NEW OB-ASSOCIATION IN PUP - CMA

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A new method of determination of distances to stellar associations is proposed. This method is based on the measurements of mean thicknesses of globules of the systems of dark globules connected with that association. It is shown that the method is in good agreement with other known methods. A new grouping of OB stars in Pup-CMa is found. It is shown that this grouping has properties characteristic for OB-associations: the stars of that grouping have similar distances, similar radial velocities, the grouping is connected with molecular clouds with Herbig-Haro objects, and cometary nebulae. All these results are in favour of this grouping to be a new OB-association. We named that association OB-association Pup-CMa. The preliminary results of $^{12}$CO observations of molecular clouds connected with that association are also given. The radial velocities of these clouds are in good agreement with the mean radial velocity of stars in the association in Pup-CMa.

1. Introduction.

In [1] the connection of radial systems of dark globules with OB-associations was investigated. It was shown that all 23 radial systems known so far are connected with OB-associations. Recently a new radial system was found in Pup with the central star 30rCMa (O9III). We could not find any association connected with this system in the catalogues. As was mentioned above, all the systems are connected with OB-associations, so we decided to search for one connected with the radial system in Pup. As will be shown below, we succeeded and found a new grouping of OB-stars, having all characteristics of an OB-association: similarity of radial velocities of stars in the grouping, connection with the molecular clouds (which have radial velocities very similar with mean radial velocity of the stars of grouping), presence of an HII region, connection with unstable young objects: Herbig-Haro objects, cometary nebulae, Herbig A/B stars, etc. So it is possible that this grouping is not a pure OB-association, but OB+T-association. This grouping of OB-stars is situated partly in Pup, partly in CMa.

A new method of determination of distances to stellar associations is also suggested, based on the mean thickness of dark globules.

2. The determination of distances by means of the mean thicknesses of dark globules of radial systems.

Since the pioneer works of Ambartsumian (see e.g. [2]) the distances to stellar associations have been revised several times. Even now in the catalogues of associations [3,4] there are distances to the same OB-association, which differ one and a half, even two times. Hence it is clear that every new method of determination of distances to OB-associations is valuable without any doubt.

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We suggest a new method based on the mean thickness of dark globules, situated in the radial systems of dark globules. These radial systems are connected with the OB-association for which we would like to obtain the distance. We presume that the mean thicknesses of dark globules are constant for each radial system (further it will be shown that such a presumption is not far from being correct). Recently it was shown that there are regions of high density inside molecular clouds, and in average these regions have similar dimensions in different clouds \[5,6\]. The main mass of the clouds is in these regions. When the ionizing front from the bright stars comes to these regions, they evaporate, if they are situated close to the ionizing stars, and evaporate partly if they are situated farther. When the distances are larger, they remain in the ionizing flow, and behind them the tails are formed. These objects are dark globules, and from the preceding we can conclude that the mean widths of these globules are similar in different radial systems.

As a standard we took the radial system in the Rosette Nebula, with a distance 1.55 kpc \[3,4\]. The mean thickness for this system is 16" (\(\sigma = 4"\)). Having these data, we can determine the distance to every radial system for which we know the mean thickness of dark globules. Let us try to determine the distances for the radial systems from Table 1 in [1].

The results are summarized in Table 1, where in the successive columns are given: 1. the number of the radial system from Table 1 in [1], 2. the number of globules for which the mean thickness is determined, 3. the mean thickness of dark globules in arcsec (and errors), 4. the distance to the radial system, determined by the method suggested above, 5. OB-association connected with radial system, 6. the distance to the OB-association from \[3,4\], 7. the difference between the distances in columns 4 and 6 (in percent).

As we can see from Table 1, these differences are small (in average ~ 10%).

Let us now consider the previously mentioned radial system in Pup. For three globules we obtained the coordinates of centres and the thicknesses in arcsec: N1. \(\alpha_{1950} = 7^h 21^m 45^s\), \(\delta_{1950} = -25^\circ 21' 03''\), thick. = 46", N2. \(\alpha_{1950} = 7^h 22^m 10^s\), \(\delta_{1950} = -25^\circ 32' 01''\), thick. = 46", N3. \(\alpha_{1950} = 7^h 22^m 16^s\), \(\delta_{1950} = -25^\circ 30' 14''\), thick. = 53". The mean thickness of globules is 48" (\(\sigma = 6"\)). Hence the distance to this radial system by the method suggested above is 520 pc. In Table 1 the distance to that grouping, calculated by us later in Sec. 3 (540 pc), is given.

We can estimate the distance to the radial system by another method. The radial system is formed by the star 30rCMa (O9III), which is surrounded by an HII region LBN1059, 1061. From Table 1 in [1] we can see, that a similar star is present in the system N4. In that system the HII region with a radius \(\sim 3^\circ\) is illuminated by the star \(\lambda\)Ori (O8III). The distance to \(\lambda\)Ori is \(\sim 450\) pc. The radius of the HII region illuminated by the star 30rCMa is \(\sim 2^\circ\), hence the distance to 30rCMa will be less than 670 pc (we must presume that the physical conditions in both HII regions are identical).

3. The grouping of OB-stars in PUP-CMA.

As we can see from Table 1 in [1], all radial systems from this Table are connected with OB-associations. We tried to look for a new OB-association which is connected with the system in Pup, mentioned above.

For that purpose we consider the distribution of OB-stars in the region \(\alpha_{1950} = (6^h 20^m - 8^h 10^m), \delta_{1950} = (-15^\circ - -35^\circ)\), which contains also the radial system in Pup. We took the size of this region to be \(\sim 200\) pc, which corresponds to the maximum dimensions of known OB-associations (if the distance is 520 pc, as was found above). We have taken the stars out of [7]. We used data from [8] and its earlier editions, but mainly from [9]. The absorption was calculated by the formula \(R = 3.1 \times E(B-V)\).

We retained the stars which have distance moduli in the interval \((7^m 91 - 9^m 7)\). The mean distance modulus for these stars is \(m(r) = 8^m 66 (\sigma = 0^m 48)\), which corresponds to the distance \(d = 540\) pc. The distribution of OB-stars is presented in Fig.1. The boundary of the grouping is outlined by a solid line. There are 54 stars in the grouping, 36 of them are of MS, the others are subgiants, giants, supergiants. There is also one late type supergiant - HIP 33152, K3lab. It was