BV photometry of a possible open star cluster pair
NGC 7031/NGC 7086

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Abstract. We present a CCD BV photometry of the possible binary open star cluster NGC 7031/NGC 7086. The aim is to confirm or disapprove their common nature on the grounds of their age and distance. An age of 224 ± 25 Myr and distance 831 ± 72 pc was determined for NGC 7031 and 178 ± 25 Myr, 955 ± 84 pc for NGC 7086, respectively. Based on these quite big age and distance differences we conclude that the two clusters are most likely not formed together from one and the same Giant Molecular Cloud and they are not a true binary cluster.

Key words: Galaxy: open clusters and associations - individual: NGC 7031, NGC 7086

BV фотометрия на вероятната двойка от разсеяни звездни купове
NGC 7031/NGC 7086
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Представяме BV CCD фотометрия на вероятната двойка от разсеяни звездни купове NGC 7031/NGC 7086. Целта на нашето изследване е да потвърдим или опровергаем техния общ произход и двойнствеността им, чрез определяне и сравняване на техните възрасти и разстояния. За NGC 7031 определихме възраст от 224 ± 25 Myr и разстояние от 831 ± 72 pc и 178 ± 25 Myr, 955 ± 84 pc съответно за NGC 7086. Тази разлика във възраста и разстоянието ни дават основание да направим извода, че двата купа най-вероятно не са се формирали заедно от общ газово-прахов комплекс и не са същинска двойка.

Introduction

A binary open star cluster is an object consisting of two open clusters. They can be basically described as: (i) binary physical systems with common origin formed together from one and the same Giant Molecular Cloud (GMC), having comparable age and chemical composition, this is a true binary cluster; (ii) binary physical systems arising from clusters formed in different part of the Galaxy and forming a pair with mutual gravitational capture, these clusters are expected to have different ages and chemical composition. There are more than 1600 open clusters in our Galaxy but only one well established double or binary cluster $h + \chi$ Persei. Subramaniam et al. [1995] proposed a list with 18 candidates pairs, NGC 7031 and NGC 7086 are included. Basic parameters of NGC 7031 and NGC 7086 as given of Dias et al. [2002] and WEBDA[1] database are presented in Table 1.

Table 1. Basic parameters of the clusters NGC 7031 and NGC 7086.

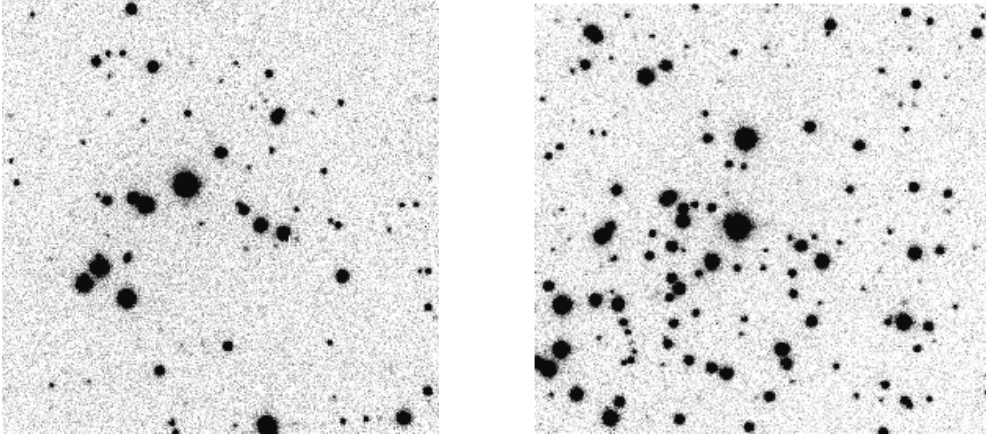| Parameter	NGC 7031	NGC 7086
R.A.(2000)	21:07:12	21:30:27
Decl.(2000)	+50:52:30	+51:36:00
Distance (pc)	900	1298
Ang. diam (arcmin)	14.0	12.0
E(B-V) (mag)	0.854	0.807
log(age)	8.138	8.142

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[1] http://univie.ac.at/webda/navigation.html

For a good selection criterion for a binary cluster Dieball [2002] consider:
(i) the maximum centre-to-centre separation is $\approx$ 20 pc
(ii) the age difference between components is either $\leq$ 10 Myr or their ages agree well within the uncertainties of their age determination.

The aim of our investigation is to determine more precisely such cluster parameters as reddening, distance and age using CCD photometry and applying criterion for binarity in order to confirm or disapprove their binarity.

1   Observations and data reduction

The clusters were observed in the night of May 30 2006 with the 2-m Ritchey-Chretien telescope of Rozhen National Astronomical Observatory - Bulgaria. The telescope is equiped with standard Johnson filters and 1340x1300 VersArray 1300B CCD camera with 20 μm pixel size that corresponds to 0.26 arcsec, giving a field of 5x6 arcmin^2 in the sky. The angular separation between the centers of the clusters is approximately 1 degree and we cannot observe them on a single frame. The exposures were 100 and 50 s in the B and V filters for NGC 7031 and 125 and 75 s for NGC 7086 respectively under good photometric conditions; seeing was between 1.6 - 1.9 arcsec. The clusters' fields are shown in the Fig. 1. Standard IRAF routines were used to reduce the data; photometry was carried out with DAOPHOT II.


Fig. 1. $5' \times 6'$ V band image of NGC 7031 (left panel) and NGC 7086 (right panel) . North of the top, east to the left.

2   Color-magnitude diagrams and cluster parameters

The luminosity function of the clusters is presented in Fig. 2 with dashed line for NGC 7031 and solid line for NGC 7086. Color-magnitude diagrams (CMDs) are presented in Fig. 3. Table 2 presents our determination of clusters' parameters. Distance module, reddenings and ages of the clusters have been derived by matching by eye the observed CMDs to isochrones with Z = 0.020 from the Geneva group, paying particular attention to the most likely shape of the main sequence, the turn-off point and the location of evolved stars .
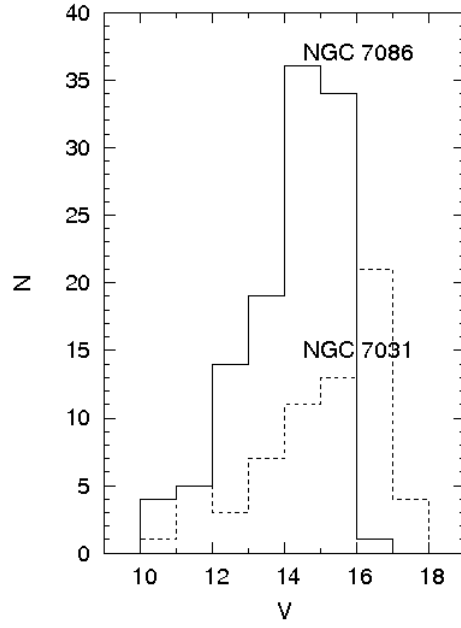
Fig. 2. Luminosity function of NGC 7031 and NGC 7086.
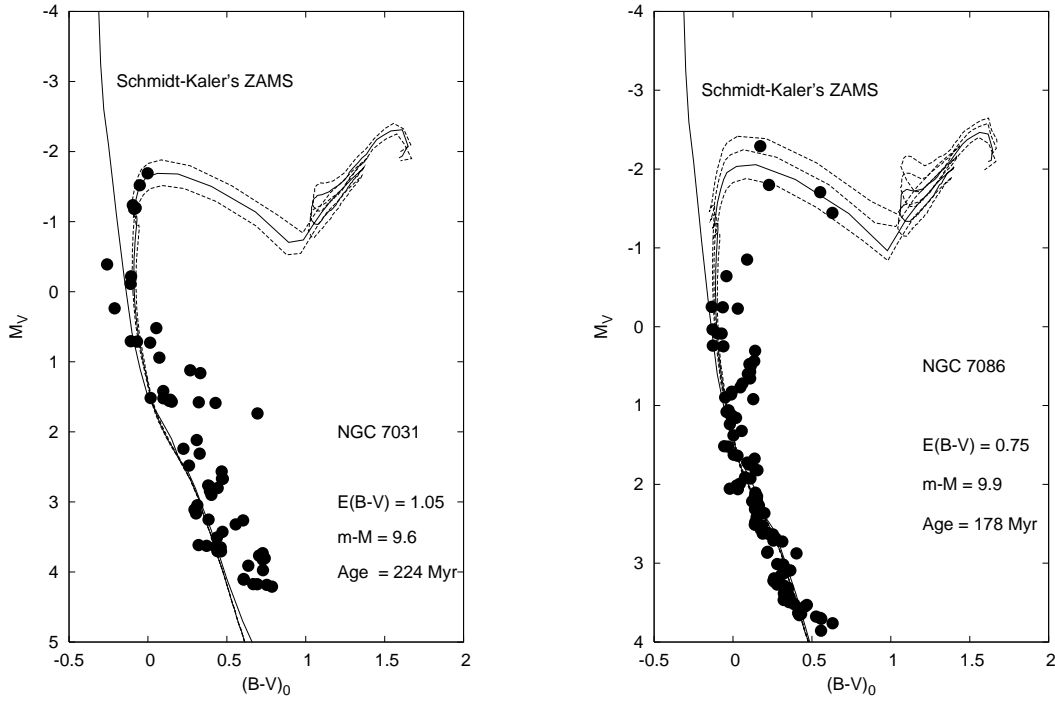
Fig. 3. M_V, $(B-V)_0$ CMD of NGC 7031 (left panel) and NGC 7086 (right panel) with the best fit isochrones.

Conclusion

We presented BV CCD photometry of the closely projected open star clusters NGC 7031 and NGC 7086. The results are summarized in Table 2. Our estimations of the

Table 2. Derived clusters' parameters.

Parameter	NGC 7031	NGC 7086
E(B-V) (mag)	1.05 ± 0.05	0.75 ± 0.05
(m-M)v	9.6 ± 0.2	9.9 ± 0.2
Distance (pc)	831 ± 72	955 ± 84
log(Age)	8.35	8.25
Age (Myr)	224 ± 25	178 ± 25

age difference between NGC 7031 and NGC 7086 and difference in distance along the line of sight are 46 Myr and 124 pc, respectively. These results do not match with the criterion for a binary cluster and we conclude that the two clusters most likely are not formed together from one and the same GMC and they are not a true binary cluster. If they are a bainary cluster it must be arising from a spatial encounter with capture but we can not confirm or disprove this.

References

Dias W. S., Alessi B. S., Moitinho A. Lèpine, J.R.D., 2002, *A&A, 389 871*
Dieball A., 2002, "Binary star clusters in the Large Magellanic Cloud", Ph.D. Thesis, University of Bonn
Subramaniam A., Gorti U., Sagar R., Bhatt H., 1995, *A&A, 302 86*