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ON THE PERSEUS CLUSTER OF NEBULAE

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The Perseus cluster of nebulae (R.A. 3^h 15^m, Dec. $+41°$ $15'$, 1930; gal. long. 118°, lat. $-13°$) according to Hubble and Humason[1] contains about 500 nebulae scattered over an area nearly 2° in diameter and lies at a distance of 11 million parsecs. As is the case with most clusters investigated, counts of nebulae made on photographs which were obtained with the 18-inch Schmidt telescope show that the Perseus cluster is considerably larger than was originally derived from the photographs taken with the large reflectors whose very severely restricted fields make them unsuitable for the efficient analysis of objects subtending large angles. For quite a different reason the analysis of the spatial distribution of the nebulae in the Perseus cluster with the 18-inch Schmidt telescope also presents considerable difficulties. The cluster is projected on a field of the Milky Way so rich in stars, that, because of the small scale of the telescope, the blurred images of close pairs and groups of stars may easily be mistaken for extragalactic nebulae. This error can partly be avoided by taking a number of well-focused photographs while the telescope is being drifted slightly in a different direction for each photograph. Groups of stars are likely to betray themselves by an image containing sharp streaks such as should not be expected in a drifted image of a nebula. Also, the precaution was taken to identify all of the nebulae involved several times through a repeated analysis conducted during several years and making use of many photographs taken on various emulsions. It is therefore felt that the results presented here can be viewed with more confidence than might have been originally hoped for.

In figure 1 the distribution of nebulae brighter than about the photographic magnitude $m_p = 16.5$ over a field of approximately 9° in diameter around the Perseus cluster is shown.

According to Hubble's investigations the Perseus cluster is seen through a large "window" of relatively high transparency in the galactic dust clouds.   Lanes and pockets of heavy obscuration surround the cluster on the east, north and west sides.   One dark pocket in which no nebulae and relatively few stars can be seen is marked *DP* in figure 1.   The galactic plane lies in the dirction NNE about thirteen degrees from the center of the
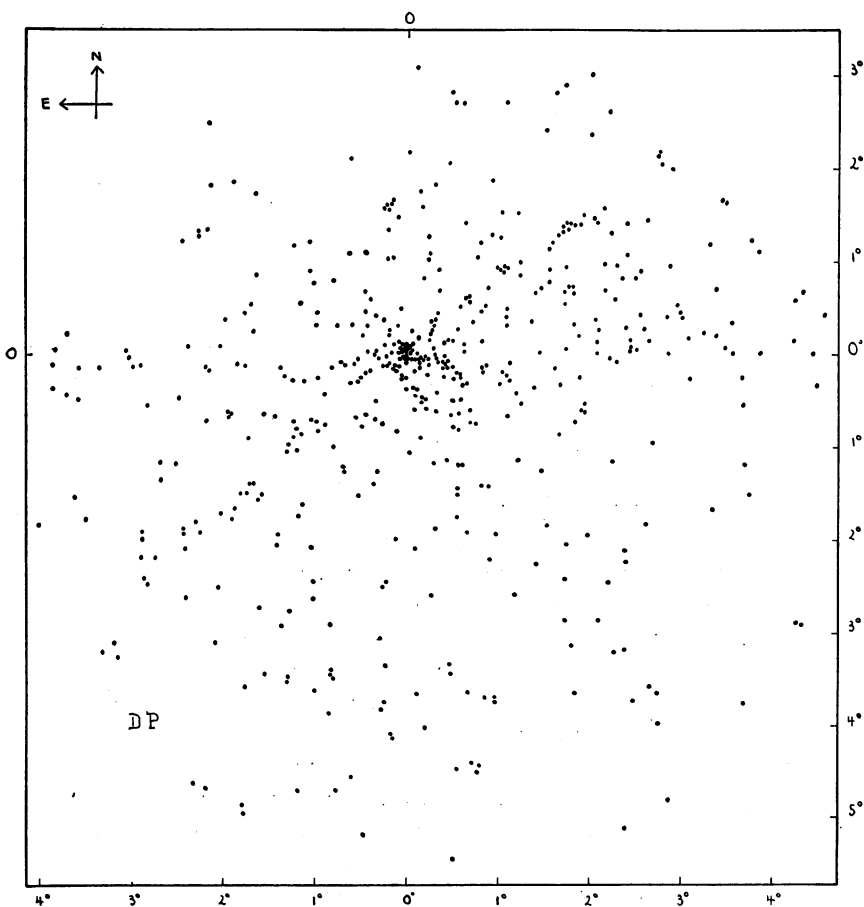

FIGURE 1
The Perseus cluster of nebulae.

cluster.   Since in this direction at distances larger than five degrees the obscuration seems to increase rapidly, we have counted the nebulae in complete rings around the center of the Perseus cluster only to a radius of 200′ of arc.   In table 1 are tabulated the total numbers n_r of nebulae contained in successive rings of 5′ of arc and 10′ of arc width, respectively.   The last

TABLE 1

COUNTS OF NEBULAE IN THE PERSEUS CLUSTER IN RINGS WHOSE RADII DIFFER BY 5′ OF ARC AND 10′ ARC, RESPECTIVELY

	QUADRANTS				TOTAL	
NO. OF RING	NE	NW	SW	SE	n_r	N_r/SQ. DEG.
1	4	3	2	3	12	557
2	5	3	4	2	14	217
3	2	2	5	7	16	149
4	4	2	4	5	15	99
5	1	3	5	3	12	62
6	2	4	6	1	13	55
7	4	2	7	2	15	54
8	1	3	4	4	12	37
9	2	0	4	3	9	25
10	1	4	2	3	10	24.4
11–12	1	6	7	4	18	19.0
13–14	5	6	8	2	21	18.7
15–16	4	3	4	7	18	13.8
17–18	3	8	3	8	22	15.0
19–20	5	8	4	5	22	13.4
21–22	4	5	3	3	15	8.3
23–24	2	11	6	3	22	11.0
25–26	2	9	6	6	23	10.7
27–28	2	7	2	8	19	8.2
29–30	2	10	2	5	19	7.6
31–32	4	9	2	4	19	7.1
33–34	1	5	3	3	12	4.22
35–36	1	6	3	6	16	5.30
37–38	1	7	1	8	17	5.33
39–40	1	2	4	4	11	3.27
Total	64	128	101	109	402	
41–42	..	...	3	3	6	3.40
43–44	..	...	2	9	11	5.93
45–46	..	...	6	10	16	8.25
			SOUTH			
47–48			4		4	3.95
49–50			5		5	4.73
51–52			2		2	1.82
53–54			0		0	0.00
55–56			5		5	4.22
57–58			4		4	3.25
59–60			4		4	3.15
Total number of nebulae counted					459	

column gives the average numbers of nebulae N_r per square degree in these rings. The area inside of the first circle is 1/46.4 square degrees.

A total of 402 nebulae was counted within a radius of 200′ of arc from the center of the cluster. Within the fluctuations to be expected these nebulae

distribute themselves uniformly over the four quadrants, except that perhaps the NE quadrant shows a slight deficiency in the number of nebulae, which is presumably due to the increasing effects of obscuration on approaching the galactic plane. From the general appearance of the stellar field it seems safe to count nebulae in the SW and the SE quadrants to a distance of 230' of arc and in the south quadrant bounded by the SW and SE directions to a distance of 300' of arc and beyond from the center of the cluster. At a distance of about 250' of arc south of the center the cluster nebulae here considered merge with the field nebulae which appear at an average density of about 3.0 nebulae per square degree. According to the counts presented here the Perseus cluster therefore has an angular diameter of at least 8° of arc and an actual diameter of at least 1.5×10^6 parsecs or five million light years.

According to Hubble[2] the average number N of nebulae per square degree in the general field is given by

$$\log_{10} N = 0.6 m_L - 9.1. \tag{1}$$

In our case the limiting photographic magnitude m_L included in the counts is about $m_L = 16.5$. This according to equation (1) corresponds to $N = 6.3$ nebulae per square degree. From our observations we obtained $N' = 3.0$ nebulae per square degree instead, a result which according to (1) is equivalent to the average number over the unobscured parts of the sky of nebulae per square degree whose apparent photographic magnitude is smaller or equal to $m_L' = 15.95$. Since on Palomar Mountain the Perseus cluster can be observed within ten degrees of the zenith no appreciable zenith distance correction is to be introduced. If we therefore assume that the unobscured field of nebulae around the Perseus cluster is comparable to the average field of nebulae all over the unobscured parts of the sky we arrive at a value

$$\Delta m = m_L - m_L' = 0.55 \text{ magnitudes} \tag{2}$$

for the local obscuration. This value is presumably smaller than the actual value because it is likely that the Perseus cluster is imbedded in the very large cloud of nebulae extending from Andromeda over Pisces into Perseus, a fact which would result in a local value for N larger than the average all over the sky and in a value for Δm larger than given by (2). Of the 460 nebulae counted about 360 nebulae are physical members of the Perseus cluster. Since these nebulae are all brighter than about the absolute magnitude $M = -14.3$ the total population of the Perseus cluster presumably includes well over one thousand nebulae.

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