which approach each other more and more. If the aperture of the projection-objective is N and the wave-length of the light λ, the distance of the still distinguishable points or lines is generally assumed to be:

$$l \geqq \frac{\lambda}{2N},$$

which for $N = 0,95$ and $\lambda = 0,6\,\mu$ yields the value of $0,31\,\mu$ for l. The central diffraction-discs, which are formed in the image of each of the two luminous points, overlap for the distance of the length of the radius of the discs.

On the other hand a thread of $0,2\,\mu$ is represented sharply defined and contrasted with an objective of the same aperture. The edges are so sharply drawn that a number of small unevennesses becomes separately visible.

6. When the same thread is represented with an objective the aperture of which is 0,18, the image becomes, indeed, less sharply contrasted and less definite, but it remains clear enough to be useful for many purposes. In this the central diffraction discs formed of a luminous point on one edge of the thread, and of one of an opposite point on the other edge overlap to an amount of $P = 94\,°/_0$ of the diameter of the discs.

7. In the direct observation of threads without application of the microscope we found as maximum values of P.... 98,2 °/₀ and 98,5 °/₀. Probably equally great and even greater values of P can be reached in the case of microscopic representation.

8. There is every reason to assume that with commercial objectives a serviceable image may still be obtained of a thread of $0,04\,\mu$.

At the meeting photos were, in fact, exhibited of a bombarded quartz thread, the diameter of which was to all probability of the said order of magnitude.

Astronomy. — *"The Distance of the Dark Nebulae in Taurus".* By Dr. A. PANNEKOEK. (Communicated by Prof. J. C. KAPTEYN).

(Communicated at the meeting of Sept. 25, 1920).

§ 1. Various investigations made in recent years, have demonstrated ever more clearly the existence of dark cosmic nebulae, that aborb and weaken the light of the stars behind them. Between the luminous patches and streams in the Galaxy, dark spots and cavities are seen, which were originally considered as empty spaces in the star-filled galactic system. The improbability of these empty spaces extending as conic tubes through HERSCHEL's lenticular star-system, with our sun as vertex, constituted one of the main arguments for the conception of the Galaxy as a ring of no great extension in depth. For a long time the possibility that they should originate by means of absorption has played no part in the theories concerning the structure of the universe.

It is through the photographs of MAX WOLF and BARNARD that we first have become acquainted with numerous details scarcely allowing of any other interpretation. Small dark spots are to be seen in the midst of the luminous star clouds; long, dark, fantastically shaped lanes intersect the luminous parts, and are evidently connected with faintly luminous nebulae. MAX WOLF has repeatedly pointed out the existence of extensive absorbing nebulous masses, as one of the main causes that determine the aspect of the Galaxy. The galactic system is then to be considered as a mixture of dense starclouds, luminous nebulae and dark nebulous masses.

In an investigation of some star-photographs in Aquila [1]), comprising the densest parts of a starcloud and also a black spot therein, the author of the present article found that in the black spot the densities of the stars from the 11^{th} to the 15^{th} magnitude were all smaller in the same proportion, compared with the cloud besides it; if the spot were caused by absorption, the absorbing substance should therefore not lie in the far depths of the starcloud, but a great deal nearer by, so that it was only accidentally projected against this luminous background.

1) A. PANNEKOEK. Investigation of a galactic cloud in Aquila. Proceedings R. A. of S. Amsterdam, Vol. XXI, Nr. 10. (March 1919).

That objects of this kind do not present themselves in the Galaxy alone, became evident from the investigations of BARNARD, who published a list of 182 mostly small, dark objects, [1]) which, though they were best discernible against the bright background of the Galaxy, are yet to be found also outside it, and which here and there are even directly visible by means of telescopes as intensely black spots. The wide extension of this absorbing substance became evident in yet another way, by an investigation of the general distribution of the stars up to the 11th magnitude [2]). It was found here that around two places with a considerable deficiency of stars, in Taurus and Ophiuchus, as around two centres of obscuration, there are wide regions where the number of stars is below the normal. As this investigation was carried out by means of averages over extensive regions, it could only give a general image, which could be equally well explained by a certain distribution of the stars in space, as by the effect of an absorption. But it became evident that in the one kernel, in Taurus, the distribution of the density of the stars to the 11th magnitude was very irregular, and that the poorest regions were precisely those, where, according to BARNARD's catalogue, a number of black objects have accumulated; this points to absorption as the most likely explanation of the general distribution of stars over the sky we had found.

We get a still clearer image of the irregularities in the star-distribution in this Taurus-region by an investigation of DYSON and MELOTTE [3]) by means of the FRANKLIN-ADAMS plates, which show the stars up to magnitude 15,8. The counts proved that there are mainly three regions of strongest obscuration, the irregular shapes of which are visible on the adjoining chart: about $3^h20^m + 30°$ (S.W. of ζ Persei), $4^h30^m + 26°$ (between the Pleiades and β Tauri) and $5^h20^m + 25°$ (S.W. of β Tauri). By comparing the numbers of stars of different sources, they come to the same conclusion, that these absorbing nebulous masses must be situated relatively near to us. "Thus, taking the area as a whole, we find the number of stars is about one fifth of the normal number whether we go down to magnitude $9^m,0$, $11^m,0$ or $14^m,0$. This would seem to indicate, that

[1]) E. E. BARNARD, On the dark markings of the sky. Astrophysical Journal **49**, 1. (Jan. 1919).

[2]) A. PANNEKOEK, On the distribution of the stars of the 11th magnitude. Monthly Notices of R. A. S. **79**, 333 (March 1919).

[3]) SIR F. W. DYSON and P. J. MELOTTE, The region of the sky between R.A. 3^h and 5^h 30 m and N. Dec. 20° to 35°. Monthly Notices of R. A. S. **80**. 3 (Nov. 1919).

if the small density is caused by absorbing matter, the screen cannot be at a great distance, say not more than 200 or 300 parsecs at most." (l. c. page 6). However, as the P. M. of the stars up to the 9th magnitude in the dark regions are found to be no higher than elsewhere, so that no larger average distance is pointed out, this conclusion again becomes uncertain. For the present investigation, which proposes to ascertain more accurately the distance of these absorbing nebulae, the chart of star-counts adjoined to their treatise proved to be most useful.

§ 2. In order to deduce from the star-densities the distance of an absorbing nebula, we must first theoretically investigate what is the influence of an absorbing screen on the number of stars of different magnitude. We suppose that the luminosity-function is known according to the formula of KAPTEYN; for the logarithm of the star-density as function of the distance we likewise, according to the empirical data, assume a quadratic formula. We call m the magnitude, M the absolute magnitude of the stars, and introduce as modulus of the distance $\varrho = 5 \log r$, where $\varrho = 0$ for $\pi = 0''.1$ is taken [1]): then

$$\log \varphi(M) = Const - \frac{1}{\alpha^2}(M - M_0)^2 \qquad \log \Delta(\varrho) = Const - \frac{1}{\beta^2}(\varrho - \varrho_0)^2$$

The number of stars of magnitude m will be

$$A(m) = \int_{-\infty}^{+\infty} \Delta(\varrho)\, 10^{0,6\rho - \frac{1}{\alpha^2}(m - M_0 - \rho)^2} d\varrho = \int_{-\infty}^{+\infty} 10^{0,6\rho - \frac{1}{\alpha^2}(m - M_0 - \rho)^2 - \frac{1}{\beta^2}(\rho - \rho_0)^2} d\varrho$$

$$\text{or } \log A(m) = Const - \frac{1}{\alpha^2 + \beta^2}\{m - (\varrho_0 + M_0 + 0,3\beta^2)\}^2$$

For the luminosity-function $\frac{1}{\alpha^2} = 0,029 = \frac{1}{34}$ and $M_0 = 9$ was assumed. For the zone between $b = 20°$ and $40°$, in which the Taurus-regions are situated, the following formula was deduced from the numbers of VAN RHIJN

$$\log A(m) = Const + 0,630\, m - 0,0118\, m^2 = Const - \frac{1}{86}(m - 27)^2$$

which is met by the values $\alpha^2 + \beta^2 = 86$, $\beta^2 = 52$, $M_0 + \varrho_0 = 11$, $\varrho_0 = 2$. These values will be used in the following calculations.

If at the distance ϱ_1 there is a screen, absorbing ε magnitudes,

[1]) If we call absolute magnitude M the magnitude for $\pi = 1.''0$, all ρ in this article should be increased by 5 and all M diminished by the same number.

then from the more remote stars we do not see those with $M = m - \varrho$, but those with $M = m - \varepsilon - \varrho$ as stars of the magnitude m. The number of stars of this magnitude A'_m will be

$$A'_m = \int_{-\infty}^{\rho_1} \Delta(\varrho)\, 10^{0,6\rho - \frac{1}{\alpha_2^2}(m - M_0 - \rho)^2}\, d\varrho + \int_{\rho_1}^{\infty} \Delta(\varrho)\, 10^{0,6\rho - \frac{1}{\alpha^2}(m - M_0 - \varepsilon - \rho)^2}\, d\varrho\,.$$

These two integrals, taken between the limits $\pm\infty$, represent the numbers A_m and $A_{m-\varepsilon}$. If now we put

$$\frac{(\alpha^2 + \beta^2)\,\varrho_1 - 0,3\,\alpha^2\beta^2 - \alpha^2\varrho_0 - \beta^2(m - M_0)}{\alpha\beta\sqrt{\alpha^2 + \beta^2}} = x_1$$

$$\frac{(\alpha^2 + \beta^2)\,\varrho_1 - 0,3\,\alpha^2\beta^2 - \alpha^2\varrho_0 - \beta^2(m - M_0 - \varepsilon)}{\alpha\beta\sqrt{\alpha^2 + \beta^2}} = x_2$$

and $\displaystyle\frac{1}{\sqrt{\pi \log e}}\int_{-\infty}^{x_1} 10^{-t^2}\, dt = \gamma_1$ $\qquad$ $\displaystyle\frac{1}{\sqrt{\pi \log e}}\int_{x_2}^{\infty} 10^{-t^2}\, dt = \gamma_2$

then

$$A'_m = \gamma_1 A_m + \gamma_2 A_{m-\varepsilon}.$$

While the number A_m is obtained from the combination of stars at all distances, by means of integration between $\pm\infty$ of a function, proceeding according to the probability-curve, the number A'_m is found from two such curves, belonging to m and $m-\varepsilon$; from the first is taken a part between $-\infty$ and x_1 indicated by the fraction γ_1 (the stars in front of the absorbing screen); of the second the part between x_2 and $+\infty$, indicated by the fraction γ_2 (the stars behind the nebula). From the above numbers we find

$$x_1 = 0,22\varrho_1 - 1,53 - 0,132\,(m - 9) \qquad x_2 = x_1 + 0,132\,\varepsilon.$$

By means of these formulae and a list of values of A_m, corresponding to it, the values of A'_m, for different suppositions concerning ϱ_1 and ε were computed. To compare them more easily with the results of starcounts, we calculated from the A'_m the $N'_{m+\frac{1}{2}}$, the total numbers of stars brighter than $m + \frac{1}{2}$, and these were compared with the normal number $N_{m+\frac{1}{2}}$. The values *log* N—*log* N', the *logarithmic defect* in starnumber, then forms the best measure for the influence of the absorbing nebula. These values have been united in the following table.

From these values, which are graphically represented in our figure it appears:

a. The influence of the absorption extends, slowly varying, over almost all magnitudes that are open to our investigation. This is especially a result of the great spreading of the luminosity-function.

m.	$\rho_1 = 4,25$			$\rho_1 = 7,25$			$\rho_1 = 10,25$		
	$\varepsilon = 1$	$\varepsilon = 2$	$\varepsilon = 4$	$\varepsilon = 1$	$\varepsilon = 2$	$\varepsilon = 4$	$\varepsilon = 1$	$\varepsilon = 2$	$\varepsilon = 4$
2									
	0,093	0,105	0,105	0,006	0,006	0,006			
3									
	135	155	158	012	013	013			
4									
	184	221	226	021	023	023			
5									
	239	301	311	035	039	039			
6									
	295	396	417	057	064	065	0,003	0,003	0,003
7									
	345	500	543	085	099	100	006	006	006
8									
	383	605	689	122	146	150	011	012	012
9									
	404	697	854	164	206	214	019	021	021
10									
	408	761	1,033	210	279	294	032	036	036
11									
	399	788	1,214	253	361	393	051	059	060
12									
	382	780	1,375	289	448	509	075	091	093
13									
	360	749	1,479	312	527	641	106	133	138
14									
	337	705	1,500	320	587	785	140	186	196
15									
	314	657	1,448	315	617	933	174	247	269
16									
	286	605	1,354	295	610	1,060	200	308	350
17									
	266	560	1,254	277	586	1,153	224	373	452
18									
				255	546	1,179	236	426	563
19									
				233	500	1,140	235	456	676
20									
				212	454	1,059	225	460	778
21									

b. For fainter stars the logarithmic defect strongly increases at first, until a maximum is reached (about proportional to the absorption), and the values again decrease. This is due to the fact that for the faint magnitudes an ever greater majority of the stars lies behind the nebula, so that the logarithmic defect approaches ever more to the difference *log* N_m—*log* $N_{m-\varepsilon}$; for fainter magnitudes, however, this difference decreases.

c. For the bright stars, where the influence of the absorption begins to be felt, *the logarithmic defect changes but little with the absorption-coefficient*. The reason is that here the obscured stars behind the screen play hardly any part at all. The decrease in the number of stars is almost entirely a result of the falling off of the more remote stars of the magnitude m. For increasing ε the logarithmic defect approaches here to a limit-value (calculated from

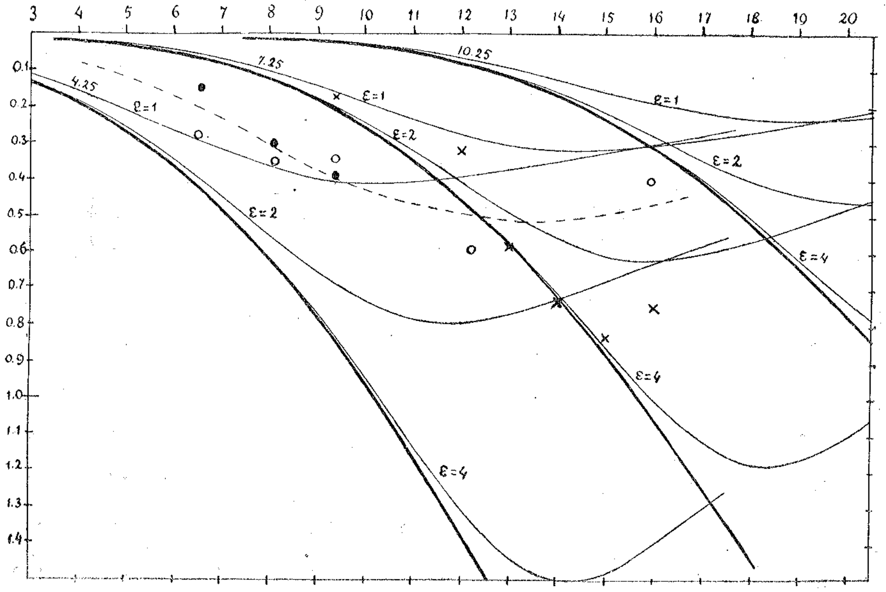

Fig. 1.

the unobscured stars before the screen only), as represented in the drawing by the heavy line ($\varepsilon = \infty$).

d. For the bright magnitudes the value of the logarithmic defect depends mainly on the distance ϱ_1, for the faint magnitudes it depends in the first place on the absorption-coefficient ε of the dark nebula. For increasing ϱ_1 the effect of one and the same absorption on the logarithmic defect decreases..

From this follows in the first place, that it will be difficult to apply this method in general. In the case of small black spots (like the trifid hole near χ Aquilae) the defect can be ascertained over some magnitudes (e.g. from the 11th to the 16th magnitude), but this range is too small to separate the two unknowns ϱ_1 and ε and to find both; the number of brighter stars is too small to allow of any deductions. As we require data over the most divergent magnitudes, this method can only be profitably applied to regions of such extent, that it gives us the disposal also over a sufficient material of bright stars. This is the case with the dark nebulae in Taurus.

§ 3. For the star-density N'_m the following sources have been used:

a. The "Bonner Durchmusterung" up to the star-magnitudes 6,5, 8,0 and 9,0 incl. (the total number up to 9,5 could not be used, on

account of the inequality and uncertainty of the limiting magnitude). The normal density N_m was adopted from the lists "Groningen Publications 18"; the argument, the limiting magnitude after the scale of Groningen 18, was taken, according to SEELIGER, dependent on the star-density, and was for the lowest limit still corrected by 0,11, [1]) which gave

$$6{,}56 - 0{,}023\,(D - 0{,}7); \quad 8{,}12 - 0{,}068\,(D - 0{,}7); \quad 9{,}36 - 0{,}246\,(D - 0{,}7).$$

On the average these limits in photometric scale are 6.6, 8.1 and 9.4.

b. Two of KAPTEYN's "Selected Areas" come within this region: N°. 47 and N°. 48; N°. 48 is situated closer to the centre, but according to the chart of DYSON and MELOTTE just outside a region with strong absorption; N°. 47, though more distant, comes just within the dark field S.W. from ζ Persei. In the "Durchmusterung of Selected Areas" [2]) the numbers of stars were counted up to 12,0, 13,0, 14,0, 15,0, and on Area 47 up to 16,0 (faintest stars 15,96 resp. 16,49).

c. From the DYSON and MELOTTE chart, for every part of the region from 3^h to 5^h30^m and 20° up to 35° we could draw the star-density per 100 square minutes on the FRANKLIN-ADAMS plates, already reduced to a common system. Regarding the limiting magnitude, for which these densities count, the authors say: "The limiting magnitude is not accurately fixed, but may be taken at about 15,8 and should be within 0^m,25 of this figure" [3]). I have tried to control these data by making use of the three "Selected Areas" (47, 48, 49) falling within this region. To this end the *log* N' for these places, as deduced from the DYSON and MELOTTE chart, was compared to that of KAPTEYN for $m = 13$, 14, 15 (and 16) and thus, through interpolation or extrapolation of the deviations from the normal *log* N the limiting magnitude was deduced. The values thus obtained are 16,02, 15,83 and 15,90: their average 15,9 has been adopted. For the rest a mistake of 0,1 in this value gives a mistake in the *log* N of 0.03 only.

d. The data of the photographic "Carte du Ciel" cannot in general be used here. The great accidental irregularities in the limiting magnitude of the separate plates does not prevent the fixing of average densities and an average limiting magnitude, it is true, but in this case it is the separate plates that count, and these can be

[1]) See with regard to this A. PANNEKOEK, Researches into the structure of the Galaxy. These Proceedings, Vol. XIII, p. 254.

[2]) Annals of Harvard College Observatory. Vol. CI.

[3]) l. c. page. 4.

greatly divergent from the average. This difficulty disappears, if the accidental irregularities can be abolished by reduction to one system, which is feasible if a great number of plates are joined so as to partly cover one another. With chart-plates this does not happen anywhere; but it does in the case of the *Paris catalogue-plates*, of which the zones 22°, 23° and 24° have been published complete. As in this case the centres of the one zone concur with the corners of an adjoining zone, each plate has a quadrant in common with each of the 4 surrounding plates. In this way it was possible to reduce all the plates of these three zones between 3^h16^m and 5^h32^m to their average. A few particulars regarding this reduction will be added here.

Two consecutive plates a and b of the central zone (23°) can be joined together by a plate of the N-zone (24°) c, which has a quadrant in common with both, and also by one of the S-zone (22°) d. If we call the quadrants $\begin{vmatrix} 2 \,.\, 1 \\ 4 \,.\, 3 \end{vmatrix}$ the density (b): density (a) $= \frac{b_1}{c_4} \times \frac{c_3}{a_2}$, and likewise $= \frac{b_3}{d_2} \times \frac{d_1}{a_4}$. For the logarithmic difference in density of every two consecutive plates of the central zone we get therefore two values, the concurrence of which gives a measure of the accurateness obtainable. We must bear in mind that the quadrants on the adjoining plates do not accurately concur, because of the convergence of the declination-circles, and because they stretch 65′ from the centre. The results obtained, starting with $\log d\,(3^h24^m) - \log d\,(3^h16^m)$ and ending with $\log d\,(5^h40^m) - \log d\,(5^h32^m)$ (in units of the 3rd decimal), are:

from de N. plate	+046	+070	−161	+030	+216	−240	+029	+369	−002
from de S. plate	+027	+106	−335	+233	+298	−535	−115	+490	−073
adopted	+036	+088	−248	+131	+257	−387	−040	+430	−037
	+639	−816	+807	−552	+359	+094	−529	+500	−165
	+469	−856	+637	−531	+382	+168	−588	+451	−120
	+554	−836	+722	−541	+370	+131	−558	+476	−142

Herefrom for every plate of the middle-zone the deviations from a medium-value were deduced and from these numbers the same was found for the N- and the S-zone; these values, with contrary sign, give the *logarithmic reduction* for each plate, the logarithm of the factor, by which the number of stars on that plate is to be multiplied, in order to count for the same average limiting magnitude. They are in the sequence of decreasing R.A.:

−09 +10 +01 −17 +07 −05 −05 +17 −02 −04 +06 +18 −03 +07 +08 +02 +14 +37

−14 −28 +20 −36 −23 +14 −40 +32 −51 +04 00 +43 +39 00 +26 +39 +14 +23 +26

−05 −07 −12 −05 −15 −16 −17 −09 −05 −33 +06 −14 −34 − 12 −05 +05 −10 +17

If on each plate a systematic difference exists between the E. and W. side, this reduction will produce a systematic error, increasing with the R. A. because the ring is not closed; the accidental errors, also because we have but three zones, will be eliminated to only a very slight degree. All the same the very considerable jumps in the limiting magnitude will thus be practically neutralized. This is evident also from the regular course of the reduced numbers of stars, which now run nearly parallel with the course of density according to the FRANKLIN-ADAMS plates, which is not the case with the non-reduced numbers. These numbers for the separate quadrants are given in the following list; (for the middle rows it gives two values, the upper one of which is always taken from the N-plate):

	5^h												4^h							
	44^m	40	36	32	28	24	20	16	12	8	4	0	56	52	48	44	40	36	32	28
25°																				
		141	124	110	39	30	25	36	53	76	75	63	53	53	30	12	13	13	25	
24°																				
		134	120	138	73	29	28	40	27	53	69	172	73	45	39	39	41	24	19	
	151	130	124	142	71	30	27	39	28	52	70	171	75	49	36	40	41	27	17	
23°																				
	154	159	174	163	146	90	38	21	46	52	83	79	74	46	52	58	54	51	31	
		143	176	170	143	93	36	20	48	52	85	78	75	51	48	60	49	55	28	
22°																				
		184	151	159	170	116	49	34	41	48	58	58	57	70	55	61	35	47	49	
21°																				

	4^h								3^h											
	28^m	24	20	16	12	8	4	0	56	52	48	44	40	36	32	28	24	20	16	12
25°																				
	19	14	38	42	42	38	37	68	75	123	107	154	80	60	72	76	63	80		
24°																				
	15	37	69	78	70	88	70	101	89	81	77	155	71	46	69	50	71	60		
	15	36	64	83	75	81	83	85	85	86	69	174	79	41	68	51	70	58	71	
23°																				
	16	46	65	62	65	74	56	68	68	67	78	83	56	44	51	49	66	71	47	
	17	45	61	67	71	68	66	57	65	71	69	93	63	40	51	51	67	73		
22°																				
	54	39	39	33	41	43	48	66	76	83	74	83	43	36	42	54	61	40		
21°																				

These numbers must be multiplied by $12^2 : 13^2$ to obtain the numbers per square degree. If we may assume, that the average limiting magnitude of these 55 plates corresponds to the average value for the entire sky, the limiting magnitude deduced from the entire zones 23°—24° by means of the tables of "Groningen 27", viz. **12.20** must be used here.

§ 4. In this part of the sky eight regions, bounded by irregular polygones, were more closely examined: A and B comprise about the two darkest regions of absorption $3^h20^m + 31°$ and $4^h30^m + 26°$; C, D, E, and F lie to the North, the East and the South around B, and contain regions with few stars, that are partly darkely traced on the chart of Dyson and Melotte; and G and H are richer regions with centra $3^h40^m + 27°$ and $4^h4^m + 32°$. For the regions E and F 21° and 25° were taken as limits of declination, in order that the Paris results might be used. For each of these fields the B. D. stars were counted and divided by the area (for F 5 stars up to 6,5, 3 of 6,6—8,0 and 3 of 8,1—9.0 were subtracted as Hyades-stars). In the same manner the average density for Paris was calculated. For the Franklin-Adams plates average values were calculated from the density-figures on the chart of D. and M.

		A.	*B.*	*C.*	*D.*	*E.*	*F.*	*G.*	*H.*
surface.		28.3	26,6	21.0	29.5	24.0	36.8	39.9	46.2
gal. lat.		21°	13°	8°	8°	9°	16°	21°	13°
B.D. per square degree	—6,5	0.32	0.23	0.19	0.20	0.12	0.19	0.07	0.30
	—8,0	1.10	0.60	1.05	0.88	0.67	0.87	0.93	1.23
	—9,0	3.82	2.03	2.86	3.29	3.71	2.93	4.14	5.07
	—9,5	10	6	10	8	15	11	14	15
Paris per sq. d.						40.4	36.1		
Fr.-A. p. 100′		9.6	9.3	13	15	18	11.3	24	26
log N′	(6,6)	9.51	9.36	9.28	9.30	9.08	9.28	9.85	9.48
„	(8,1)	0.04	9.78	0.02	9.94	9.83	9.94	9.97	0.09
„	(9,4)	0.58	0.31	0.46	0.52	0.57	0.47	0.62	0.70
„	(12,2)					1.61	1.56		
„	(15,9)	2.54	2.52	2.67	2.73	2.81	2.61	2.94	2.97
log N′/N	(6,6)	+0.14	—0.09	—0.22	—0.20	—0.42	—0.14	—0.52	+0.04
„	(8,1)	— 10	— 46	— 27	— 35	— 44	— 25	— 16	— 13
„	(9,4)	— 17	— 57	— 48	— 43	— 33	— 34	— 11	— 14
„	(12,2)					— 61	— 58		
„	(15,9)	— 44	— 59	— 48	— 42	— 34	— 46	— 04	— 10

In these values for the logarithmic defect the following characteristics may be noted:

a. The difference between the strongly and the slightly obscured regions is not noticeable at all with the bright D. M. stars up to 6,5, and it is hardly noticeable with those up to the 8th magnitude; it is only with those up to the 9th that G and H differ considerably from the others. By the accidental uncertainty of the numbers the difference between the more or less obscured regions A—F is not clearly evident.

b. The defect for the stars up to 15.9 is about as great as that for the stars up to 9.4. This corresponds to the results obtained by Dyson and Melotte.

c The Paris results for the fields E and F point to the fact that the logarithmic defect for the limiting magnitudes between 10 and 15 is greater.

If we take first the fields E and F, where the data are most complete, we see that their averages (— 0,28, — 0,35, — 0,34 — 0,59, — 0.40 for the 5 magnitudes), represented on our figure by open circles, concur pretty well with a curve (dotted in the figure) answering to $\varrho_1 = 5{,}5$, $\varepsilon = 1{,}5$. The values of ϱ_1 between 4 and 6 with an absorption $\varepsilon < 2$ give a maximum for the logarithmic defect for m 12 à 13, so that in this case we shall find, that the defect in stars for the magnitudes between the 9th and the 15th does not fluctuate very much.

This, however, is contradicted by the results of the "Selected Areas". These could not be united with the former, because they comprise separate, smaller regions. The counts give the following results:

	Area 47	$b = -21°$ surf. $= 3600'$		Area 48	$b = -12°$ surf. $= 1600'$	
	Number	*log N′*	*log N′/N*	Number	*log N′*	*log N′/N*
>12.0	23	1.36	—0.32	19	1.63	—0.15
>13.0	29	1.46	—0.58	37	1.92	—0.25
>14.0	44	1.64	—0.73	72	2.21	—0.31
>15.0	70	1.85	—0.83	84	2.62	—0.22
>16.0	178	2.25	—0.75			

From the first field, falling within the region A of strong absorption, we find:

d. In the Selected Area 47 a regular, strong increase of the defect from the 12th to the 15th or 16th magnitude is shown.

Separately considered these values represented on our figure by crosses, especially if supplemented by the value for 9,4 of field A, can well be harmonized with a curve for $\varrho_1 = 7{,}5$ (in which case the decrease of 15^m to 16^m is not real). But the result (*d*) is utterly opposed to the result (*b*); the numbers of stars in the S.A. demonstrate, that the defect in stars for 9,4 and 15,9 cannot be about equal, cannot have a maximum at 12^m and afterwards decline.

The contradiction does not lie simply in a difference between the FRANKLIN-ADAMS plates and the Selected Areas. The S.A. 47 comprises only 1 square degree of strong absorption, in which the counts on the F.A. plate give a defect of 0,71, about the same therefore — and this is only natural, the limiting magnitude employed, viz. 15,9, having been deduced from these Selected Areas themselves. The case might be explained by the fact that there is a real difference in structure between S.A. 47 and region A on the one side, (the small values for A from 6,5 to 9,4 i.e. the slight defect in B.D. stars would then be considered as real) and the other regions of absorption on the other side; that therefore A is caused by another nebula at a far greater distance. It may be questioned, however, whether the data are accurate enough to allow of such a conclusion. The values for the B.D. in A are based on a moderate number of stars only; the numbers of stars 12—14 in S.A. 47 are very small, so that accidental irregularities in the distribution play a great part; and the taking of averages for the F.A. plates from the irregularly distributed density-numbers is somewhat uncertain also. This proves once more, that as yet we dispose of much too small a number of data concerning the star-density for the fainter stars 10^m—16^m over sufficiently extensive regions.

Now, according to § 2, the determination of the distance of absorbing nebulae depends mainly on the bright stars; the uncertainty in the numbers of the weaker magnitudes is of very little importance here. It is upon the data of the B.D. therefore that this determination must almost exclusively be based. To avoid accidental mistakes, we will therefore unite these 8 fields 2 by 2 into groups, in the order of the N' (15,9).

Also now the accidental uncertainties still give an irregular course. Between the three first groups A—F no marked difference presents itself for these magnitudes; therefore these have still been combined to a general average, to which the values in the last column apply and which are represented in the figure by dots. The slight dependence on the absorption ε can be taken into account in such a way, that corrections are introduced to reduce them to the limiting value

	A—B	*C—F*	*D—E*	*G—H*	*ABCDEF*
log N'/N (6,6)	+0,04	—0,18	—0,30	—0,13	—0,15
„ (8,1)	—0,26	—0,26	—0,39	—0,15	—0,30
„ (9,4)	—0,37	—0,41	—0,38	—0,13	—0,39

for $\varepsilon = \infty$; the figure shows that for ε between 1 and 2 for these corrections the amounts 0,05 and 0.10 are to be adopted.

From the limiting values thus obtained: 0,15 for $m = 6{,}6$, 0,35 for $m = 8{,}1$ and 0,49 for $m = 9{,}4$ the values of ϱ_1 can be directly deduced; we find for it: $\varrho_1 = 6{,}1$; 5,5; 5,6.If we consider that differences of resp. 0,05 0,10 and 0,13 in these three limiting values mean a change in ϱ_1 of 0.6, we may assume that the uncertainty of each of these values for ϱ_1 remains below the unit. As the average we then find $\varrho_1 = \mathbf{5{,}7} \pm 0{,}6$, from which follows

$$\pi = \mathbf{0''{,}0072} \qquad r = \mathbf{140} \textit{ parsecs}$$

where r probably lies between the limits 100 and 200 parsecs. The absorbing nebulae in Taurus therefore lie behind the Hyades at about a four times greater distance. They stretch on DYSON and MELOTTE's chart over an extent of 30°, which is to say about 70 parsecs. The dimension of the oblong, strongly absorbing region *A* are about 9° by 3°, or 20 by 7 parsecs. BARNARD in his catalogue describes small black objects lying therein (and in the other region *B*) of 1° (nr. 5 and 18), 8′ (nr. 24) and 4′ (nr. 28) dimension; their linear dimensions are then 500000, 40000 and 30000 astronomical units.