GAIA-ESO project: Cluster Membership Analysis

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IAA-CSIC

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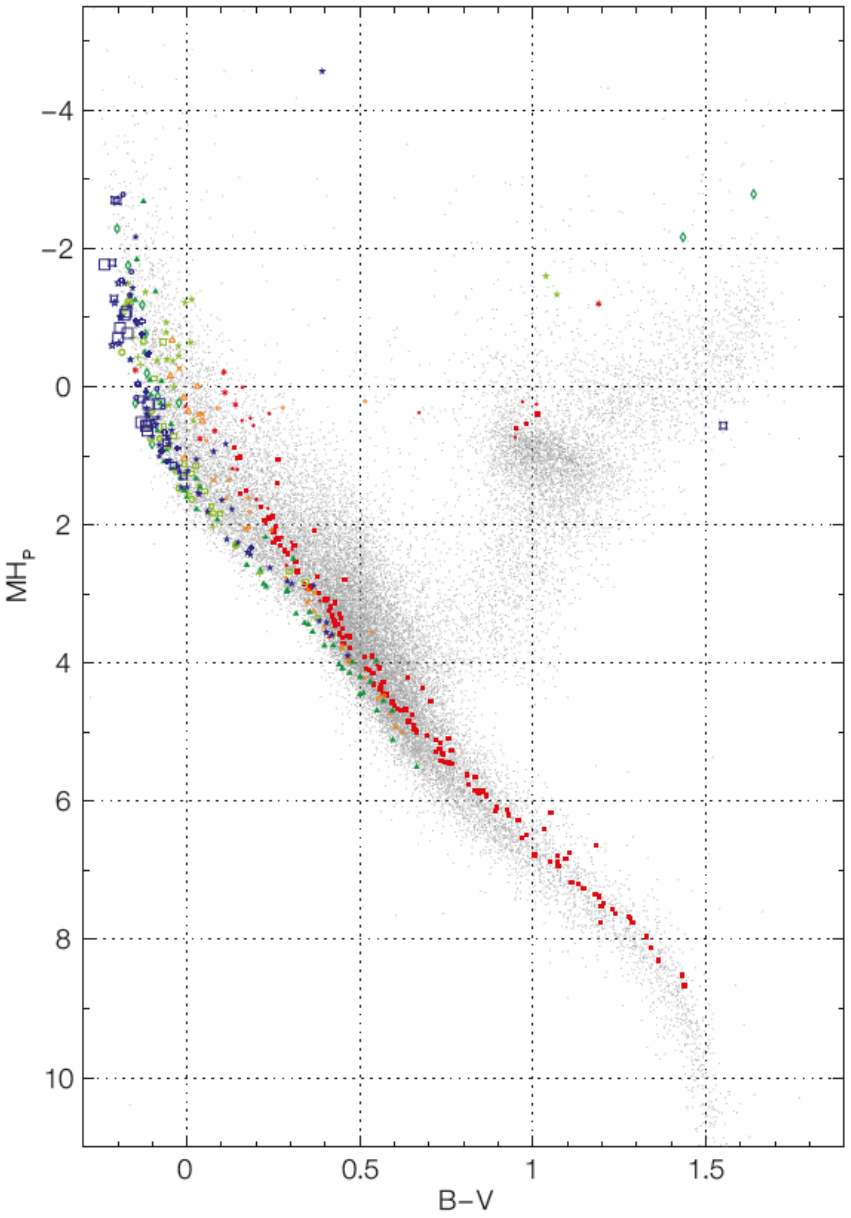
GES goals

- Spectral Survey with VLT-Flames for 10^5 field and cluster stars in the MW up to V~19.
- Homogeneous kinematic and chemical description of MW subsystems and selected open clusters.
- A sample of around 100 open clusters covering the whole range of age.
- GIRAFFE + UVES (medium + high spectral resolution)

Gilmore & Randich + GES Comsortium 2012, Messenger, 147, 25



Cluster Scientific Goals

- General Objectives: Formation, evolution and dispersal of open clusters + Stellar evolution channels using OC as most suitable labs.
- UVES@UT2: Massive stars at different evolutionary stages + Red Giant clump up to V~17.7 (520nm+580nm)
- GIRAFFE@UT2: All stellar populations in clusters up to V=19 (HR03/05A/06/14A/15N/21)

Scientific Objectives

How do the clusters form?
How do the clusters survive?
What physical variables, if any, do control the switch between isolated and clustered star formation?
How do the stars form inside the cluster?

Resolved Clusters:

- **IMF analysis**
- **Low mass tail**
- **Individual stars**
- **Metallicity spread**
- **Age spread**

Compact Clusters:

- **Cluster properties in different environments**
- **Interaction with the gas**

Physical Variables to be Measured

Individual Stars in Clusters:

- Chemical Composition
- Metallicity
- Spectral Types
- Masses
- Effective Temperature
- Age
- Extinction
- Radial velocities
- Proper motions

Star Clusters:

1) Resolved

- Extinction
- Distance
- Age
- Metallicity
- Integrated Mass
- Luminosity Function
- Members Selection

2) Compact

- Mass (Luminous & Dynamical)
- Age
- Velocity Dispersion
- Chemical Composition
- Metallicity

GES Working Groups

- 20 WGs numbered from 0 to 19.
- WG 1, 2, 4, & 6 are in charge of target selection and OB preparation for selected clusters.
- In fact, the organization is not so partitional but is now mainly based on the figure of "Cluster Responsible".
- WG2&4 Angela Bragaglia; WG6(Clusters) Ettore Flaccomio; WG1 Emilio J. Alfaro

Working Scheme

- CR collects any kind of information on the cluster stars (mainly visible + infrared photometry & spectroscopic information if any) + previous studies on the cluster parameters. This information is posted on the WG4 wikipage.
- A. Spagna (from Turin) provides astrometric data for cluster stars from different catalogs. UCAC4 is considered to be the most suitable one, so far. Posted on WG4 wiki page.
- This information is taken by WG1 which proposes a list of cluster member candidates based on the photometry, spectroscopy and astrometry of the cluster stars. Selection posted on WG1 and WG4 wikipages.
- CR makes OB files which are finally sent to WG6 for quality control and sent again to WG0 to be observed.

WG1: How does it work?

- Photometry
  - Starting with optical photometry (in some cases a data mix from various authors)

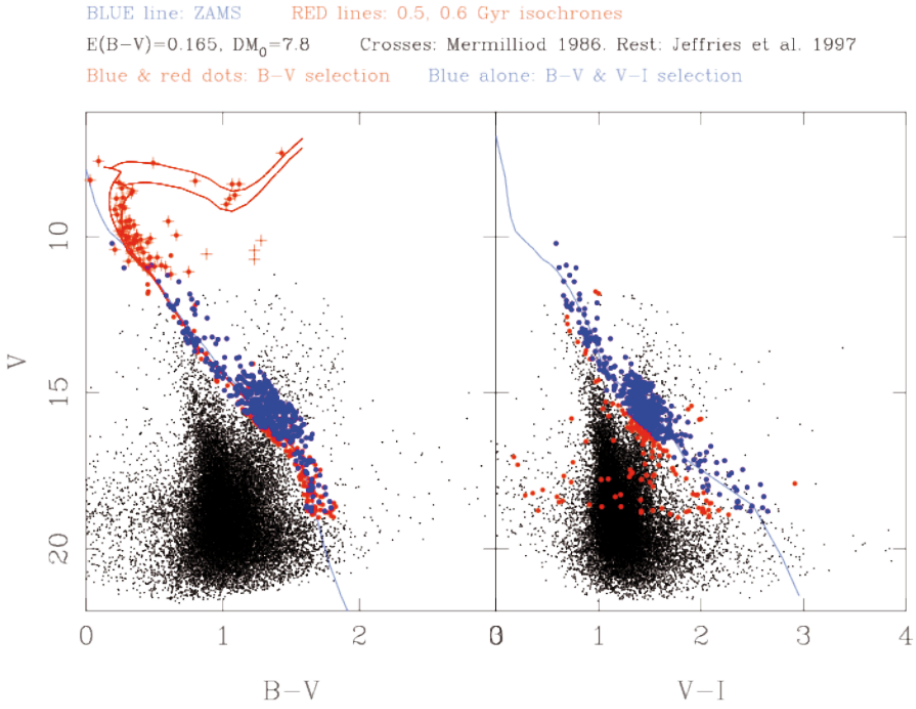


Fig. 1.- V vs. B-V and V-I diagrams for the cluster NGC6633, showing the selection of probable members based only on the V vs. B-V (red and blue dots) and probable members determined from their relative position in both diagrams (blue dots).

WG1: How does it work? (II)

- Photometry (II)
  - IR Photometry (most cases 2MASS photometry)
  - Removing those stars with flags other than A, B, & C
  - Selection by hand using VO facilities (sequence width, a critical issue)
  - IR photometry is tipycally shallower than optical photometry => low mass tail selection is only based on optical photometry

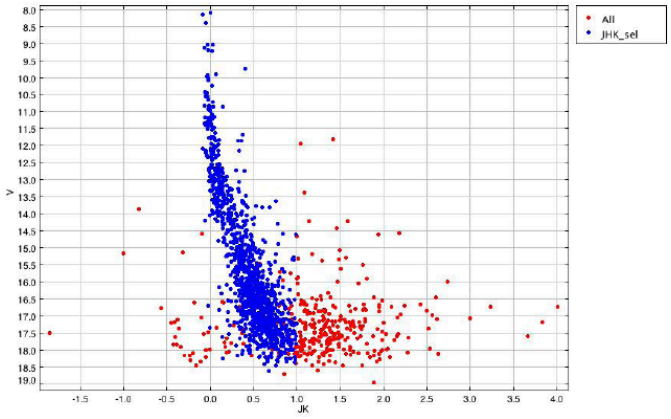


Fig.5 CMD (J-K) vs V for all stars (red) and for JHK selection (blue)

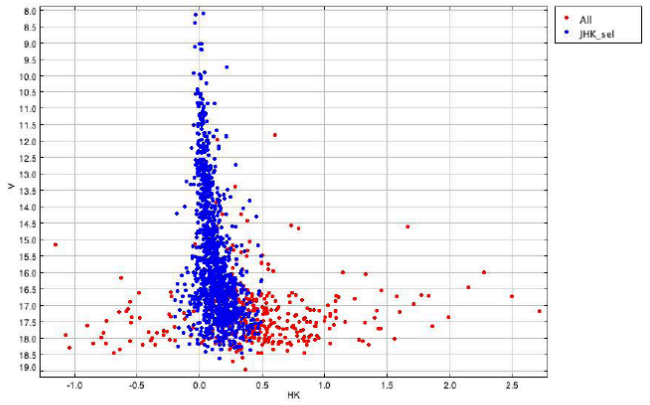


Fig.6 CMD (H-K) vs V for all stars (red) and for JHK selection (blue)

WG1: How does it work? (III)

- Kinematics
  - SPM or UCAC4 (SPM deeper and more precise than UCAC4 but limited to Delta < -10º)
  - Selection of N (> 20) "bona fide" cluster members from RV (better) or PM data analysis
  - Matching this sample with the PM catalog to be used
  - Chi-Square estimates of first and second moments of PM distribution weighted by PM errors
  - If Chi > 1, repeat the fitting but including a new additive term in the second moment which could account for internal dispersion, non-gaussian errors, bias, etc..
  - Remove those stars with distance to the PM cluster centroid larger than 5 times the extended dispersion
  - Keep all the stars without PM information

http://great.ast.cam.ac.uk/GESwiki/GesWg/GesWg1#WG1_Plan_and_Procedures

Observed Clusters

- Cha I
- Gamma2 Vel
- Rho Oph
- NGC 6705
- NGC 4815
- Be 81

Other 25 clusters are in different stages of the whole procedure