Bulg. J. Phys. **30** (2005) 1–5

Age determination of possible binary open clusters NGC 2383/NGC 2384 and Pismis 6/Pismis 8

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Received ...

Abstract.

Based on 2MASS J and Ks photometry for the open star clusters NGC 2383, NGC 2384, Pismis 6, Pismis 8 and using color magnitude diagrams with isochrones fit, we found an age of $\log(\text{age})$ = 8.3 (200 $\pm$ 6 Myr) for NGC 2383 and $\log(\text{age})$ = 6.9 (8 $\pm$ 6 Myr) for NGC 2384. For Pismis 6 and Pismis 8 we adopted an range of $\log(\text{age})$ = 6 - 7 (1 - 10 Myr). We conclude that Pismis 6 and Pismis 8 have similar age and may have been formed in the same Giant Molecular Cloud, and they are a good candidate for binary cluster. For NGC 2383 and NGC 2384 we foud a big age range, and conclude that they not be formed in the same Giant Molecular Cloud.

PACS number: 98.20.Di

1 Introduction

Open clusters are very important objects in the study of stellar evolution because the stars are all of very similar age and chemical composition, and the effects of other more subtle variables on the properties of stars are much more easily studied than they are for isolated stars. The total number of open clusters known in our Galaxy is over 1600, (see "New catalog of optically visible open clusters and candidates" Dias et al. [1]) of these the only well established double or binary cluster is NGC 869 and NGC 884 (known also as $h + \chi$ Persei), located at a distance of more than 2 kpc from the Sun. The existence of other possible double clusters has been proposed earlier form Pavloskaya et al. [2], but not been

seriously looked into. Subramaniam at al. [3] examined existing catalogues of open cluster and suggested 18 probable binary open star clusters. The aim of this study is to determing age on probable binary open star clusters NGC 2383, NGC 2384, Pismis 6, and Pismis 8 using J and Ks photometry from Two Micron All Sky Survey (2MASS project used two highly-automated 1.3-m telescopes, and provide all-sky photometry in J (1.25 microns), H (1.65 microns), and Ks (2.17 microns) bands).

2 Earlier studies

Vogt and Moffat [4] from photoelectric UBV measurements, derived a distance of 1970 pc to NGC 2383 and 3280 pc to NGC 2384, the reddening are very simular E_{B-V} = 0.27 mag and 0.29 mag, respectively. Though both clusters appear close to each other on the sky, Vogt and Moffat concluded that they are not physically connected because of their different distances. Subramaniam and Sagar [5] presented first CCD photometry for NGC 2383 and NGC 2384, they estimate the distance to NGC 2383 to be 3340 $\pm$ 155 pc and an age of 400 Myr, for NGC 2384 they found a distance of 2925 $\pm$ 135 pc and an age of 20 Myr. Within the errors, the distances are close enough to still match the selection criterion of Subramaniam at al. [3], but the large age difference indicates that the clusters did not form together from the same Giant Molecular Cloud (GMC).

First studies on Pismis 6 and Pismis 8 are from Vogt and Moffat [6], using photoelectric photometry they derived a distance of 1650 pc for Pismis 6 and 1420 pc for Pismis 8, and a reddening of E_{B-V} = 0.40 mag and 0.74 mag, respectively. Fitzegerald et al. [7] found that both clusters are 1700 $\pm$ 200 pc away (photometric distance) and are 17 pc of each other in the plane of the sky, spectroscopic distance module are slightly larger than photometric module see also Fitzgerald et al. [8]. The reddenings are compatible whit the values derived by Vogt and Moffat [6], Fitzegerald suggested that Pismis 6 and Pismis 8 have an age of 30 Myr and thus a common origin. Battinelli and Capuzzo-Dolcetta [9] suggested a reddening of E_{B-V} = 0.41 mag and an age of 32 Myr for Pismis 6. In contrast, Forbes and Short [10] suggested that Pismis 6 is only 8 $\pm$ 2 Myr old, with reddening E_{B-V} = 0.46 $\pm$ 0.04 mag and distance of 1850 $\pm$ 100 pc.

3 Clusters data and age determinations

We used the photometry for the clusters from 2MASS using VizieR tool available at http://visier.u-strasbg.fr. We made circular extractions centered on the coordinates for each clusters: NGC 2383 (α2000 = 07:24:41.0 , δ2000 = -20:56:42), NGC 2384 (α2000 = 07:25:12.0 , δ2000 = -21:01:24), Pismis 6 (α2000 = 08:39:04.0 , δ2000 = -46:13:36), Pismis 8 (α2000 = 08:41:36.0 , δ2000 = -46:16:00). Apparent diameters on NGC 2383 and NGC 2384 is 5.0 arcmin, and 3.0 arcmin for Pismis 6 and Pismis 8, for this we used an extraction

radius of 5.0 arcmin and 3.0 arcmin respectively. Using the interstellar extinction law: $\frac{A_J}{A_V}$ = 0.282 and $\frac{A_K}{A_V}$ = 0.112 from Rieke & Lebofsky [11] and data for the distance and the reddening from [5], for two clusters NGC 2383 ($V - M_V$ = 13.3 $\pm$ 0.3 , E_{B-V} = 0.22 $\pm$ 0.05) and NGC 2384 ($V - M_V$ = 13.2 $\pm$ 0.3 , E_{B-V} = 0.28 $\pm$ 0.05), we derived reddening E_{J-K_S} = 0.12 $\pm$ 0.05 and E_{J-K_S} = 0.15 $\pm$ 0.05 respectively. For other two clusters Pismis 6 ($V - M_V$ = 11.2 $\pm$ 0.2 , E_{B-V} = 0.41 $\pm$ 0.06) and Pismis 8 ($V - M_V$ = 11.0 $\pm$ 0.25 , E_{B-V} = 0.76 $\pm$ 0.06) we using data from [8], and derived reddening E_{J-K_S} = 0.25 $\pm$ 0.10 and E_{J-K_S} = 0.40 $\pm$ 0.10. Colour-magnitude diagrams (CMDs) M_J versus $(J - K_S)_0$ for clusters are given on Figure 1.

We determined the age of the clusters overplotting the best fitting isochrones on the CMDs. We have adopted an age of $\log(\text{age})$ = 8.3 (200 $\pm$ 6 Myr) for NGC 2383 and $\log(\text{age})$ = 6.9 (8 $\pm$ 6 Myr) for NGC 2384, for Pismis 6 and Pismis 8 we adopted an age range of $\log(\text{age})$ = 6 - 7 (1 - 10 Myr). The isochrones are based on the stellar models of the Geneva group Schaerer D., at al. [12], whit Z = 0.008 which corresponds to metallicity [Fe/H] = -0.3 dex. For NGC 2383 and NGC 2384 we determine less age from given in [5], but for Pismis 6 and Pismis 8 our ages determination are comparable with [8], [9], and [10].

4 Conclusions

Using 2MASS J and Ks photometry for the open star clusters NGC 2383, NGC 2384, Pismis 6 and Pismis 8, and fitting CMDs with isochrones based on the Geneva models, we found $\log(\text{age})$ = 8.3 (200 $\pm$ 6 Myr) for NGC 2383, $\log(\text{age})$ = 6.9 (8 $\pm$ 6 Myr) for NGC 2384, and range of $\log(\text{age})$ = 6 - 7 (1 - 10 Myr) for Pismis 6 and Pismis 8. Pismis 6 and Pismis 8 have similar age and may have been formed in the same GMC, and we conclude that they are a good candidate for binary cluster. In contrast NGC 2383 and NGC 2384 have a big age range between, and may be not formed in the same GMC.

Acknowledgments

Our work is partially supported by the grant F-1302/2003 of the Bulgarian NSF. This publication makes use of data products from the Two Micron All Sky Survey, which is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation.

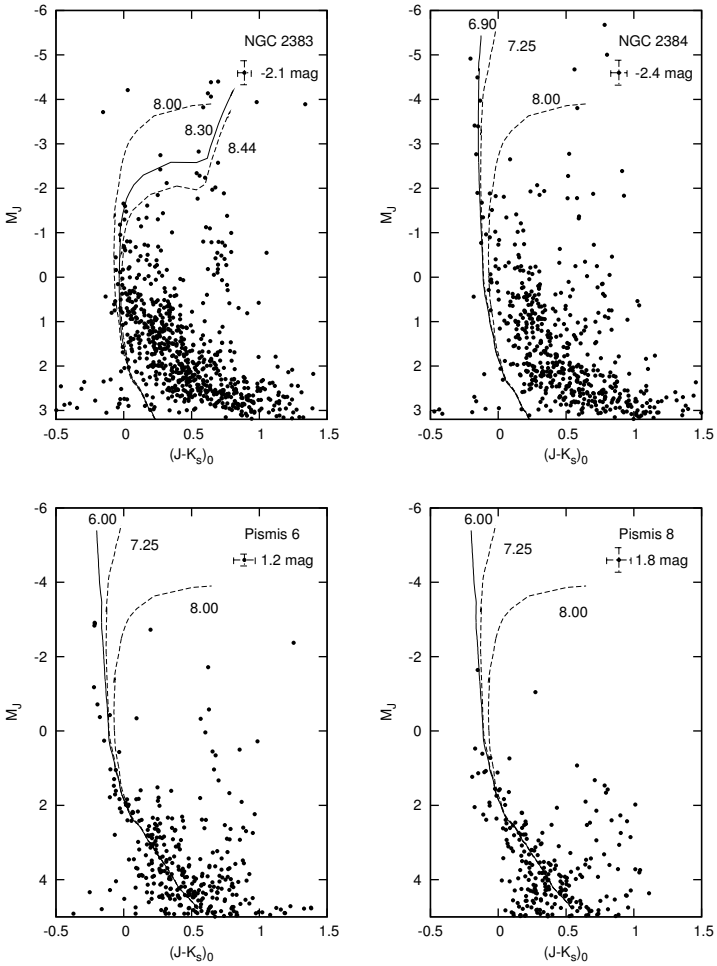

Figure 1. Colour-magnitude diagram for NGC 2383, NGC 2384, Pismis 6 and Pismis 8 with the best isochrone fit. We have adopted an age of $\log(\text{age})$ = 8.3 (200 $\pm$ 6 Myr) for NGC 2383 and $\log(\text{age})$ = 6.9 (8 $\pm$ 6 Myr) for NGC 2384. For Pismis 6 and Pismis 8 we adopted an range of $\log(\text{age})$ = 6 - 7 (1 - 10 Myr).

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