Study of possible binary open star clusters in our Galaxy

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We analyzed the possibility of the existence of binary open star clusters in our Galaxy.

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 ages and chemical compositions (we call this a true binary cluster);
(ii) binary physical systems arising from clusters formed in different parts of the Galaxy and forming a pair through gravitational capture. Cluster pairs formed through tidal capture have different ages and/or chemical composition.

Four possible pairs were studied:
King 14/NGC 146, NGC 2383/NGC 2384,
Pismis 6/Pismis 8, NGC 7031/NGC 7086.

In our study we used the following criterion for a binary cluster:

Two clusters form a primordial binary cluster if the distance between them is ≤ 20 pc, and the difference in their age is ≤ 10 Myr.

For the open star clusters King 14, NGC 146, NGC 2383, NGC 2384, Pismis 6 and Pismis 8 we used 2MASS J and Ks photometry and fitted their colour-magnitude diagrams (CMDs) with isochrones based on the Geneva models with metalicity Z = 0.008.

We found:
King 14: log(age) = 7.8 (63 $\pm$ 8 Myr)
NGC 146: log(age) = 7.5 (32 $\pm$ 8 Myr)
NGC 2383: log(age) = 8.3 (200 $\pm$ 6 Myr)
NGC 2384: log(age) = 6.9 (8 $\pm$ 6 Myr)

The difference in age between King 14/NGC 146 is 31 Myr, and the one between NGC 2383/NGC 2384 is 192 Myr. Both differences are bigger than our criterion for a binary cluster, so we conclude that the two pairs of clusters above most likely do not form primordial binary clusters.

For Pismis 6/Pismis 8 we found similarity of age: log(age) = 6 -7 (1 - 10 Myr), and we conclude that they are a good candidate for a binary cluster.

For NGC 7031/NGC 7086 we used B and V Johnson-Cousin photometry and fitted their CMDs with isochrones with metalicity Z = 0.020.

We found also:
$(m - M)_v$ = 9.6 $\pm$ 0.2 (831 $\pm$ 72 pc) for NGC 7031
$(m - M)_v$ = 9.9 $\pm$ 0.2 (955 $\pm$ 84 pc) for NGC 7086
log(age) = 8.35 (224 $\pm$ 25 Myr) for NGC 7031
log(age) = 8.25 (178 $\pm$ 25 Myr) for NGC 7086

Our estimation of the age difference between NGC 7031 and NGC 7086 is 46 Myr, and the difference in distance along the line of sight is 124 pc. The

formal application of the criterion for binary clusters makes us conclude that most likely the two clusters were not formed together from the same giant molecular cloud, and are not a true binary cluster.
However, it is possible that the criterion for binary clusters is satisfied. If we minimize the errors in the age determination of the two clusters ($224Myr - 25Myr = 199Myr$ for NGC 7031 and $178Myr + 25Myr = 203Myr$ for NGC 7086), we shall obtain a difference in the age of the clusters of 4 Myr which satisfies the age criterion.
The distance criterion is satisfied under the following two conditions:
– assuming that the distance between the observer and the two clusters is 893 pc ($(831pc + 955pc)/2 = 893pc$);
– assuming that the angular separation between the centers of the clusters is 1 degree.
Thus, the separation between the two clusters becomes 15 pc.
Given this possibility we conclude that the probability of the two clusters NGC 7031/NGC 7086 forming a true binary cluster should not be ruled out.

References

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