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Abstract

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Analysis of the Distribution of Interstellar Polarization in Cygnus

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For the present investigation a field in the constellation Cygnus was chosen, covering the interval in α from 19^h52^m to 20^h20^m with δ within $+34^\circ.5$–$+38^\circ.0$, and the interval in α from 20^h04^m to 20^h32^m with δ within $+38^\circ.0$–$+41^\circ.5$. Both in its location and in the character of the polarization, it is the complete opposite of the region of the constellation Perseus, for which we carried out an analysis of the polarization some time ago ([1]).

We carried out electropolarimetric observations of stars in Cygnus at the Byurakan Observatory in 1953, and their results are included in our catalogue of the polarization of the light of 389 stars ([2]). Numerous polarization observations in the Cygnus region were made by Hiltner ([3]), and also by Hall and Mikesell ([4]). On the basis of all these data we derived and reduced to a single system the polarization for 196 stars. These stars served as the material for the present investigation. For the hot stars, which, incidentally, constitute the overwhelming majority of the stars in the list, the interstellar absorption was derived and, for almost all the stars, the distances as well. This gave us material for considering the spatial distribution, in the region under study, of stars and dust matter, which is necessary for an analysis of interstellar polarization.

The existence of an O-association in the region studied was first pointed out by V. A. Ambartsumian and B. E. Markarian ([5]). According to present-day data ([6–8]), there exist in it a number of spatial groupings of hot stars, but their characteristics are not known with sufficient reliability. Our material, although unsuitable for statistical studies of the distribution of stars in general, nevertheless makes it possible to refine the data on the spatial groupings of hot stars. From its analysis we came to the conclusion that the following stellar associations exist. In the southwestern part of the region, at a distance of 2.3 kpc, the association Cygnus I stands out, with its center in the cluster NGC 6871 and a probable size of about 150 pc. The association Cygnus II can be reliably distinguished in the region with boundaries in b: -1°–$+2^\circ$ and in l: $40^\circ.5$–$44^\circ.5$. Its distance is 1.6 kpc and its size is not less than 110×80 pc. The cluster IC 4996, judging from the distance we determined for it, is its nucleus. Some stars apparently belonging to the cluster NGC 6883 also enter into this association. Next come two associations overlapping one another: Cygnus III with a distance

Fig. 1. Distribution of absorption A_v for distances of order 1.5-2 kpc.

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of 2.0 kpc and Cygnus V with a distance of 1.3 kpc. The association Cygnus III is localized within the field studied, within the boundaries in b $-1^\circ-+2^\circ$ and in l $44^\circ-46^\circ$. Its nucleus is the cluster NGC 6913. Most of the stars assigned by us to the association Cygnus V lie in a region extending from the eastern boundary of the field to $b = +2^\circ$ and enclosed in the interval in l $43^\circ-48^\circ$. This association has a size of the order of 100 pc, and the cluster NGC 6910 is its nucleus. The existence of an association at modulus $12^m.2$ also seems very probable, but our material is insufficient for determining its parameters.

The majority of the stars assigned by Morgan, Whitford, and Code ([6]) to the aggregates Cygnus I, II, and III, respectively, belong to the associations Cygnus I, II, and III. They can also be traced in the complexes of I. M. Kopylov ([7]), if the difference in the distance scales is taken into account. The data on the Cygnus II association agree with the data on the cluster of hot stars identified by

Fig. 1. Distribution of absorption A_v for distances of order 1.5-2 kpc.
a $-1^m.0 < A_v < 1^m.5$; b $-1^m.5 < A_v < 2^m.0$; v $-2^m.0 < A_v < 2^m.5$; g $-2^m.5 < A_v < 3^m.0$; d $-3^m.0 < A_v < 3^m.5$; e $-3^m.5 < A_v < 4^m.0$; zh $-4^m.0 < A_v < 4^m.5$; z $-4^m.5 < A_v < 5^m.0$; i $-5^m.0 < A_v$

Roman ([9]) and Nassau and Harris ([10]). The Cygnus V association has not been identified up to now, but it can be traced in the form of condensations of stars in Kopylov' s complex at magnitude $10^m.9$. Finally, the cluster of OB stars discovered by Münch and Morgan and now usually designated as Cygnus VI, according to our data, does not form a single spatial grouping.

The light-absorbing matter is distributed over the field extremely nonuniformly. Thus, in the southern half of the field (with $\delta < +38^\circ$), the regions west of the equator (in the northern Galactic hemisphere) are comparatively little affected by absorption, and the dust matter here is distributed relatively uniformly. The only exception is the region of the dark nebula Barnard 144. Our data confirm the conclusion of Nassau and MacRae ([11]) that here, at a distance of about 900 pc, there lies a dust cloud with a mean absorption of the order of 1^m. East of the Galactic equator (in the southern Galactic hemisphere) lie powerful dust clouds with a boundary running approximately along the Galactic equator. Already at distances of 1.3-1.6 kpc they produce absorption of the order of 3^m and more. In the western regions of the northern half of the field (with $\delta > +38^\circ$), the absorption is again small and fairly uniform. Farther to the east the absorption becomes considerably greater and very irregular. Most of the dust clouds lie at dista-

at distances greater than 1 kpc, and the absorption caused by them, for distances of the order of 2 kpc, reaches 4^m. These separate clouds near the galactic equator

Figure 2: graphical representation of the polarization of the light of 196 stars

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and still farther to the east (in the southern galactic hemisphere) pass into a continuous dust curtain, which at distances of the order of 1.6 kpc leads to an absorption of 4^m–5^m. Our data do not contradict the conclusions of Ikhsanov [12] and Tifft [13], that the main mass of the dusty matter is concentrated

Fig. 2. Graphical representation of the polarization of the light of 196 stars (the directions and lengths of the straight-line segments correspond to the position of the plane of the preferred oscillations and to the magnitude of the polarization)

within distances of 1–1.5 kpc. The overall picture of the distribution, in the region under study, of absorption for distances of the order of 1.5–2 kpc is presented in Fig. 1.

The region in Cygnus is characterized, as we have already noted above, by a polarization that at first glance is quite disordered; this is well illustrated by Fig. 2, which shows the polarization of all the stars of the region included in the present consideration. However, when we single out stars at different distances from us–belonging to different associations–we obtain a considerably more regular distribution of polarization. Moreover, in each given direction the character of the polarization usually turns out to be common to all stars, provided only that they are at least 1–1.5 kpc distant. This is quite understandable if one assumes that the polarization of starlight arises as it passes through the interstellar medium, and if one takes into account that interstellar dusty matter lies chiefly at distances not exceeding 1.5 kpc. Considering the change in the directions of polarization and the magnitude of the ratio of polarization to absorption, we can naturally form an idea of the character of the change in the light-polarizing properties of the interstellar medium and of the structure of the magnetic field that orients the interstellar dust particles.

The general map of the distribution of the polarizing action of the entire thickness of dust matter out to distances of 1.5-2 kpc is presented in Fig. 3. Analysis of this map and its comparison with analogous maps compiled from nearer and more distant stars allows us to assert that interstellar

Fig. 3. Schematic map of the total polarizing action of the entire thickness of dust matter out to distances of 1.5-2 kpc (the directions of the straight lines correspond to the position of the plane of preferential oscillations, and the length to the ratio p/A_v).

matter in Cygnus has a capacity to produce polarization that differs greatly from place to place, but the uniformity of its polarizing properties may be preserved in fields extending up to many hundreds of parsecs and, apparently, usually having a noticeable elongation along the line of sight, i.e., along the spiral arm.

Evidently the magnetic field must have a similar structure. It has also been noted that regions of a homogeneous magnetic field sometimes turn out to be considerably larger than the directly observed dust clouds.

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REFERENCES

1. V. A. Dombrovskii, *Vestn. Leningr. Univ.*, No. 19, 135 (1959).
2. V. A. Dombrovskii, *Vestn. Leningr. Univ.*, No. 1, 129 (1958).
3. W. A. Hiltner, *Ap. J.*, **114**, 241 (1951); *Ap. J.*, **120**, 454 (1954); *Ap. J. Supplement*, **2**, 389 (1956).
4. J. S. Hall, A. H. Mikesell, *Publ. Naval Obs.*, **17**, 1 (1949).
5. V. A. Ambartsumian, B. E. Markarian, *Soobshch. Byurakansk. Obs.*, No. 2, 3 (1949).
6. W. W. Morgan, A. E. Whitford, A. D. Code, *Ap. J.*, **118**, 318 (1953).
7. I. M. Kopylov, *Astr. Zh.*, **25**, 390 (1958).
8. A. B. Numerov, *Izv. Krymsk. Obs.*, **19**, 189 (1958).
9. N. G. Roman, *Ap. J.*, **114**, 492 (1951).
10. J. J. Nassau, D. L. Harris, *Ap. J.*, **115**, 459 (1952).
11. J. J. Nassau, D. A. McRae, *Ap. J.*, **110**, 478 (1949).
12. R. N. Ikhsanov, *Izv. Krymsk. Obs.*, **21**, 257 (1959).
13. W. G. Tifft, *A. J.*, **63**, 127 (1958).

Note: Figure translations are in progress. See original paper for figures.