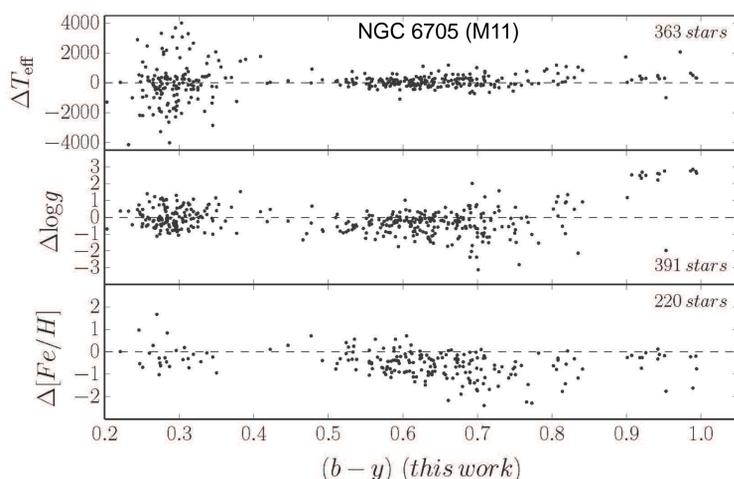


From our catalogue of 63437 stars (in grey) with photometry (12137 with all filters), we were able to calculate physical parameters for 8617 stars. In blue, we show member stars chosen from Cantat-Gaudin et al. (2014) radial velocities. In red, main sequence members of the cluster with calculated physical parameters (721 stars). In green, red clump member stars in common with GES UVES. Isochrones from PARSEC and Dartmouth models.

From our catalogue of 44035 stars (in black) with photometry (18231 with all filters), we were able to calculate physical parameters for 10911 stars. In red, 447 stars with calculated physical parameters in common with GES UVES/GIRAFFE. Isochrones from PARSEC (Bressan et al. 2012).

From our catalogue of 1518 stars (in black) with complete photometry in all filters, we were able to calculate physical parameters for 760 stars. In blue, we show 524 member stars chosen from our absolute proper motions for 2841 stars calculated on the basis of new measurements made with the Meridian Circle of San Fernando CMASF at El Leoncito (Argentina). Isochrones from PARSEC.

## Comparison with Gaia-ESO Survey (GES)



We have compared our physical parameters with the ones in the **Gaia-ESO Survey** second release for the stars in common. There are clear different trends for the stars bluer and redder than  $b-y=0.4$  ( $T_{\text{eff}} \approx 8000 \text{ K}$ ), due to the different instrumental setups used by UVES and for GIRAFFE observations. We can see them in the figure of NGC6705 on the right.

Our work – GES (U+G)	NGC 6633	N. Stars
$\Delta T_{\text{eff}}$	$260 \pm 515 \text{ K}$	447
$\Delta \log g$	$0.10 \pm 1.21$	364
$\Delta [\text{Fe}/\text{H}]$	$-0.23 \pm 0.45$	341

Our work – GES only UVES	NGC 2682 (M67)	N. Stars
$\Delta T_{\text{eff}}$	$40 \pm 108 \text{ K}$	19
$\Delta \log g$	$0.05 \pm 0.14$	15
$\Delta [\text{Fe}/\text{H}]$	$-0.07 \pm 0.19$	15

Our work – GES	b-y < 0.4 (HR3)	b-y > 0.4 (HR15N)	N Stars
$\Delta T_{\text{eff}}$	$220 \pm 1580 \text{ K}$	$115 \pm 345 \text{ K}$	363
$\Delta \log g$	$0.08 \pm 0.63$	$-0.31 \pm 0.70$	391
$\Delta [\text{Fe}/\text{H}]$	$-0.01 \pm 0.59$	$-0.65 \pm 0.58$	220

## References

- Bressan et al. MNRAS 427, 127 (2012)
- Cantat-Gaudin et al. A&A 569, 17 (2014)
- Jordana, N. Trabajo fin de grado UB, jun.2016.
- Massana, P. Trabajo fin de grado UB, jun. 2016.