

# Open Clusters: a program to analyse the Color-Magnitude diagram with the help of the stellar kinematical data

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We constructed a program that allows to use simultaneously and interactively photometric and astrometric stellar data (proper motion) to analyze color-color and color-magnitude diagrams.

With this program we are able to determine, based on photometric membership, the distance and age as well as the mean proper motion and radial velocity of several open clusters which had very uncertain parameters in previous analyses.

## INTRODUCTION

Open clusters constitute a system of objects of great value for the study of the dynamics of the Galaxy because they span a relatively wide range of ages, and their ages can be determined with more precision than any other spiral arm tracer with the help of the HR diagram. They are key objects to understand the motion of spiral arms (Dias & Lépine 2005), to derive the rotation curve and to distinguish between star formation processes.

We constructed a program that allows to use simultaneously and interactively photometric and astrometric stellar data (proper motion) to analyze color-color and color-magnitude diagrams.

The basic analysis procedure of the diagrams consists of 3 phases:

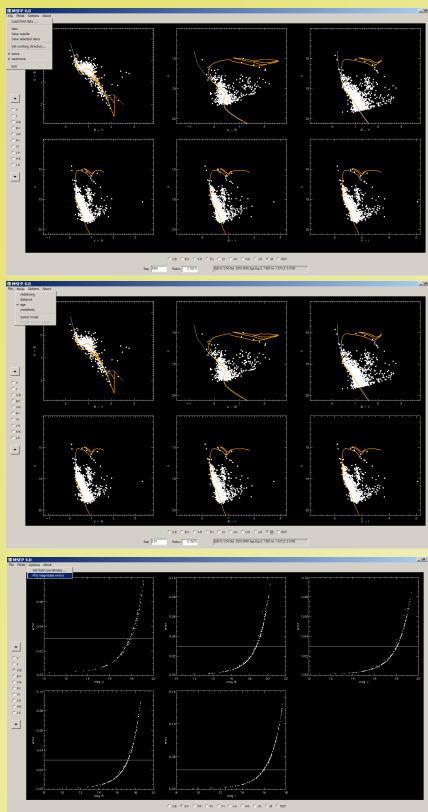
1. Choice of the radius of the cluster to be analyzed based on the plot of the radial density profile;
2. Manual selection of a number of stars that obviously belong to the cluster in the color-magnitude diagram of that region of the sky;
3. The program marks the stars with similar proper motion of those selected before.

The procedure above may be iterated: the selected stars are temporarily discriminated with different colors in the plots to search for the expected cluster characteristic features (a main sequence, a turn-off and stars considered members in the giant branch).

Thus, analysis of a given cluster includes the following interactive operations:

- identify the signature of the cluster to apply the main sequence method and determine the color-excess, distance and age;
- use the photometrically selected stars to estimate the mean proper motion and radial velocity of the cluster.

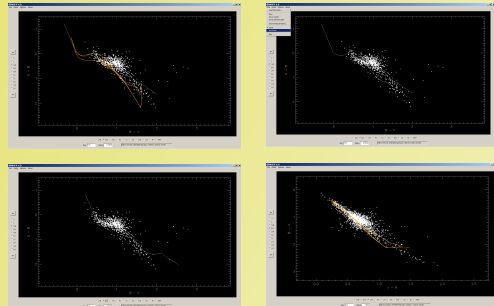
## THE SOFTWARE



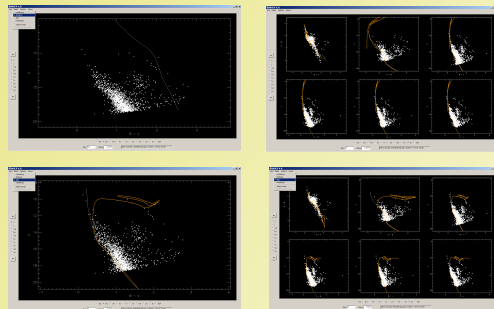
## THE SOFTWARE: an example

To provide minimal information on this application are summarized briefly some important, even if non exhaustive points, applying this code to open cluster Ruprecht 176, observed in 19th april 2009, at LNA (Brazil) .

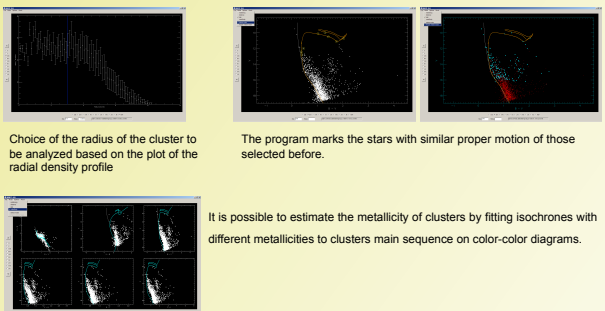
### Color-excess



### Distance and age



### Helpful tools



Choice of the radius of the cluster to be analyzed based on the plot of the radial density profile

The program marks the stars with similar proper motion of those selected before.

It is possible to estimate the metallicity of clusters by fitting isochrones with different metallicities to clusters main sequence on color-color diagrams.

## Final Results

Ruprecht176 RA=16 14 48 DEC=-51 20 00 J2000  
Colour Excess E(B-V): 0.5400 +/- 0.0886  
Distance (pc): 2790.0000 +/- 391.5772  
Age (Myr): 8.0500  
Mv\_alpha\_cordellari (mas): -4.7584 +/- 1.3008  
Mv\_delta (mas): -2.0313 +/- 1.5980  
Used stars in the mean proper motion: 88  
Radial velocity (km/s): NaN +/- NaN  
Used stars in the mean radial velocity: 0  
Metallicity: 0.0190

*Colour –excess, distance and age*

*mean proper motion and radial velocity based on photometric membership*

Used stars in the mean proper motion of the cluster:  
ID RA DEC V errV mu\_alpha mu\_delta  
10 243.6517480 -51.2627640 13.104 0.005 3.57 -2.70 2.80 2.40  
08 243.6500950 -51.2705270 12.899 0.005 -6.52 -1.50 2.70 2.50  
12 243.5873520 -51.2759590 13.184 0.003 -0.19 -8.90 2.70 2.50  
02 243.5626680 -51.4137110 11.984 0.002 -9.54 -14.20 2.80 2.70

*Stars with proper motion considered as members based on photometric criteria*

Used stars in the mean radial velocity of the cluster:

Not found

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