PHOTOMETRY OF STARS IN GALACTIC CLUSTERS

by

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ABSTRACT

The work is described in three main parts. Section I contains a detailed investigation of the Pleiades. The investigation is based up on star counts, published proper motions, and an extensive three-colour photometry of the Pleiades region. It is found that the dispersion of the faint members of the Pleiades at lower luminosities (Herbig 1962) is due to errors of several tenths of a magnitude in the photographically determined colours of Johnson and Mitchell (1958), and to the inclusion of field stars within the proper motion criterion. It is also established that the main sequence of the Pleiades extends as faint as $V = 15^m.0$, and there is no evidence of a contracting sequence brighter than $V = 15^m.0$. An excess of red stars in the magnitude range $10 < V < 12$ in the cluster area appear to be distant red giants ; although these are viewed through the nebulosity, they do not appear to be significantly reddened.

Section II deals with the three-colour photometry of the southern galactic cluster NGC 3766. This work has been published. The colour excess of the cluster is $0^m.16$, its distance is 1450 parsecs, and its age lies in the neighbourhood of 10^7 years.

Section III describes an investigation into the optical alignment and photometric errors of the Edinburgh Schmidt telescope.

CONTENTS

I N T R O D U C T I O N

INTRODUCTION

The structure and evolution of a star, from the time it reaches the main sequence to the time it becomes a red giant, is now fairly well-known. The states through which a star passes before it reaches the main sequence and after it becomes a red giant, are still largely unknown. Our lack of knowledge results largely from lack of adequate data. The premain sequence and the post red giant phases are almost certainly traversed by a star relatively quickly, the former because the energy supplies in this state are small, the latter because the energy losses are large. Consequently few stars are observed in these states at any given time, and the collection of adequate data is therefore difficult.

This thesis is a contribution to the task of providing data about the premain sequence phase, particularly for the Pleiades.

According to Salpeter (1953) such stars should lie above the main sequence in a colour-magnitude diagram, indicating a break-off point at the faint-end of the normal main sequence of the cluster.

In 1953 Levee developed a theory from first principles for stars contracting gravitationally on to the main sequence. This theory was later refined and modified by Henyey et.al (1955) who computed various evolutionery tracks for stars of given masses and compositions.

Soon after this Walker (1956-57) published his data, based on three-colour (UBV) photometry, for the extremely young clusters M8 and NGC 2264, in which stars are supposed to be still contracting on to the main sequence. In these clusters it was found that several stars at the faint-end do lie above and off the main sequence and the predicted break-off points are also available, but if we take these stars as lying on the predicted evolutionery tracks of Henyey et. al., their ages become some 200 times greater than the cluster to which they belong. Apart from this time-scale difficulty, the dispersion at the lower end of the colour-magnitude array of NGC 2264 is so great and ambiguous that we are forced to conclude either that the theory is wrong or that the errors of observations are large.

Various attempts, described later in detail, were made to reconcile the observations and theory, and though Hayashi's (1961) modified theory for premain sequence stars agrees well with the observations of NGC 2264, the problem posed by the dispersion at the faint-end of this cluster and a similar well-established but larger dispersion in the Pleiades faint-end (Herbig 1962) remains unanswered.

In NGC 2264, the membership of the stars at the faint-end is not certain since data for proper motion is not available (Underhill 1960). In the Pleiades, the proper motion data to ascertain membership of the faint-end stars is available (Hertzprung 1947), but when we look to the colour-magnitude array (Herbig 1962) of the faint members, we find that not only is the dispersion enormous, but many of the members fall below and towards the left of the main sequence. It may be that these stars are not members of the Pleiades cluster, and that the wrong assignment of cluster membership is due to the fact that all stars near Alcyone, having the same proper motion as Alcyone, have been treated by Hertzprung (1947) as members. This may be erroneous, since not only is the cluster proper motion small ($0''.046$/yr, p.a.150°) but it lies not far from the direction to the solar antapex (146°) and to the antapex of the galactic rotation (about 133°). It is, therefore, possible that many field stars may have been included as members. Under these circumstances, it is desirable to get

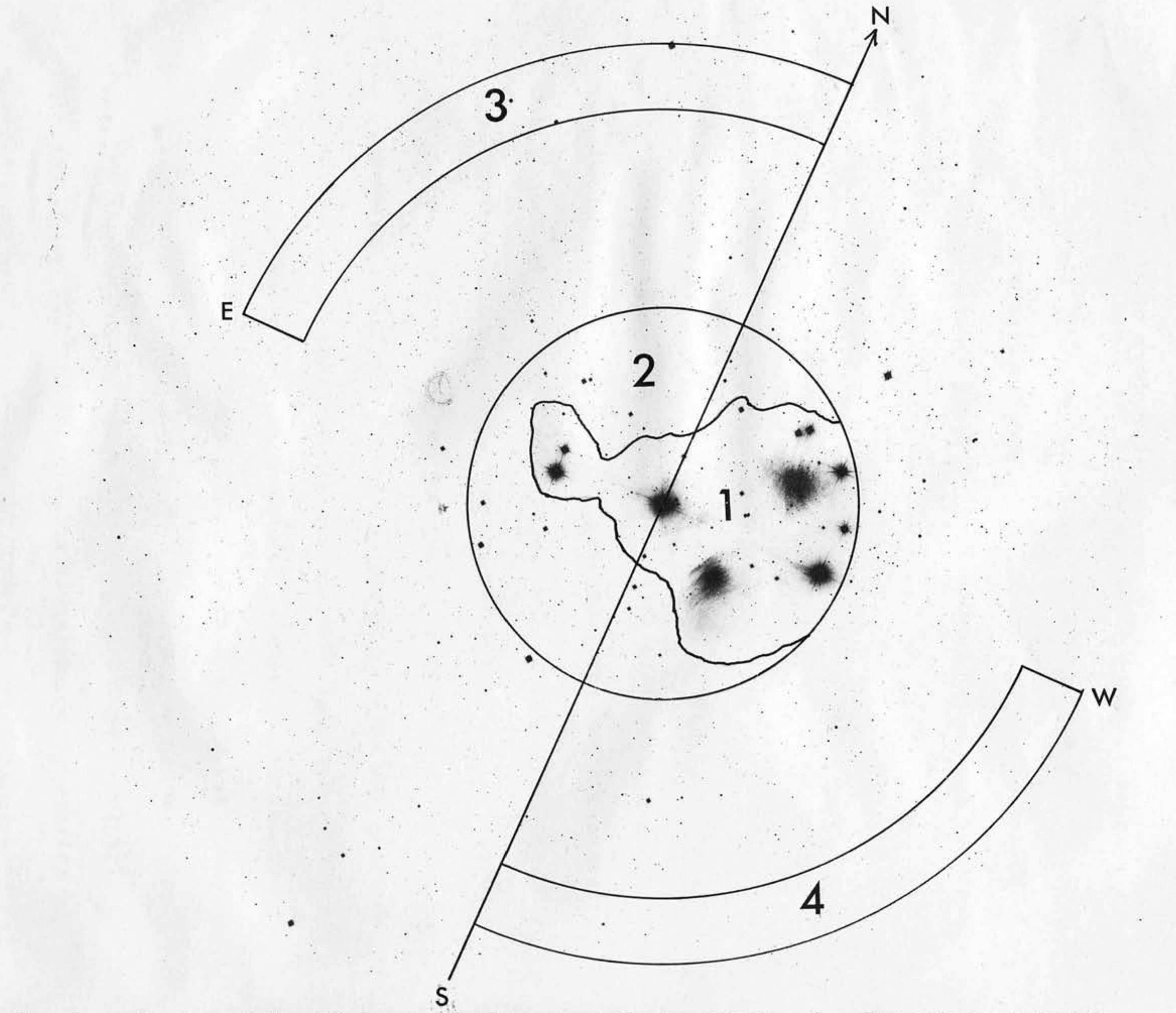

Fig. 1. - Region of the Pleiades showing areas photometered. 1 - The nebulous region. 2 - The circular region of radius 40 minutes of arc from Alcyone. 3 - The outer north sector. 4 - The outer south sector.

more information about the faint-end members of the Pleiades.

It is desirable to determine the colour-magnitude distribution of field stars in the region of the cluster, and it may be possible to find out whether or not the faint 'members' are really field stars by using the statistical subtraction method developed at the Hamburg observatory (Ozsvath 1960). This method requires three-colour photometry of nearby field regions as well as of the cluster area itself. In the case of the Pleiades the observations have to be made in an area several degrees across, and the problem is, therefore, ideally suited to a Schmidt telescope. Previous photometry of the Pleiades has been restricted to an area about 2^{o} in diameter (Hertzsprung 1947, Binnendijk 1946, Johnson and Mitchell 1958).

The Edinburgh Schmidt telescope has a field 4^{o} in diameter. Preliminary calculations based on star counts across the region indicated that optimum statistical accuracy should be obtained by photometering an area 40' in radius centred on Alcyone, and two comparison regions, each half of the central area, near the north-east and south-west edges of the telescope field as shown in Fig.1. The areas together contain about 3200 stars brighter than $V = 16^{m}.0$. Statistical considerations further showed that adequate accuracy would be obtained by measuring two plates in each colour. The total of some 2×10^4 star images were measured on the semi-automatic iris photometer (Fellgett and Seddon 1963) in a period of five weeks in January and February 1963, and the measurements were reduced primarily on the Edsac II computer of the Cambridge University, and partly manually.

In order to draw accurate conclusions, it was necessary to examine the sources of errors in the photometry. Hence a section on errors and their consequences ~~have~~ has been incorporated in the thesis. Also included in this thesis is a three-colour (UBV) survey of the southern galactic cluster NGC 3766 which further demonstrates the method of statistical subtraction for reducing the influence of the field stars in colour-magnitude and two-colour arrays. The results of this survey have already been published in the Publications of the Royal Observatory, Edinburgh, Volume III, No.3, 1962.

The investigation of the Pleiades is described in Section I . Here it will be useful to summarise those earlier investigations, made by various astronomers during the past ten years, which have provided reasons for the present investigation being made.

Observations. In 1953, Salpeter suggested that the colour-magnitude diagram of a very young cluster having stars in gravitational contraction should consist of a normal main sequence which terminates at the faint-end at a luminosity whose value depends on the age of the cluster.

Parenago (1953) observed I-Orionis and did find that the main sequence terminated at a certain luminosity. At fainter luminosities non-main sequence sub-giants appeared.

This was further confirmed by Walker (1956, 1957) who published his work on NGC 2264 and M8 . The colour-magnitude diagrams of both of these clusters show a normal main sequence which covers a spectral type range from O5 to A0 . In both clusters this sequence abruptly ends at A0 . Many sub-giants are present fainter than this, lying 0.5 to 5 magnitudes above the normal main sequence. Walker suggested that these stars may be in the stage of gravitational contraction. This conclusion can be compared with the theory above.

A simple theory of contracting stars, based on homologous stellar models and Kramer's opacity law, leads to expressions for the time of gravitational contraction and the contraction tracks,

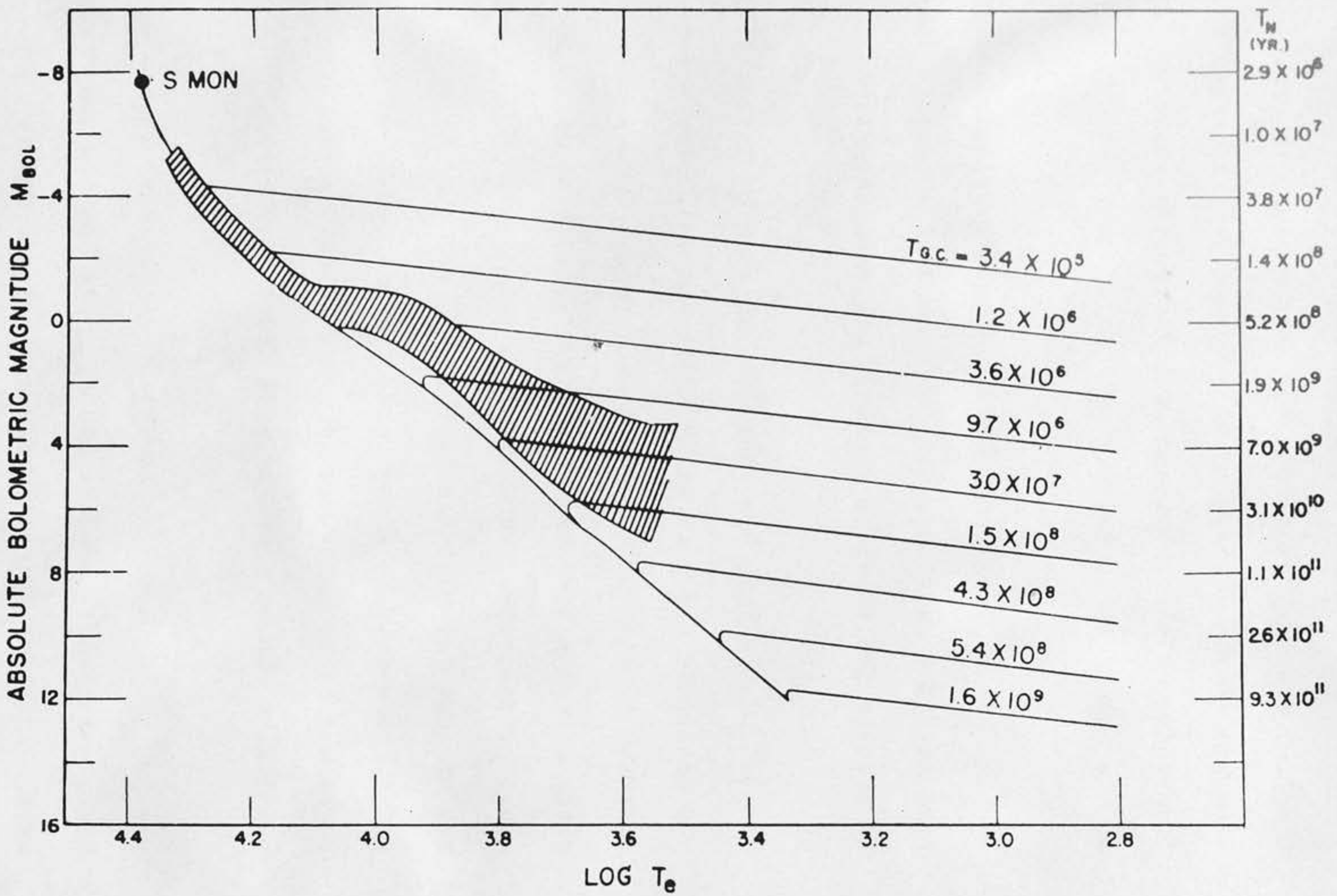

Fig. 2. – The contraction tracks in the M_{bol} – log Te plane along with Walker's cluster NGC 2264.

$$t_{gc} = 6.32 \times 10^7 \frac{M^2}{LR} \quad .... \quad (1)$$

where M, L and R are in solar units (Sandage 1957), and

$$M_{bol} = - 2 \log Te + \text{constant} \quad .... \quad (2)$$

The tracks given by eq.2 are shown in Fig.2 along with Walker's recent data for the very young cluster NGC 2264. The age of the cluster as estimated from the break-off point at the faint-end agrees with that determined from the upper termination point of the main sequence, being $\leq 3.6 \times 10^6$ years.

At the break-off point the eq.1 fits very well, but the stars near $M_v = +6$ are so close to the main sequence that on the basis of the above theory they cannot have reached there unless they have existed for 10^8 years. This indicates a real spread in the ages of the stars in a cluster, the less massive stars being 200 times as old as the massive stars. This implies that the less massive stars began contracting from the gas cloud some 10^8 years before the more massive stars. Walker's study of M8 also gives similar indications.

Henyey et. al.,(1955) later carried out theoretical

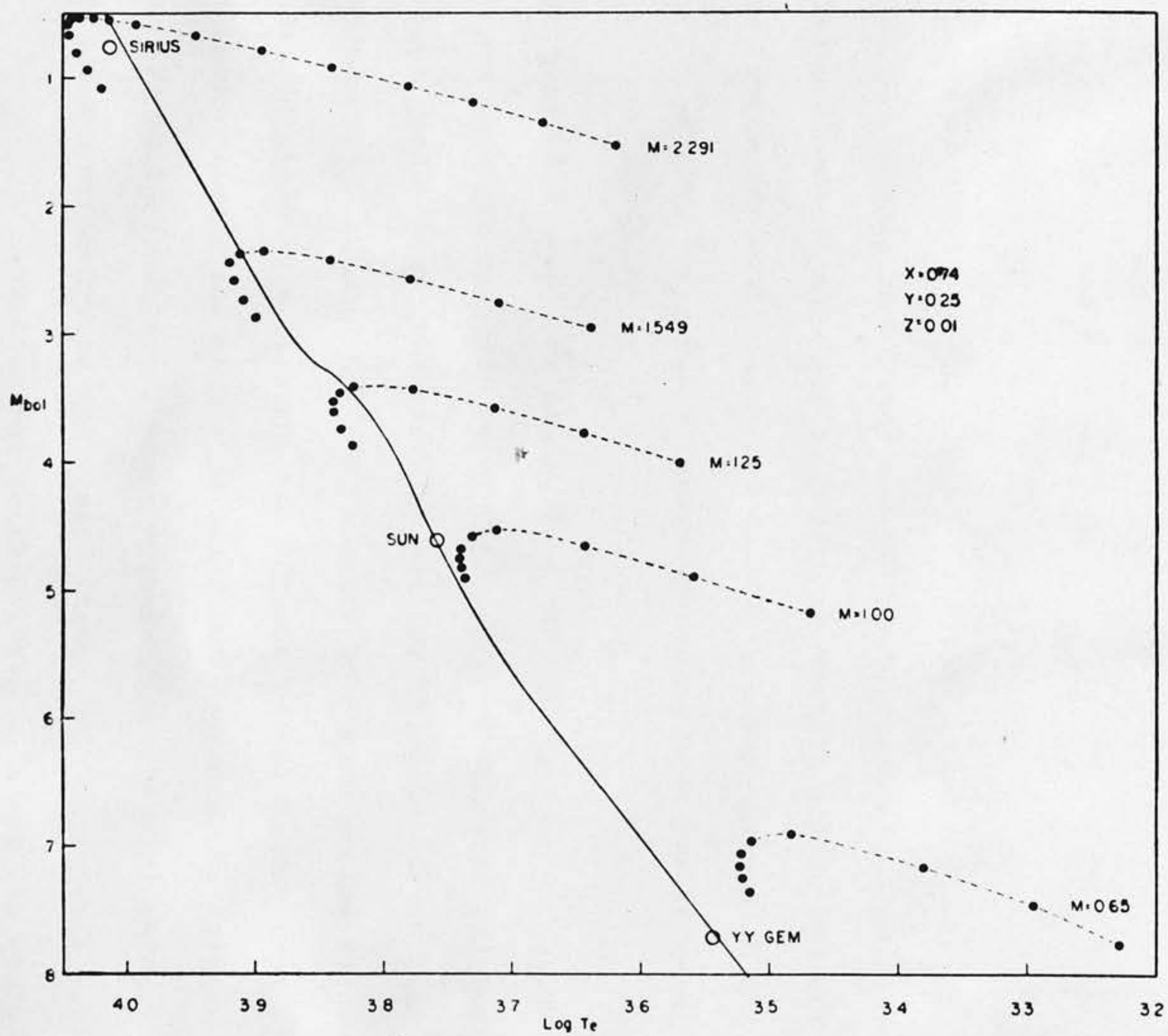

Fig. 3. - Theoritical contraction tracks of Henyey et. al., for different masses.

investigations by considering a law of opacity based on detailed opacity tables. They also included energy production both by the C-N cycle and the p-p chain. Their computed tracks are similar to eq.2 and shown in Fig.3 . Su-shu Haung (1961) in his theoretical considerations also arrived at a result which does not agree with Walker's observations unless there is a spread in the ages of the stars of a cluster.

A spread of 10^8 years in the time of formation of stars in Walker's clusters is not, however, the only possible explanation of the disagreement between theory and observations. Sandage (1957) has suggested fragmentation of massive stars just before they reach the main sequence. According to McCrea and Williams (1962) the initial conditions are important for the distribution of premain sequence stars in the log L - log Te diagram, for if initial conditions are such that at any epoch, especially at the beginning, the stars lie on a locus appreciably different from that representing gravitational contraction starting from vanishingly small initial density, then the difference will be maintained throughout their contraction until the nuclear burning starts. On the basis of this conclusion they propose that the abnormal behaviour of very young clusters in the log L - log Te diagram may be explained if the correct initial conditions are found. One, according to them, is the

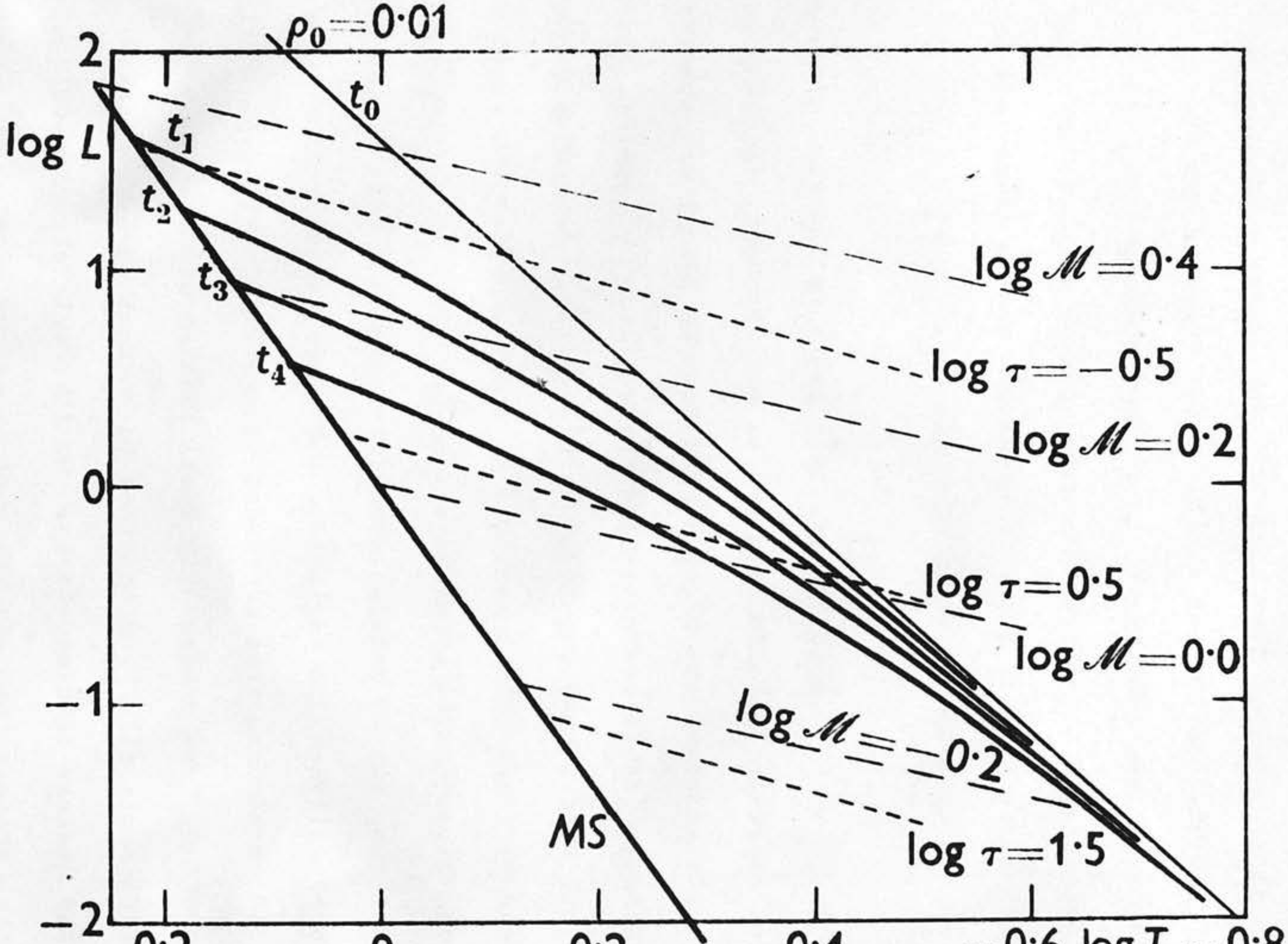

Fig. 4. - The contraction tracks of McCrea and Williams.

argument for a real spread in times of formation of stars of different masses. Stars of smaller masses may be formed before more massive stars. However, they also show that if the initial condition of contraction from infinitely low density is replaced by contraction from a relatively high density, say one percent of the final main sequence star density, results more in agreement with Walker's observations are obtained. This theory implies that fragmentation of a gas cloud into stars occurs at this relatively high density, a not unreasonable assumption. McCrea and Williams results are reproduced in Fig.4 . MS is the main sequence, the broken lines $\mathcal{M}$ = constant are the evolutionery tracks of the stars having the indicated masses, the dotted lines τ = constant are loci of stars at epoch τ after starting to condense from vanishingly small density at epoch $\tau = 0$. If stars start at epoch $\underline{t}_o$ from mean density ρ_o then the loci at epochs $t_1 \ldots\ldots, t_4$ are as shown, the loci being drawn for $\rho_o = 0.01$, $\underline{t}_1 - \underline{t}_o = 0.05$, $\underline{t}_2 - \underline{t}_o = 0.1$, $\underline{t}_3 - \underline{t}_o = 0.2$, $\underline{t}_4 - \underline{t}_o = 0.4$. $\mathcal{M}$, L, T, ρ are measured in solar units, and τ , $\underline{t}$ in the Helmholtz - Kelvin time-scale for the sun.

The membership of stars at the faint-end in Walker's clusters is highly doubtful, and the faint-end members lie closer to the main sequence and appear to be more evolved than expected by the above theories. The discrepency may lie in converting the planes from M_v/B-V to M_{bol}/logTe . The peculiar spectral energy distributions of many stars at the faint-end giving rise to contamination of the B and U filter bands by emission lines and continua may explain the positions of stars off the main sequence. But the entire effect seen especially in the case of NGC 2264 can hardly be explained by the above argument.

Hayashi (1961) has pointed out that the main reason for the conflict between theory and observation in the case of very young clusters lies in the fact that in constructing such theories the role of hydrogen convective zones has been neglected. In a study of outer envelopes of late-type giants he calculated the locus $\vdash$ = constant in the H-R diagram, where $\vdash$ is the characteristic value which determines the degree of central condensation in the star and is given by

$$\vdash \;=\; \text{const.}\; M^{0.5}\, R^{1.5}\, P_c/T_c^{2.5} \qquad \ldots\ldots\ldots\ldots \qquad (3)$$

where P_c and T_c are central values. As $\vdash$ is increased, the locus moves to the right in the H-R diagram. There are no

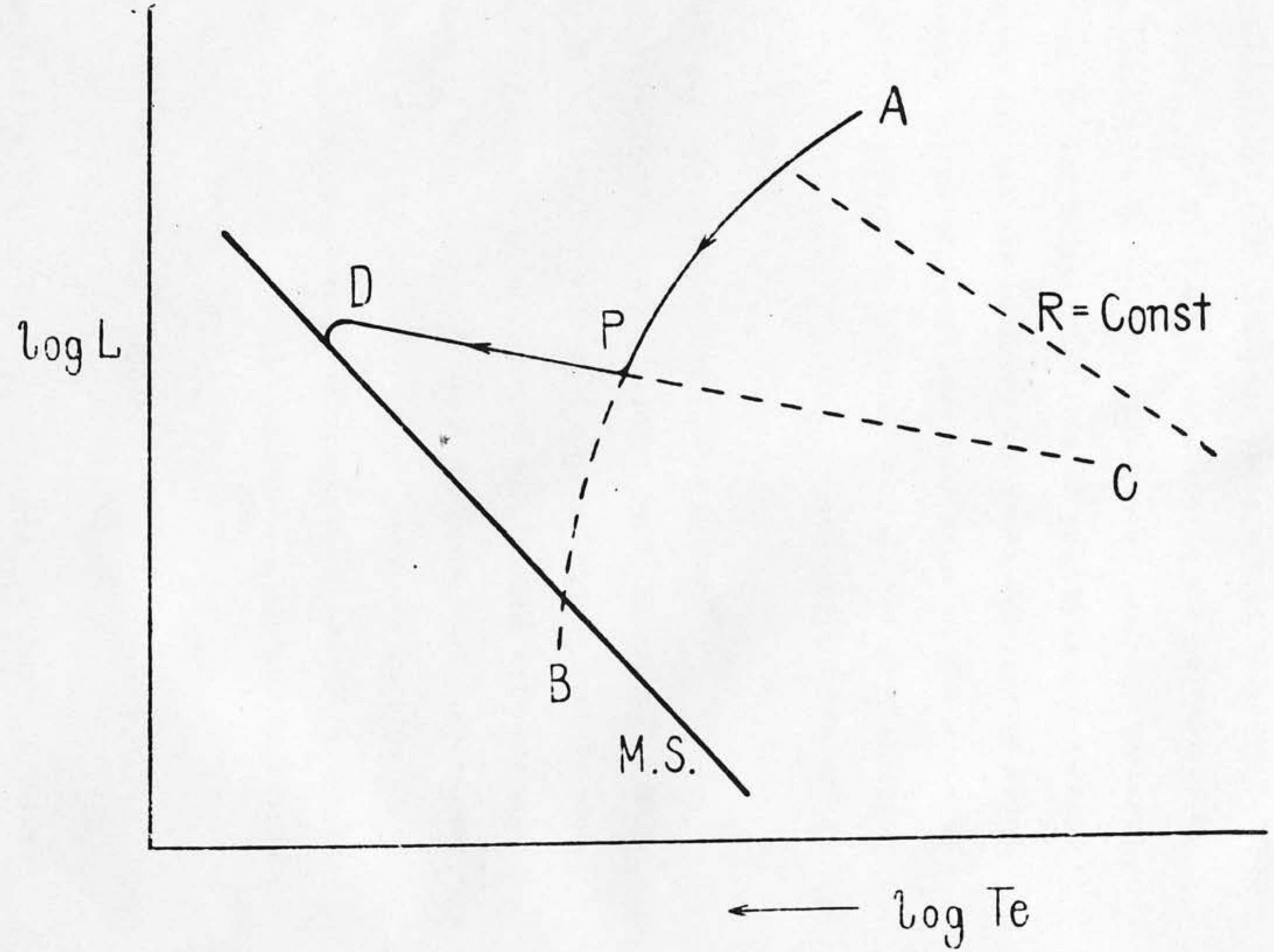

Fig. 5. - Schematic track for contracting stars with given mass and chemical composition.

stable solutions for $E > 45$, so that no loci lie to the right of the curve $E = 45$. This curve intersects the evolutionery track of Henyey et al. Any star born in the forbidden region adjusts its internal structure, moves rapidly along a locus R = constant and goes on to Hayashi's curve. The star then descends along this curve as the region to the left of it and above Henyey's track corresponds to solutions having centrally condensed cores. Hayashi's diagram is shown in Fig.5 .

Hayashi approximates his computed tracks by a relationship of the form $L \propto R^{-\beta}$. The age of the star from $R = \infty$ to the present value R is then given by

$$t = C/(1-\beta), \quad C = GM^2/2RL = 10^{7.2} M^2 R^{-1} L^{-1} \quad \ldots\ldots \quad (4)$$

$$L = - dE/dt, \quad \text{and} \quad E = - \frac{3\gamma-4}{3(\gamma-1)} \frac{3}{5-n} \frac{GM^2}{R} \quad \ldots\ldots\ldots\ldots \quad (5)$$

where n is the polytropic index. The computed tracks on the $\log L - \log T_e$ diagram are not straight lines and, therefore, β is not a constant. Hayashi chooses $\beta = -3/2$ as a typical value, and thus the age at the point of intersection mentioned above is $2C/5$. This may be compared with $2C$ $(\beta = 1/2)$ along the evolutionery track of Henyey et al.

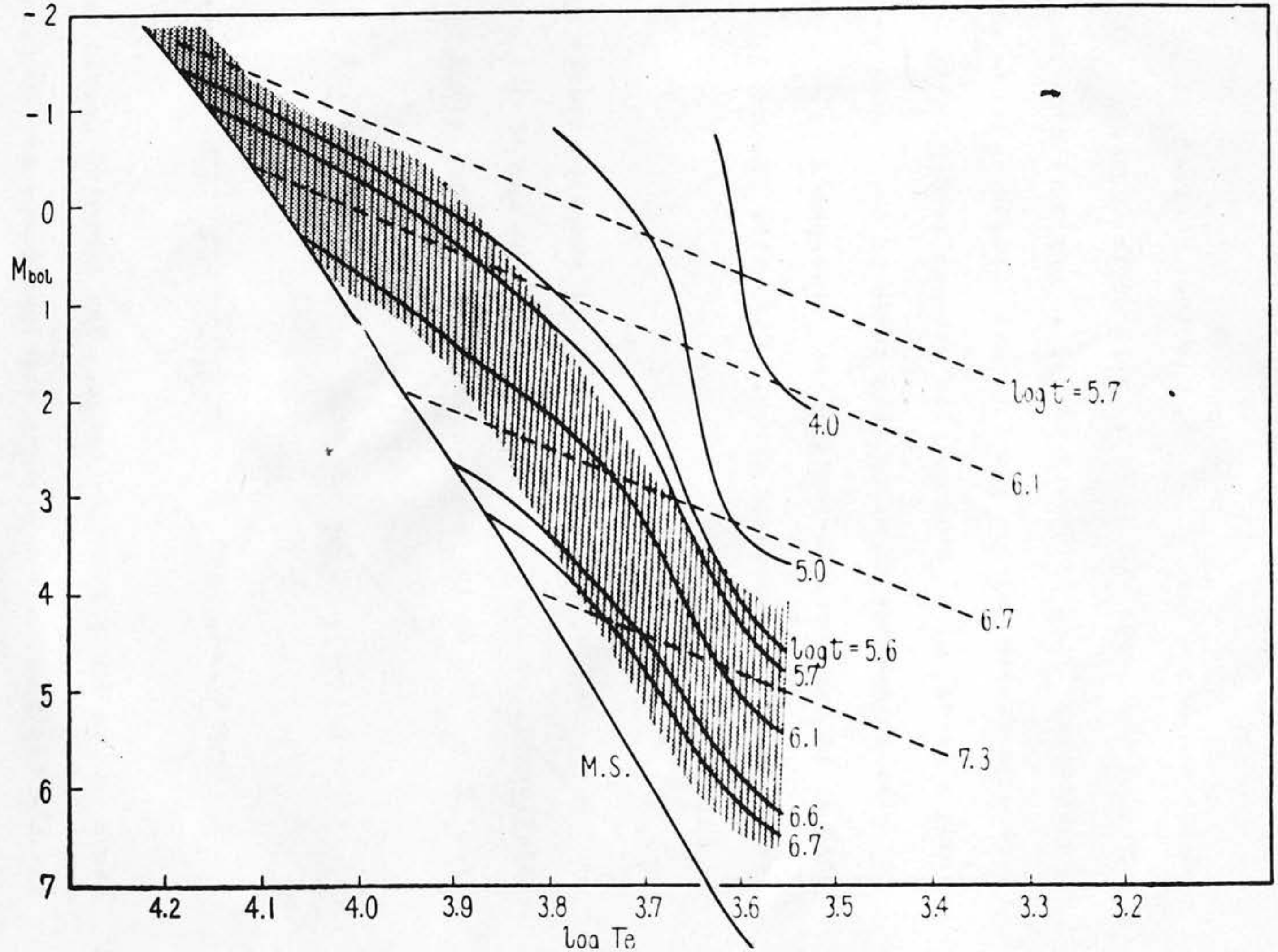

Fig. 6. - Hayashi's curves for constant ages for stars with different masses along with the H-R diagram of NGC 2264.

The result of evolutionary paths and ages computed by Hayashi is shown in Fig.6 along with Walker's cluster NGC 2264 . The agreement between theory and observation is excellent and the assumption that the member-stars all originated at the same epoch at very low density once again holds good. The age of these late-type stars is reduced greatly as they evolve nearly vertically in the H-R diagram. Their positions in the diagram show that they may be T-Tauri stars.

Hayashi's theory agrees well with Walker's cluster provided the stars at the faint-end are the members of the cluster. Doubts have been raised (Underhill 1960) by suggestions that many of the stars lying above the main sequence may not be members. Some late type variable stars have been identified in the Orion nebula and NGC 2264 . If they are contracting stars, they appear to be 10^8 years old. Both of these clusters contain a number of G and K type giants several magnitudes fainter than the most luminous main sequence members. These stars may be very young contracting stars or old ones which have already evolved off the main sequence. In the case of NGC 2264, they are not associated with nebulosity, none is variable in light, none has T-Tauri like emission spectra and none appears to have abundance of lithium proving T-Tauri stars of the premain sequence type. Hence they may be regarded as having evolved from an earlier generation of B- or A- type stars. This gives the cluster an age in excess of 10^8 years. This is contrary to the ages calculated by Hayashi's theory.

To investigate further, clusters of intermediate ages having definite turn-off points will be more suitable. In this respect the Pleiades is important. It has a large number of stars both at the bright end where a turn-off point is available as well as at the faint-end where the existence of a break-off point is however, the subject of doubt and criticism. Its age determined from the upper turn-off point is around 5×10^8 years. A membership criterion based on proper motions is available to about 16 magnitudes (Hertzprung 1947) . This criterion is, however, not reliable for the fainter stars because of the large number of field stars and because of the fact that the cluster proper motion ($0''.046$/yr, p.a. 150°) is not only small but lies not far from the direction to the solar antapex (146°) and to the antapex of the galactic rotations (about 133°) .

This uncertainty in the membership may be the cause of the large dispersion in the lower portion of the

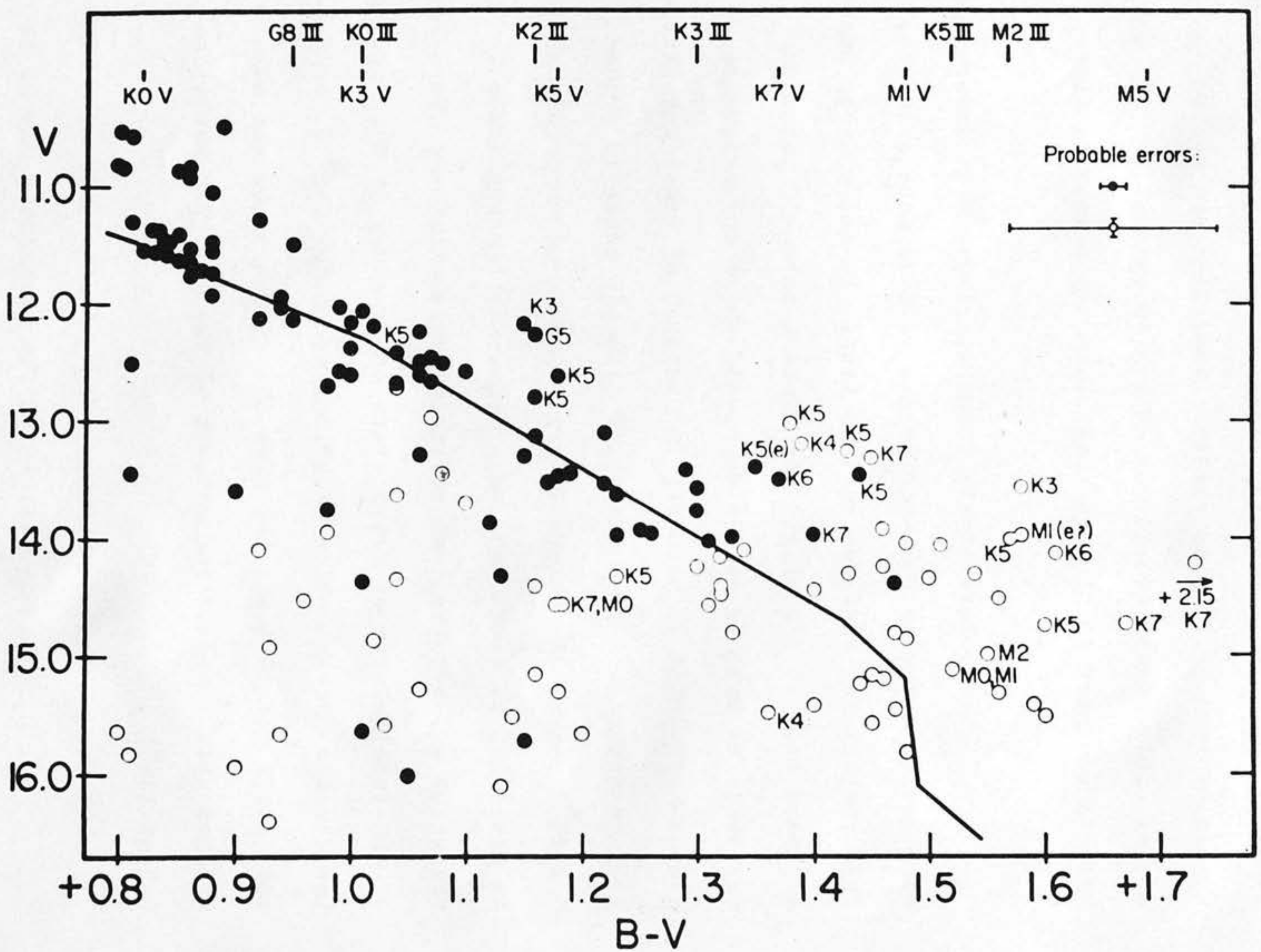

Fig. 7. - The colour-magnitude diagram of the Pleiades based on the photometric observations of Johnson and Mitchell.

colour-magnitude diagram shown in Fig.7 which is due to Herbig (1962) . The data from this figure is from Johnson and Mitchell (1958) .

According to calculations by von Hoerner (1957), improved by Sandage (1958) and Limber (1960), a cluster having an upper turn-off point must yeild a break-off point seven magnitudes below. The Pleiades has a distance modulus $= 5^m.5$ and its upper turn-off point occurs at spectral type B6 near $m_v = 3^m.2$, so that the break-off point should be near dG2 or $m_v = 10^m.2$. The photoelectric observations in the figure show no systematic turn-off point as far as $m_v = 14^m.0$ or $M_v = +8^m.5$. There is a broadening of the main sequence after $m_v = 12^m.0$ and the stars lie above and below the main sequence. One possible reason for this dispersion has already been mentioned above i.e. the uncertainty in the membership of the cluster at faint luminosities. Another is errors in photometry : Johnson and Mitchell's investigations at the faint-end are largely photographic, bearing a probable error $\pm 0^m.09$ in B-V which is roughly equal to eight times the photoelectric error. This discrepency can be remedied by photoelectric observations of the stars at the faint-end. But the dispersion is so large that one cannot account for this solely in terms of observational error. Some improvement may also be achieved when radial velocity information become available, though this improvement will not be great because of the direction of the cluster proper motions.

Some of the stars lying above the main sequence with $B-V > +1^m.3$ have been identified as genuine members. Flare-like variability has been reported by Johnson and Mitchell in HII 1332 and 1306 and suspected in several others. The first two are early K5 type ordinary flare stars, and neither show hydrogen emission. Although the classical flare activity is associated with dMe stars, there are some cases known in which the stars are not late M type and no permanent H-emission is present.

The next approach to identify stars lying above the main sequence is by a search for $H\alpha$ emission. It is known that the Pleiades contain no bright T-Tauri stars. Herbig (1960) made a search for faint emission-$H\alpha$ stars up to $m_V = 16^m.0$. His search was completely negative. Thus there is no spectroscopic evidence for contracting stars in the Pleiades brighter than $M_V = +10^m.0$.

Herbig's conclusions are contrary to Kotok (1960), who claims that the two ends of the Pleiades main sequence are compatible on the basis of contraction tracks together with Johnson and Mitchell's photometry. Kotok's results refer to the main sequence stars and no explanation has been given for stars lying above and below the main sequence.

Varsavsky (1960) suggested that the relation between B-V and Te does not apply to T-Tauri variables and other stars in the contracting stages. For these stars have emission lines, frequently a strong ultraviolet continuum, and occasionally a continuum throughout the photographic region of the spectrum that veils the absorption lines. Both the emission lines and continua are of variable intensity. The presence of emission lines and continua does not affect the V-readings, on the other hand the blue filter is transparent to $H\gamma$, $H\delta$ and to some extent to H_{ρ} , H_{ε} and H and K of CaII . The strength of these lines and the presence of a blue continuum may be a factor in determining the colour of these stars, making them too blue for their spectral type. These stars are very difficult to classify because of the weakness of their absorption spectra. As a result T-Tauri variables and other related objects may seem in the V/B-V plane to be very close to or even on the "wrong" side of the main sequence before they have actually reached it. It is supposed that this is what is observed in the case of faint members of NGC 2264 and the Pleiades. Herbig (1952) suggested that they may be K type stars. In both clusters the possibility of ruling out these stars as members still exists.

In NGC 2264, there are about ten stars which fall below the main sequence and in the Pleiades the number of such stars is large. Hayashi's theory does not explain these objects though it provides a clue to the observed age discrepency of the faint-end of NGC 2264 . It seems that Varsavsky's arguments (1960) may have some bearing on the positions of these stars in the colour-magnitude diagram. The other alternative is to discard these stars lying below the main sequence as members and treat them as field stars.

Under these circumstances a more thorough investigation of faint stars in the region of the Pleiades appeared to be worthwhile. The investigation tackles the problem in a number of ways. The catalogue of Hertzsprung (1947) is examined to find out how reliable the proper motion criterion is, especially for stars fainter than $m_{pg} = 13$, and how many field stars are likely to have been included within the criterion. The effect of the nebulous fog on the photographic photometry of Johnson and Mitchell (1958) is determined. Star counts over the field of the Pleiades are used to find the total population of the cluster down to the limit of the Palomar O-chart , $m_{pg} = 21.5$. Three-colour photometry of all stars within 40' of Alcyone, to $V = 16^{m}.0$, $B = 17^{m}.0$, corrected for the effects of the nebulous fog, is used to find the distribution in magnitude and colour of the field stars in the region, in order to know in which parts of the colour-magnitude diagram they are most likely to be confused with cluster members. The star counts revealed a 'step' in the field star surface density in the central region of the cluster ; because of the possibility that this may be caused by obscuration associated with the Pleiades, and the possibility that statistical subtraction of field stars may reveal a main sequence or contracting branch at faint magnitudes, three-colour photometry of stars in two regions near to the cluster on opposite sides of the 'step' was carried out. The results of these investigations are described in section I .

S E C T I O N   I

An Investigation of the Region of the Pleiades

Star Counts. To produce information on the distribution of stars in the region of the Pleiades, star counts were carried out on the Mount Palomar O-chart along two strips 33' wide, one centred on Alcyone and running north-south for a distance of over 3°, the other adjacent to it east of Alcyone. A similar count was also made on a strip at right angles to the north-south strip, again centred on Alcyone. The results are shown in Figs.1, 2 and 3, where the number of stars per 100 (minutes of arc)^2 in rectangles of width equal to the width of the strip (33'), and length 3.3', are plotted against their distances from Alcyone. The limiting photographic magnitude on the Mount Palomar O-chart is about $21^{m}.5$. Similar counts were also made on an Edinburgh Schmidt blue plate No.24 on north-south and east-west strips only, reaching up to the boundary of the plate (roughly 2° from Alcyone). The limiting photographic B-magnitude of the counts on this blue plate is $16^{m}.0$. The results are shown in Figs.4 and 5.

From these figures it is obvious that the apparent surface density of the stars is higher to the north and east of the Pleiades than to the south and west. There is a distinct step in the star densities on Figs.1, 2 and 3 in the region of the cluster. This approximately divides the

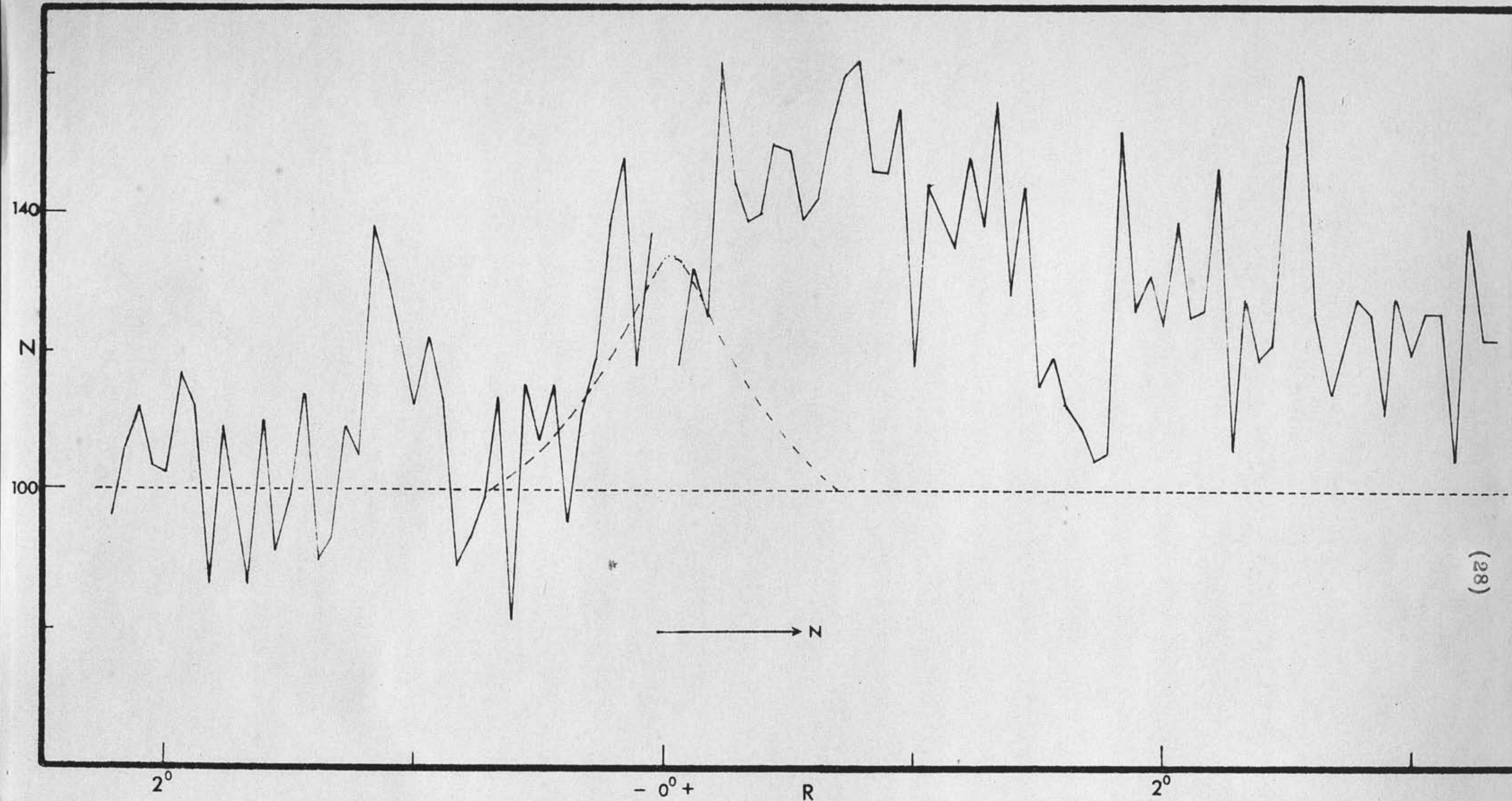

Fig. 1. - The number of stars per 100 (minutes of arc)^2 on Mount Palomar O-chart against distance north and south of Alcyone.

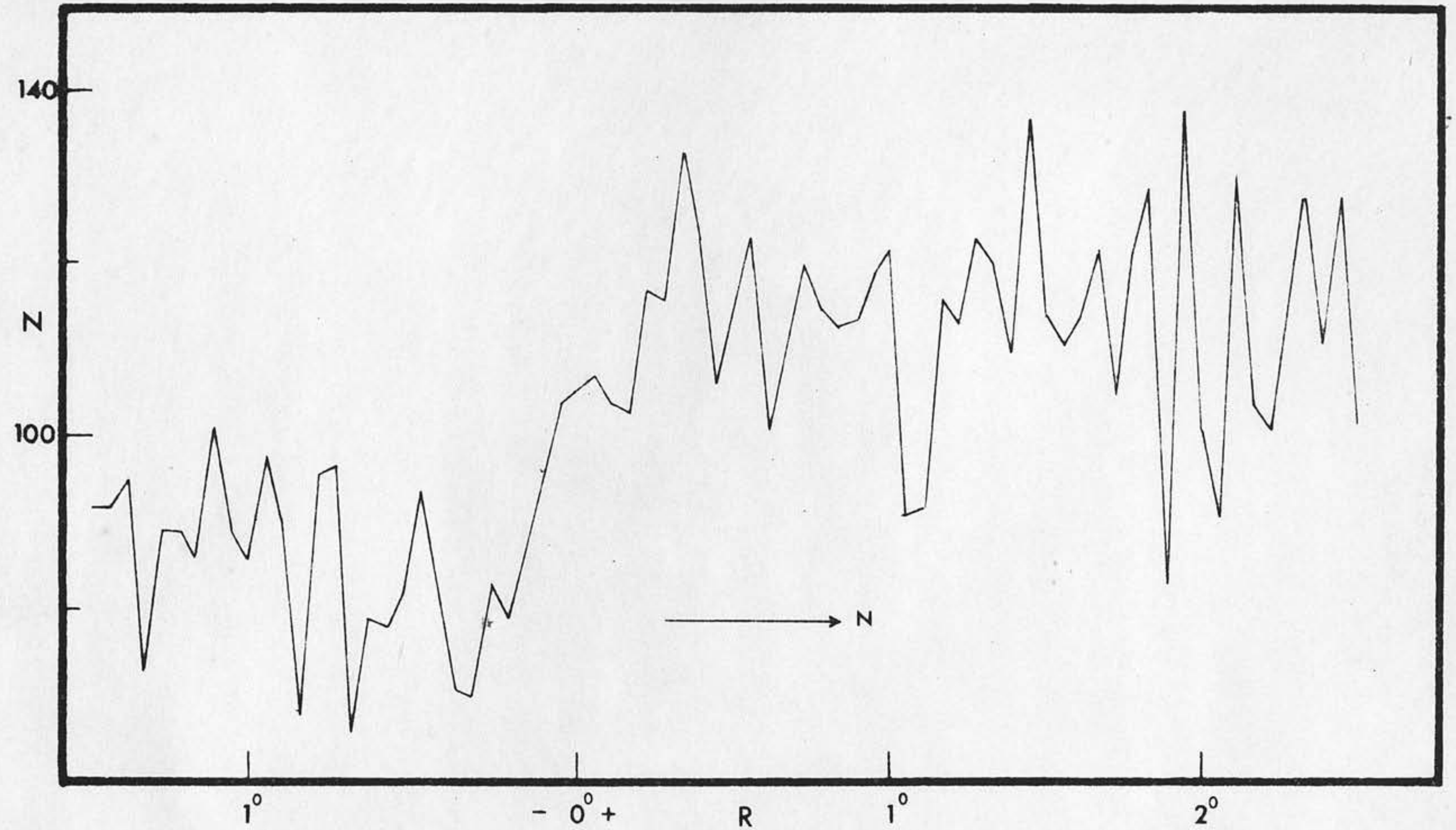

Fig. 2. - The number of stars per 100 (minutes of arc)^2 on Mount Palomar O - chart on a north-south strip adjacent to the west side of the strip of Fig. 2.

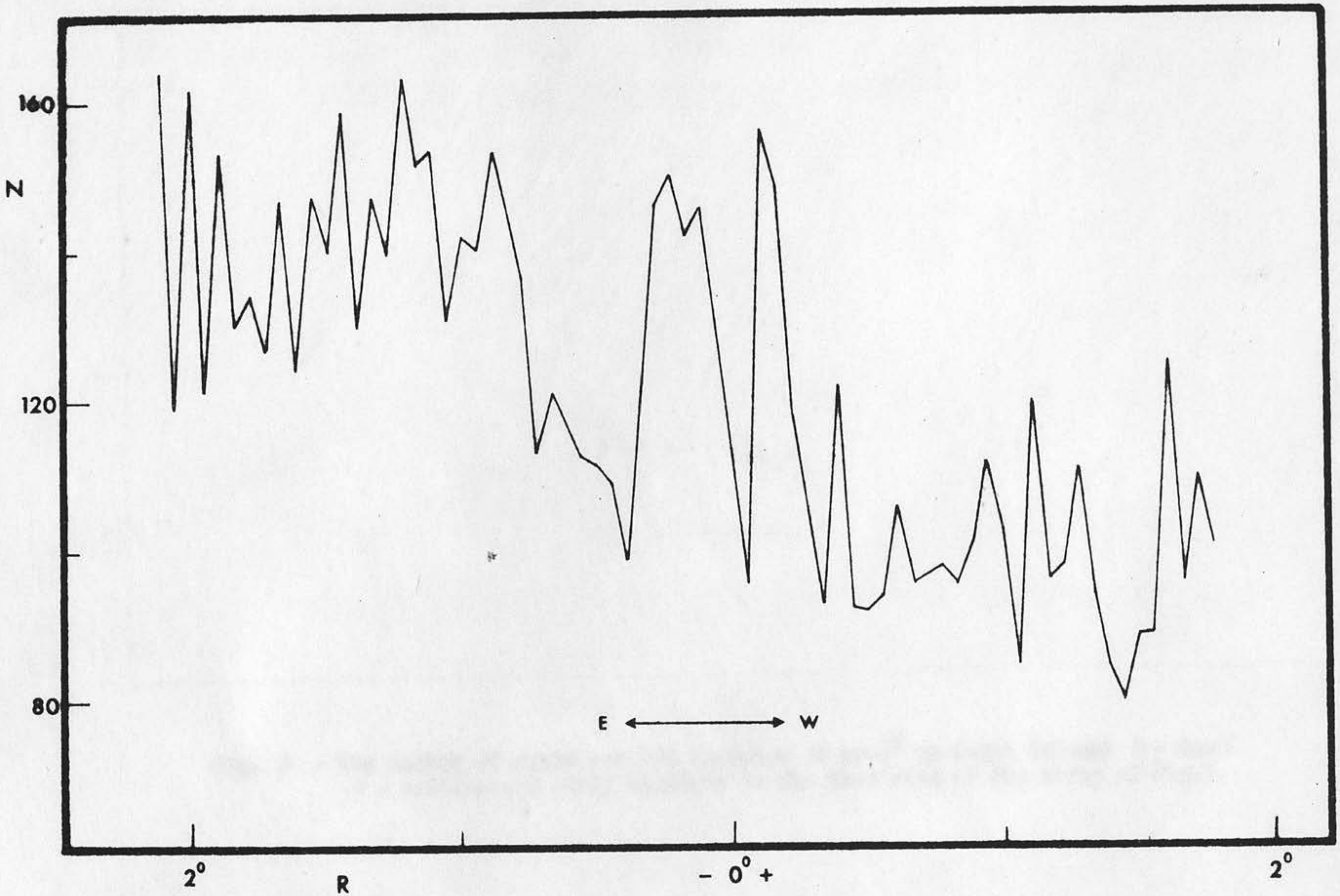

Fig. 3. - The number of stars per 100 (minutes of arc)^2 on Mount Palomar O-chart against distance east and west of Alcyone.

entire field into two halves by a line running north-west to south-east. This is in agreement with the presence of nebulosity which obscure most of the faint stars in the south-west quadrant of the field (see also Binnendijk 1946). This variation in the star densities presents some difficulty in the statistical assessment of the number of field stars to be subtracted from the corresponding numbers in the central region, if the net number of cluster stars is to be determined after the manner of Ozsvath (1960) in the present investigation. In Fig.1 of counts on the Mount Palomar 0-chart to the limiting magnitude $21^m.5$, there are about 100 stars per 100 (minutes of arc)^2 towards the south and the uncertainty in the star density about a mean line there is expected to be about $\pm (100)^{1/2}$ or ± 10 . The r.m.s. deviation about the same line was found to be ± 9.6 indicating that the fluctuations are indeed random. In Fig.4 of plate number 24 for limiting magnitude $16^m.0$, the level is the same throughout. The uncertainty in the star density along a mean line is expected to be of the order of $\pm (10)^{1/2}$ or ± 3.2 , while the r.m.s. deviation from the same mean line was found to be ± 3.8 .

In Fig.1 the transition from high density to low, the 'step' , appears to be ambiguous. Either the field

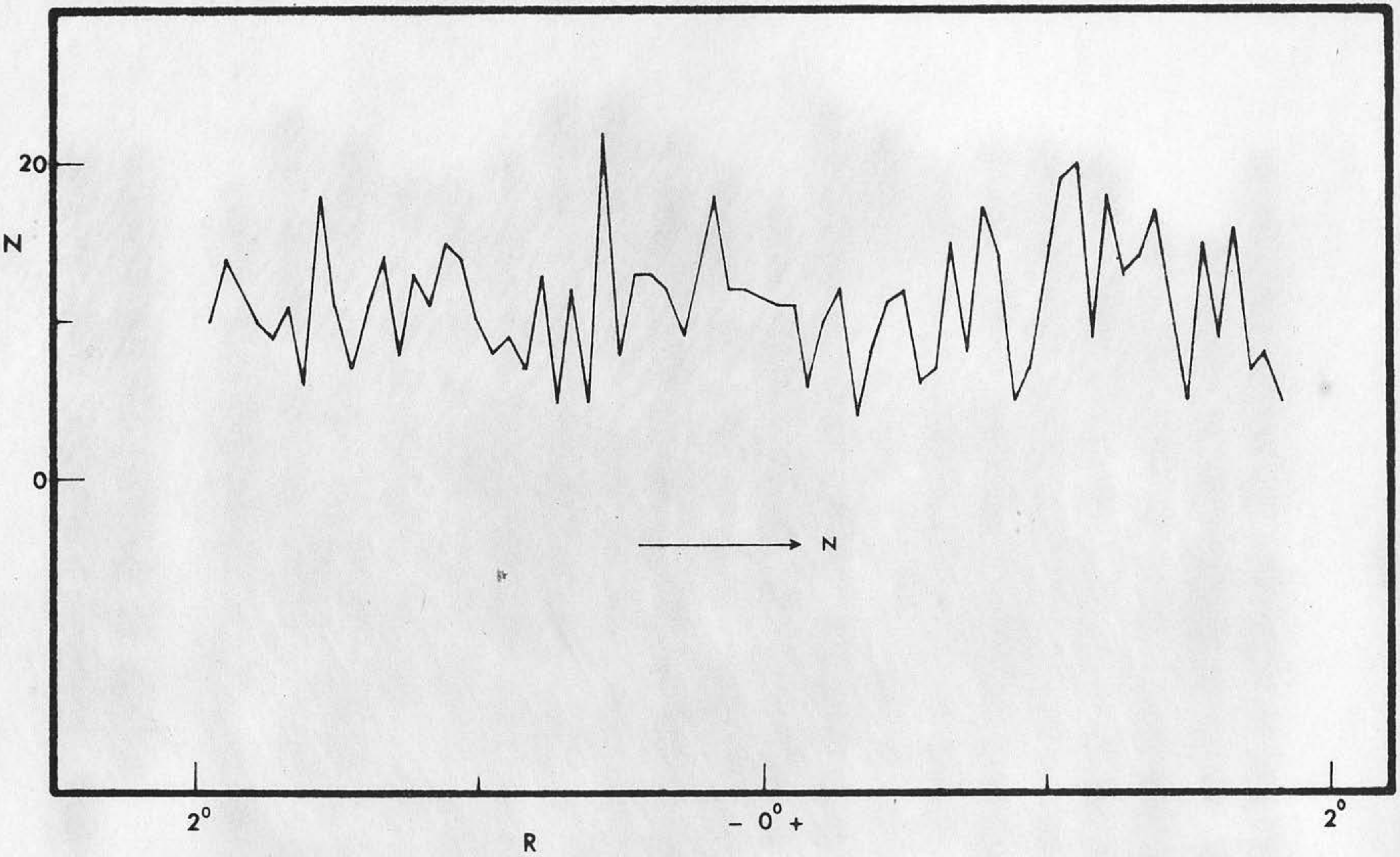

Fig. 4. – The number of stars per 100 (minutes of arc)^2 on Edinburgh Schmidt plate No. 24 against distance north and south of Alcyone.

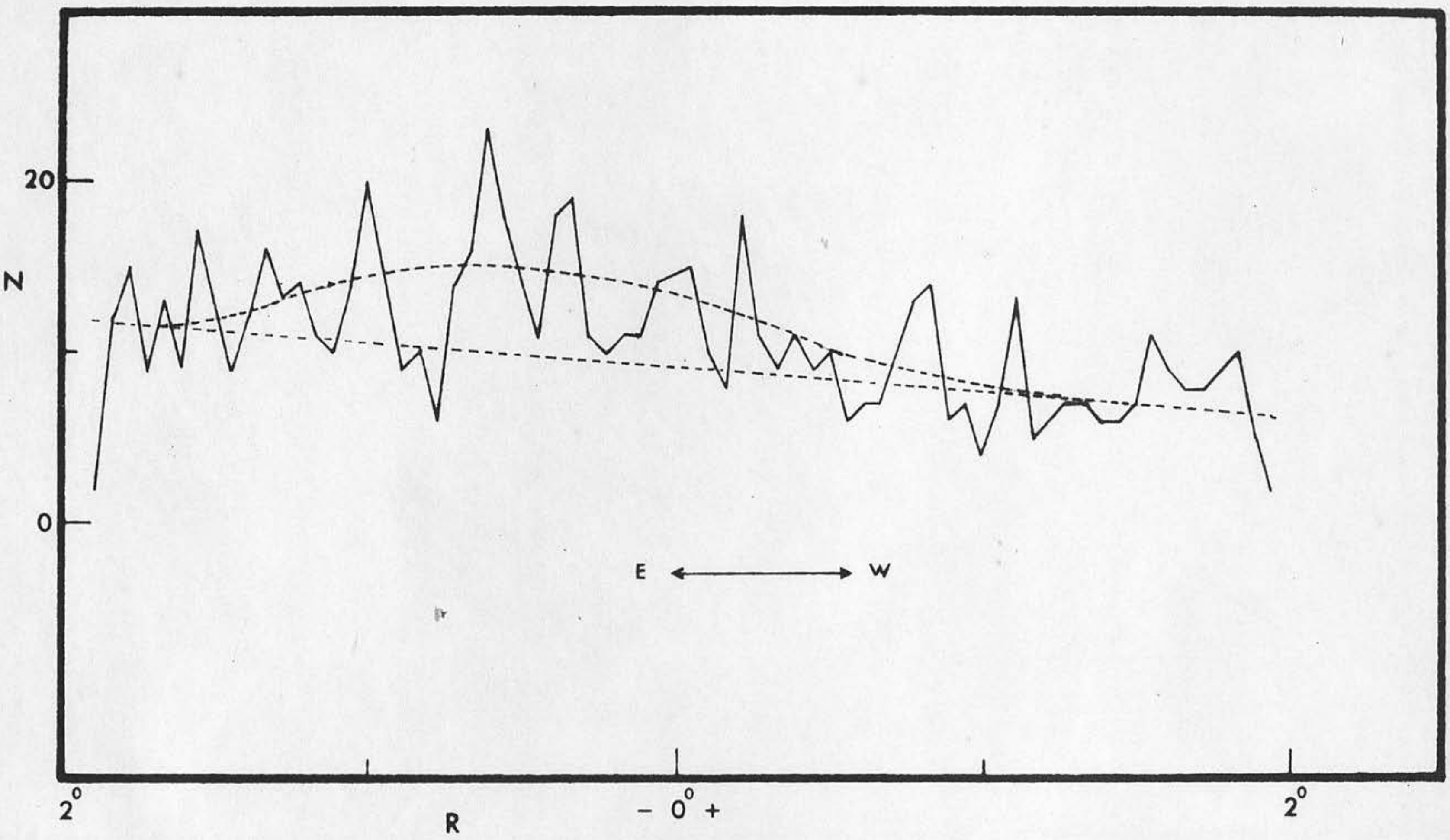

Fig. 5. - The number of stars per 100 (minutes of arc)^2 on Edinburgh Schmidt plate No.24 against distance east and west of Alcyone.

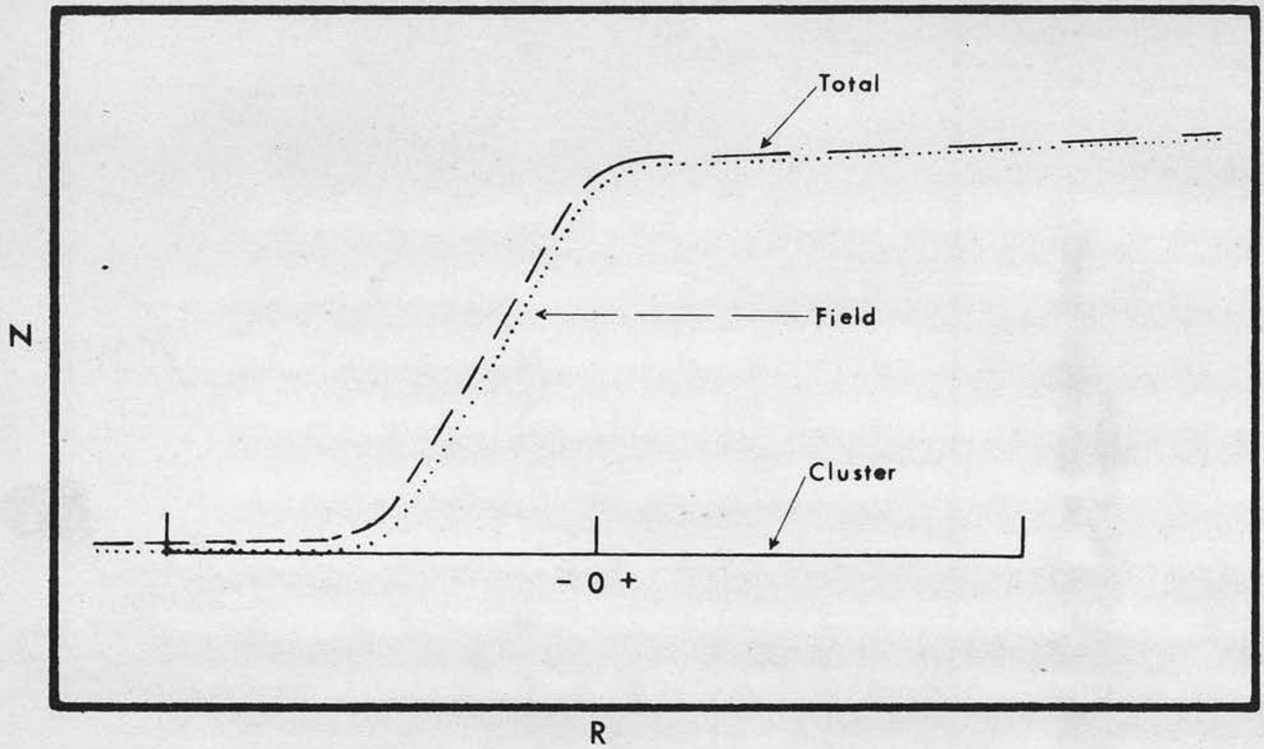

Fig. 6 - Possible distribution of field and cluster stars with no significant contribution from cluster stars.

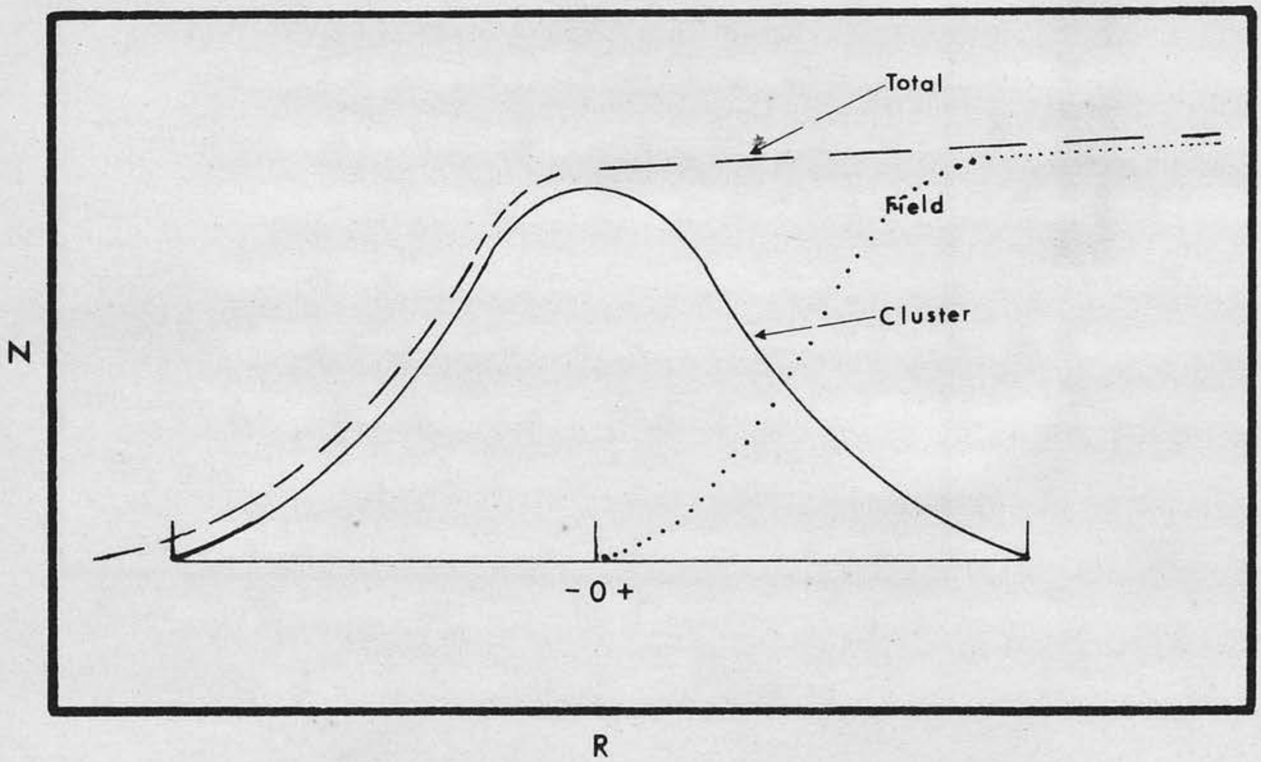

Fig. 7 - Possible distribution of field and cluster stars with significant contribution from cluster stars.

star density is equal to the total star density as shown in Fig.6 , in which case there will be no significant contribution from the cluster stars ; or, the step may be as shown in Fig.7 , the field star density having already decreased to its low value where the contributions from the cluster stars reach a maximum. Similar interpretations may be made of Figs.2 and 3 . The second interpretation applied to Fig.1 gives an upper limit to the total number of cluster stars up to the limiting magnitude $21^m.5$; by numerical integration over the area of the cluster it was found that the number of cluster stars should be less than 500 for this limiting magnitude.

In Fig.4 no peak is detectable, but one possibly exists in Fig.5 . As shown in this figure, a mean line and a mean curve was drawn and it was found that the number of cluster stars should be less than 530 . However, Fig.5 may more probably be interpreted as showing the 'step' as on Fig.3 . In that case, whether or not there is a large number of cluster stars depends on whether Fig.6 or Fig.7 is relevent. In this connection the absence of any peak on Fig.4 is significant, and indicates that cluster stars do not contribute appreciably to the counts ; an upper limit of about 100 cluster stars is set by the level of detectability on this figure.

It is notable (and from a statistical point of view unfortunate !) that the 'step' in the star densities in Fig.1 occurs so near to the centre of the Pleiades cluster. It may be that the step is due to interstellar obscuration. The ratio of the star numbers on opposite sides of the step together with an apparent luminosity function can be converted to the total photographic absorption A_{pg} . The higher the ratio, the larger the difference in obscuration between the two regions ; thus although the following calculations indicate that the difference in obscuration is higher for stars counted to $16^m.0$ than for the (on average) more distant stars counted to $21^m.5$, the actual obscuration may be much higher in the latter case. From the table of luminosity function due to Allen (p.235, 1963), it was found for the limiting magnitude $21^m.0$, that if the ratio of the star numbers is $2 : 1$, the difference in the obscuration would be of the order of one magnitude i.e. $A_{pg} = 1^m.0$. The ratio in Fig.1 is roughly 120/100 or $1.2 : 1$, or $(2)^{1/3.75} : 1$. Hence on this interpretation, the obscuration south of the cluster exceeds that due to north by

$$\Delta A_{pg} = \frac{1}{3.75} = 0^m.27$$

therefore, for limiting magnitude $21^m.5$, we have

$$\Delta(\text{colour-excess}) = \frac{\Delta A_{pg}}{4} = 0^m.07$$

Similarly the ratio in Fig.3 for east and west is 1.4 : 1 , or $(2)^{0.5}$: 1 , hence we get

$$\Delta A_{pg} = 0^m.5$$

or

$$\Delta(\text{colour-excess}) = \frac{\Delta A_{pg}}{4} = 0^m.12$$

For the limiting magnitude $16^m.0$, we find from the same table that if the ratio of star numbers is 2.2 : 1 , then $A_{pg} = 1^m.0$. In Fig.5 , the ratio is 1.7 : 1 , or $(2.2)^{0.66}$: 1 , therefore,

$$\Delta A_{pg} = 0^m.66$$

Hence for the limiting magnitude $16^m.0$, we have

$$\Delta(\text{colour-excess}) = \frac{\Delta A_{pg}}{4} = 0^m.16$$

These figures will be compared with the result of the three-colour photometry.

Three-colour photometry. (a) Introduction. The main purpose of the three-colour (UBV) photometry of the Pleiades region is to investigate the influence of the field stars on the colour-magnitude and two-colour diagrams ; in particular, to determine the distribution in colour and magnitude of field stars in the region of the cluster. Since the cluster members are supposed to be concentrated around Alcyone, a criterion is to be set up to choose a suitable size for the central region containing a large number of the cluster stars. This region will obviously contain field stars too. In order to investigate further the effect of these field stars in the central region, an equal area away from Alcyone containing nothing but field stars is to be measured.

(b) Choice of areas to be measured. To obtain the sizes of these areas the following considerations were taken into account.

From the General Catalogue of the Pleiades Region due to Hertzsprung (1947), the number of cluster members given by the proper motion criterion, and the total number of all stars, lying at distances within 5', 10', 15' etc. from Alcyone were

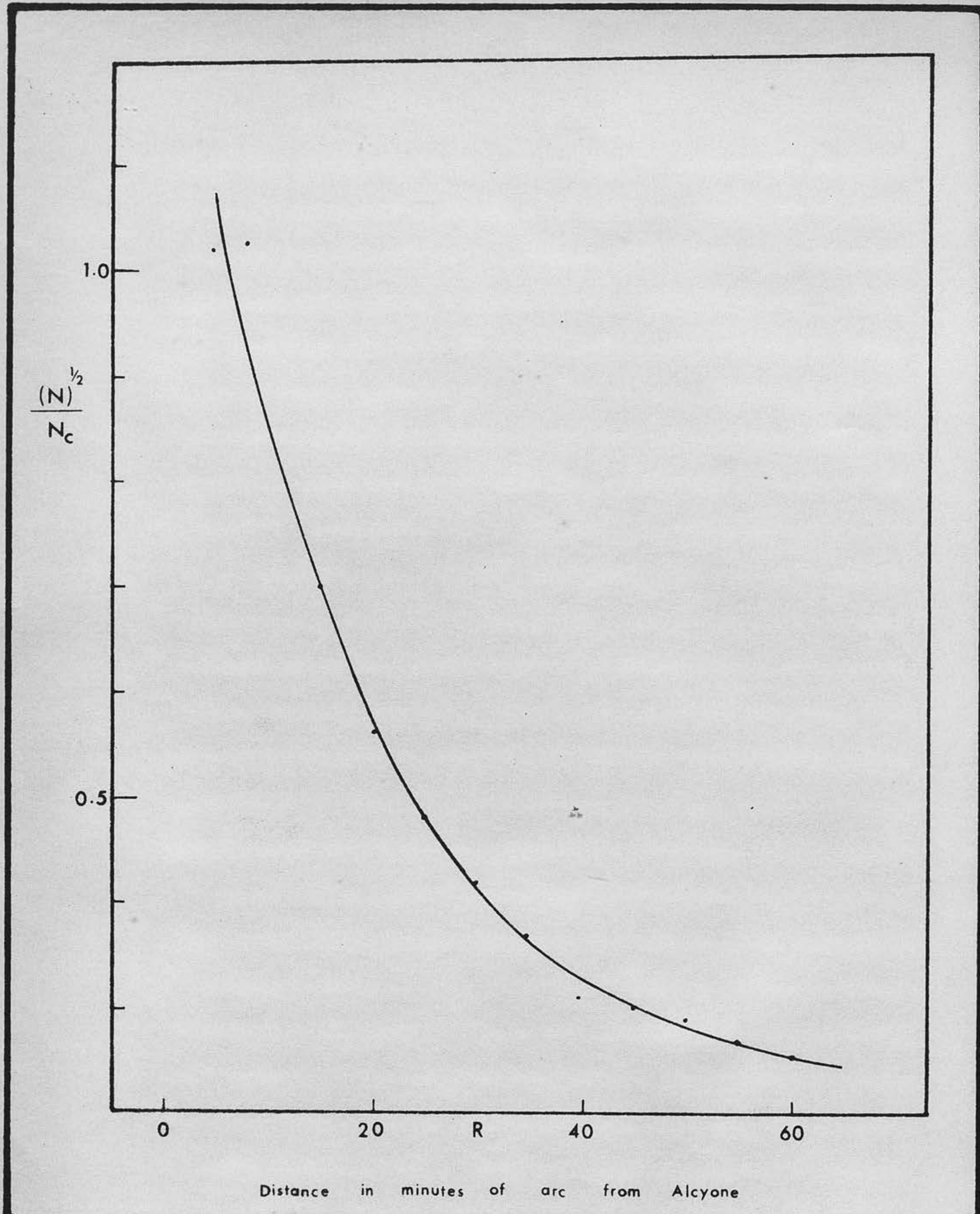

Fig. 8.- The proportionate error in counts of the number of cluster stars within r minutes of arc of Alcyone due to random variations in field star density.

counted. The ratios of the square root of the total numbers of stars to the number of cluster stars were plotted against their respective distances from Alcyone and the results are shown in Fig.8 . The limiting magnitude of Hertzsprung's Catalogue is approximatelythe same as the plates taken at the Edinburgh Schmidt telescope, namely $16^{m}.0$. It is clear from this figure that the proportinate error in the number of cluster stars N_c due to statistical uncertainty $(N)^{1/2}$ in the number of field stars reaches a minimum value for an area of radius 60' around Alcyone. An area of radius 40' is, however, little worse in this respect, and contains far fewer stars to be photometered. It was, therefore, chosen as the cluster region to be measured. The application of this criterion will provide optimum accuracy in the method of statistical subtraction of a comparison region.

An equal area has to be chosen away from Alcyone for inter-comparison of the colour-magnitude and two-colour diagrams. Star counts show (p.27) that there is a step in the surface density of field stars in the region of the Pleiades along a line running north-west to south-east. In order to avoid the step in the star densities occuring within the comparison region, two equal sectors were chosen north-east and south-west of the cluster (see Fig.1 of Introduction). The sum total of their areas is equal to the area of the central region. It was also hoped that this choice may, through comparison of each of the sectors with each other and with the Pleiades, solve the problem of where exactly the step occurs in relation to the cluster, and whether it is due to obscuration or a real change in the star densities.

All the stars in these chosen areas were included for measurement, thus avoiding the possibility of a selection effect being present. There are about 1775 stars in the central region and about 1400 stars in the two outer sectors.

The central region was further divided into two parts, one which is under the influence of nebulosity and the other which is comparatively free from it. The nebulous region is also marked in Fig.1 of Introduction. To mark its boundary, the following criterion was set up. Nearly fifty readings of the background fog on the Edinburgh plate No.136 were taken at different places in the non-nebulous central region. The mean was calculated and the standard deviation from this was derived. The plate was surveyed on the iris photometer and the boundary was marked where the background reading surpassed the mean plus one and half times the standard deviation value. The nebulous region contains nearly 560 stars. The entire field of Fig.1 of

Introduction is, therefore, divided into four sub-regions denoted as Nebulous Region, Circular Region, the Outer north-east and the Outer south-west Sectors.

(c) Observation and reduction. The field covered by the telescope is four degrees across on the photographic plate. The plates (which were square) and the filters used were :

Ultraviolet	U	IIaO + UG2 (2mm)	Two plates	Nos.144, 150.
Blue	B	IIaO + GG13(2mm)	Two plates	Nos.136, 149.
Yellow	V	IIaD + GG11(2mm)	Two plates	Nos.142, 148.

The photoelectric standards used for the calibration of the photographic plates were those of Johnson and Mitchell (1958). The nebulous region was reduced by standards occuring within the region only, while the central circular region and the two outer sectors used the standards for their reduction which were outside the nebulous region.

The plates were measured on the semi-automatic iris photometer (Fellgett and Seddon 1963), the 2×10^4 images being measured in five weeks of January and February 1963. The measurements were reduced on the Cambridge Edsac II computer

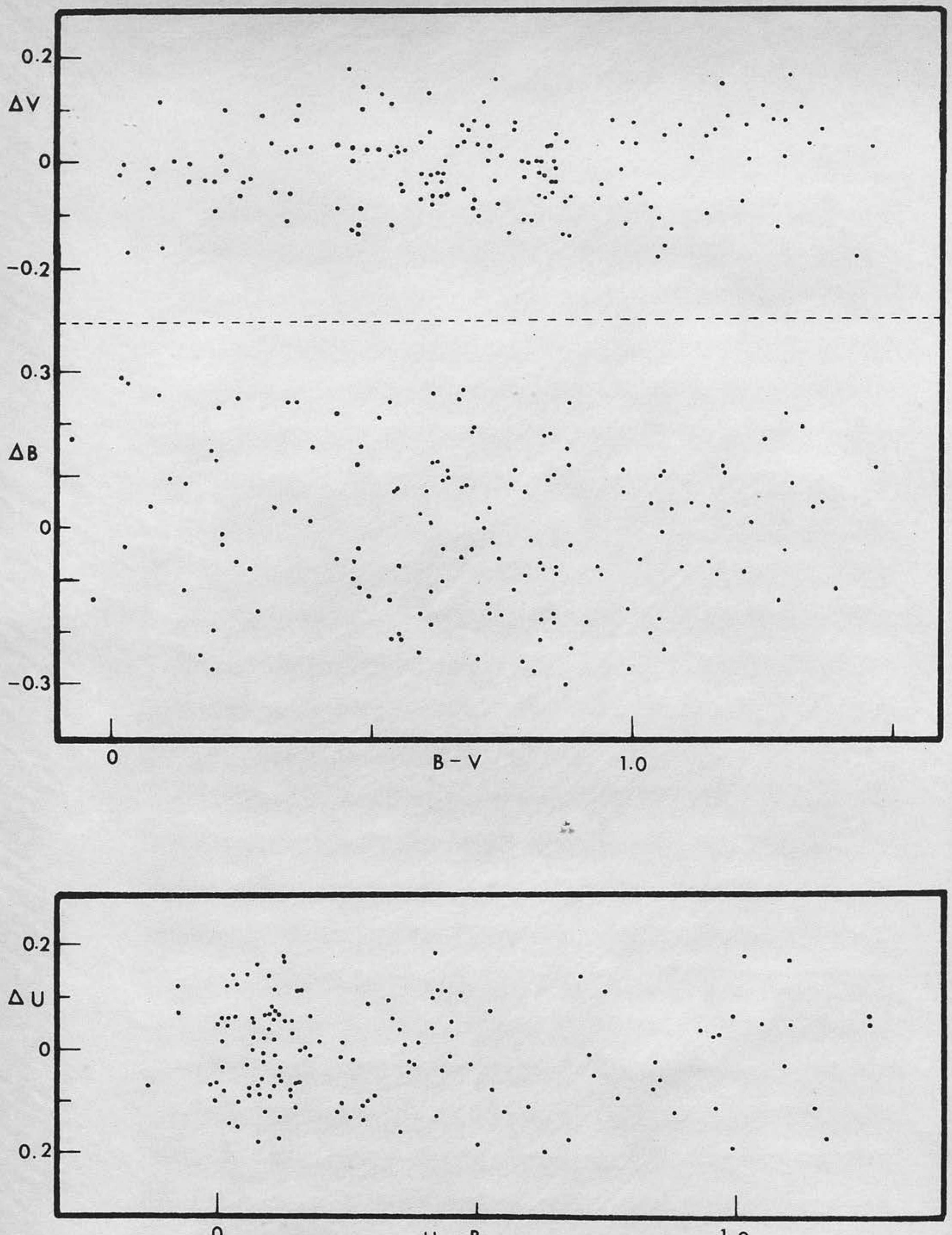

Fig. 9. - Magnitude differences 'standard - observed' against colour-index showing the absence of any colour equations.

using the program written by A.N. Argue (1961).

The reduced data was examined for colour and field corrections. Plots of ΔV, ΔB against B-V and ΔU against U-B for standard stars, where Δ signifies 'standard - observed', are shown in Fig.9 . These plots indicate that there is no colour equation, but when ΔV, ΔB and ΔU were plotted against the coordinates X and Y as shown in Figs.10 and 11 , a field error dependent on X for magnitudes B and U was detected. There was no field error dependent on Y . Measurements of the focus plates taken before, during and after the series of the Pleiades plates show that there was no plateholder tilt, this having been removed by earlier adjustments as described in Section III.

Photometry of focus plates and of plates taken on other regions (e.g. Cygnus II) showed no detectable field errors. It was, therefore, suspected that the field errors apparent in Fig.10 are the result of variations in background fog caused by the Pleiades nebulosity. This reflection nebulosity is illuminated by B-type stars and is essentially blue : it shows up most strongly on B-plates , less strongly on U- plates and hardly at all on V-plates . This is consistent with the amplitudes of the errors in Fig.10 . Further support is given

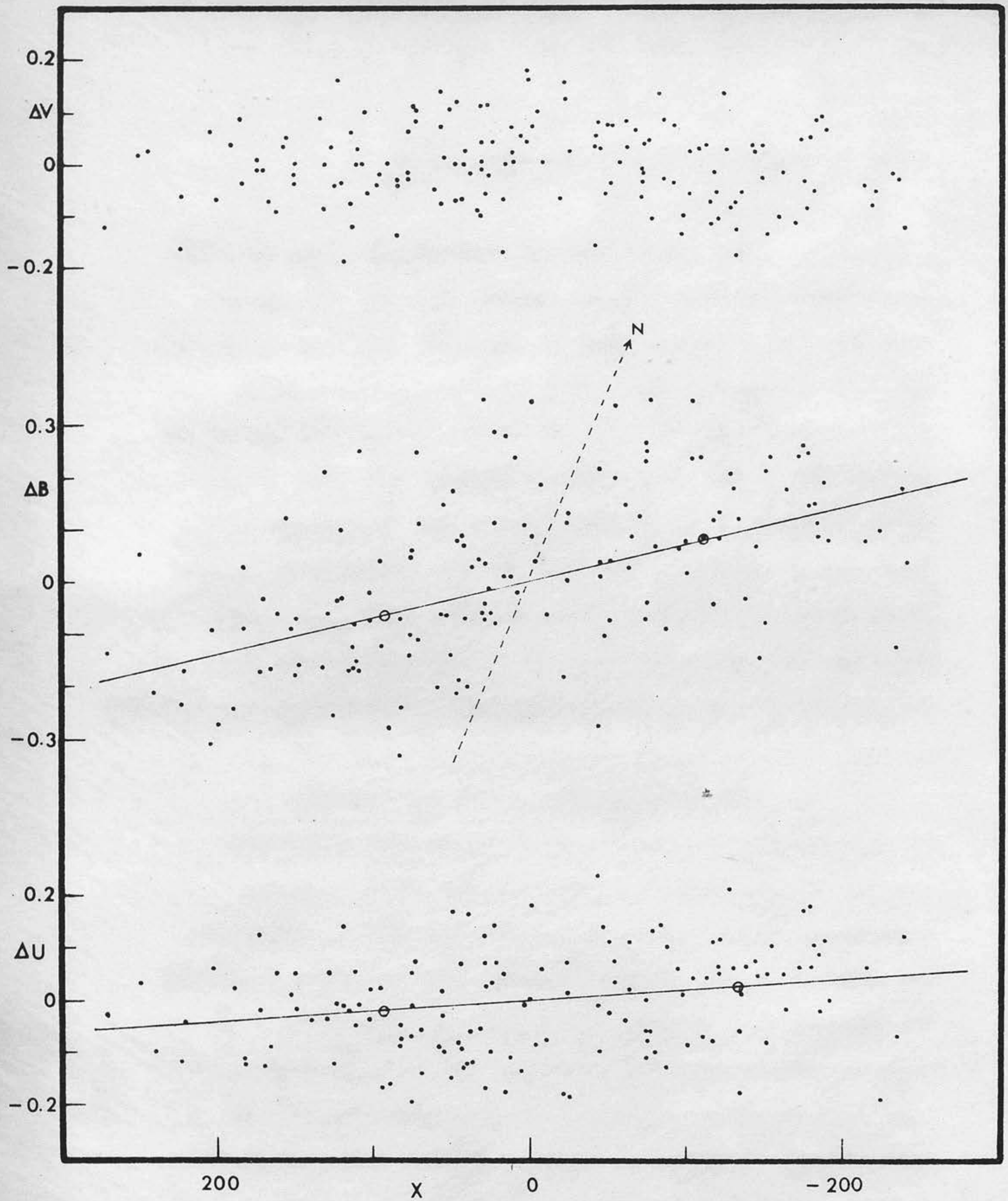

Fig.10. - Deviation in magnitude as a function of position along x-axis shows field error in B and U magnitudes.

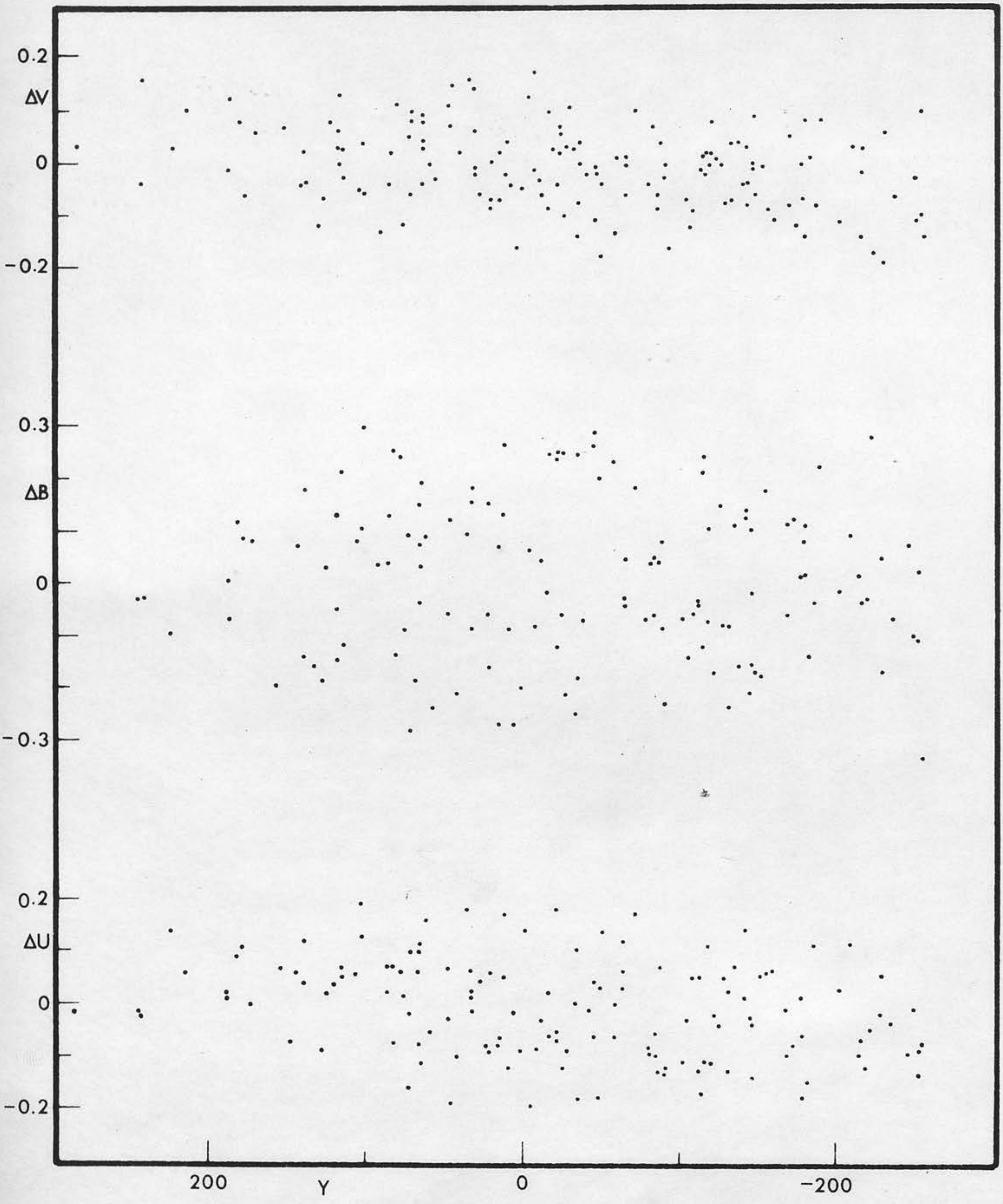

Fig. 11. - Deviation in magnitude as a function of position along y- axix shows no significant field error.

to the supposition by the fact that errors of plate No.136 are well correlated with those of plate No.149 , and the errors of the U-plates are correlated with those of the B-plates. Because of the importance of photometric errors in a number of Schmidt telescope programs, a wider investigation into the effect of nebulous fog was undertaken jointly with L.C. Lawrence and V.C. Reddish.

The investigation was concerned with two factors : the measurement of background fog in the region of star images, and the dependence on background fog of errors of magnitudes derived from iris photometer readings. Four regions were considered ; Pleiades, Praesepe, Cygnus and Orion. There is no significant nebulosity in the region of Praesepe and no systematic field errors exceeding $0^m.02$; the standard deviation of magnitude measures on a single plate, derived from measurement of the dispersion about a mean curve through a plot of iris reading versus photoelectric standard magnitude, varies from $\pm 0^m.06$ for fine grain process emulsion (Ilford R40) to $\pm 0^m.09$ for courser grain fast emulsions (Ilford SRO, astro-zenith ; Kodak IIaO, IIaD). In the case of Cygnus, the measures were of standard stars in the association Cygnus II and in the cluster NGC 6910 which is 3^o away. Although nebulosity is visible in the region of the cluster on the Mount Palomar E-charts, it is primarily $H\alpha$ emission and does not appear at all on our own Schmidt plates. Again no field errors were detected. In Orion, the reflection nebulosity is illuminated by early type stars, and as in the case of the Pleiades the effect of the nebulous fog appears most strongly on the B-plates. The errors in the B-magnitudes are correspondingly large, and correlated with the nebulous fog density.

On a part of the plate where nebulosity produces high fog level, the star images are also enlarged at any given photographic density. The photometer iris, therefore, opens wider to allow a given amount of light through and around the image. The magnitude thus measured is brighter than it should be. This effect can be seen clearly on Fig.14 where iris readings of a number of standard stars in the Pleiades are plotted against their photoelectric B-magnitudes. From an examination of the Palomar O-chart of this region, which shows nebulosity to fainter limits than do our own plates, those standards occuring in regions free of nebulosity were noted, and are marked by circled crosses on Fig.14 . They are seen to lie along the lower envelope of the iris readings, as expected, and their dispersion is small. This envelope curve is, consequently, the correct calibration curve to use for reducing iris measures of stars in non-nebulous regions of the plate, such as the outer comparison sectors of the Pleiades field shown in Fig.1 of the Introduction.

The nebulous fog in the Pleiades increases from east to west over the region within which the standard stars are found, and it is this correlation of nebulous fog with the X-coordinate which produces the field errors shown in Fig.10 . Within the circular and nebulous regions, therefore, corrections given by the mean lines in Fig.10 have been applied to the magnitudes reduced on the Edsac II computer. The corrected magnitudes and colours thus obtained are given in Appendix I .

The effect of nebulous fog is more pronounced within the image, where it is added to the star light and acts at higher contrast, than outside the image ; furthermore the iris closes to a small area on the background fog outside the image and the effect of graininess therefore produces large errors in the background fog reading. This may be overcome in the case of the Becker photometer by inserting a neutral filter in the signal beam after the viewing optics, so causing the iris to open much wider, to a reading of say 500 instead of the usual 50, and thus measuring the fog over an area a hundred times larger, and reducing the effect of grain 'noise' by a factor ten.

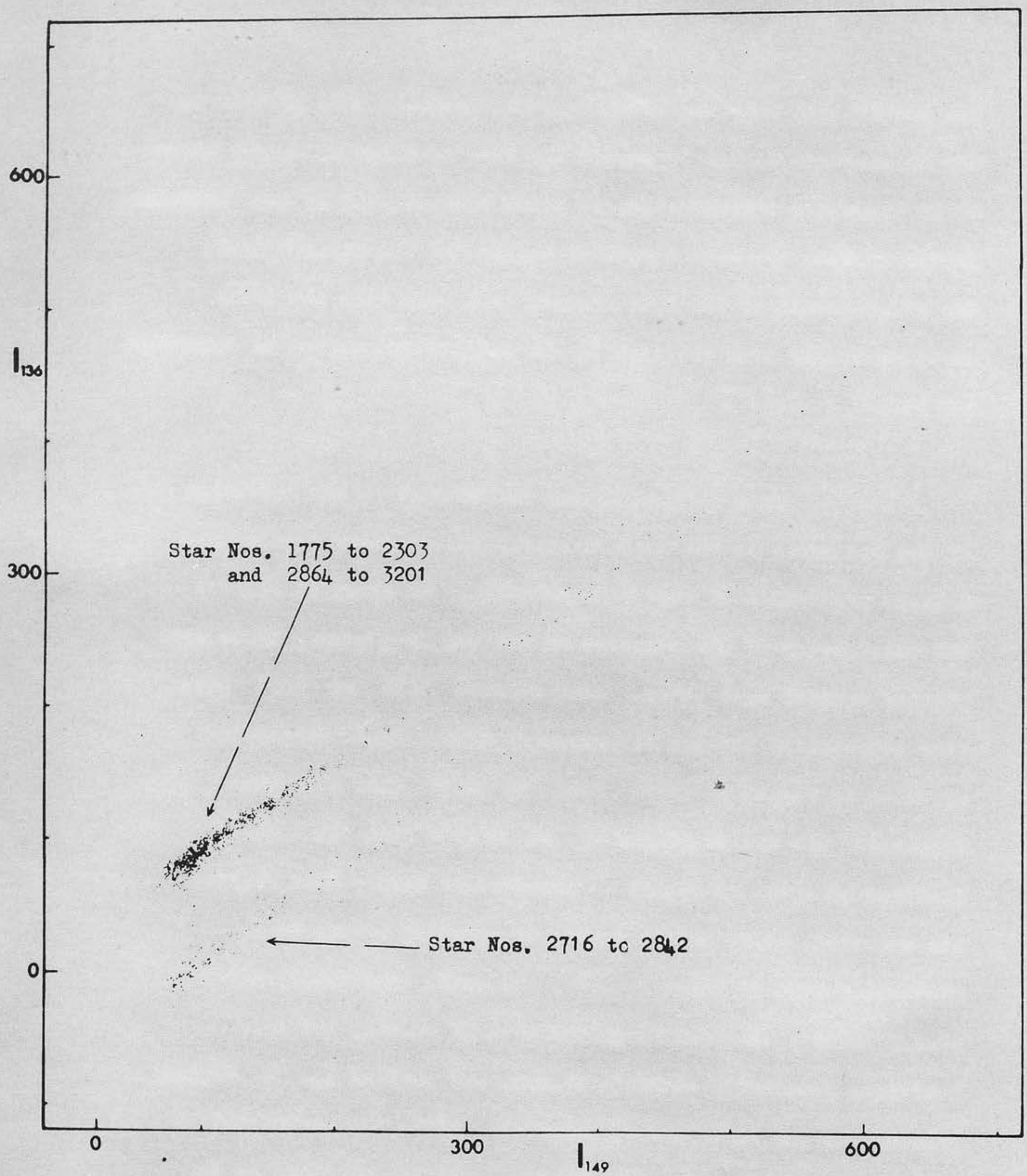

Fig. 12. - Comparison between iris measures of plate Nos. 136 and 149. The lower dots indicate the shift in the iris measures as mentioned in the text.

The possibility that the background fog readings made in this way may be accurate enough to enable the iris readings of nearby stars to be corrected individually, is being investigated by L.C. Lawrence. At the moment, the most sensitive measure of fog appears to be the displacement of the iris reading on a star from the lower envelope of the iris readings on the calibration curves as described for Fig.14 .

Some difficulty was encountered in the reduction of the two areas in the outer sectors, the computer rejecting a large proportion of the B-magnitudes . In order to examine the consistency of the measures on the two B-plates , these were plotted against each other. Star numbers 1775 to 2303 show good correlation between the measures with a small dispersion as shown in Fig.12 . Stars 2304 to 2715 show a larger dispersion and are displaced by 10 digits from the earlier readings as shown in Fig.13 . Immediately before Star No.2716 was measured, there were a number of punching errors on the photometer tape of plate No.136 , and again immediately after star No.2842 . Between these two sets of errors, the iris readings, presumably of plate No.136, are shifted by 80 digits relative to the first set of measures. After the second set of errors, the relationship between the first set of measures is

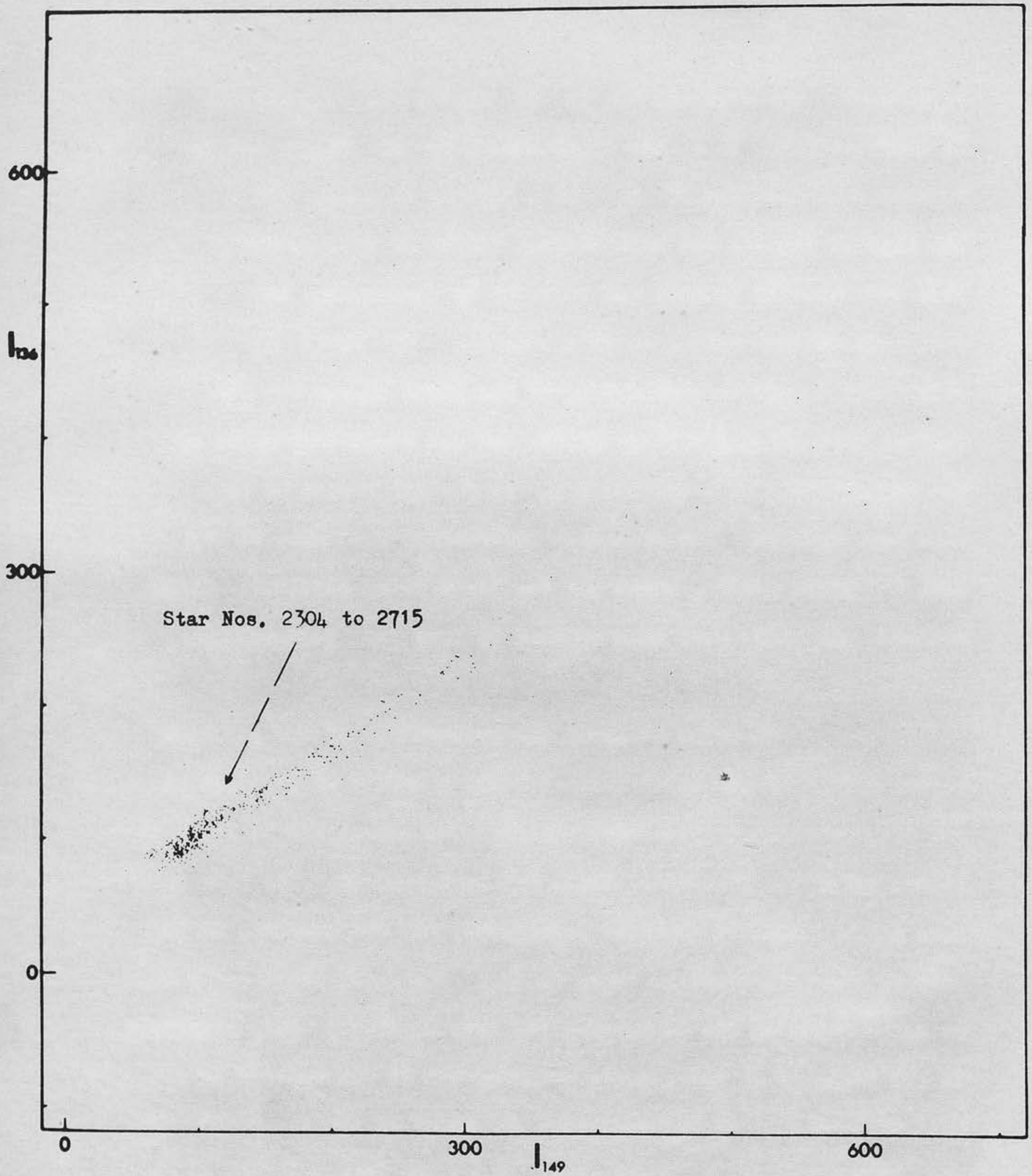

Fig. 13. - The comparison between the iris measures of plate Nos. 136 and 149 indicates the dispersion caused by fault in the digitiser of the photometer.

reproduced. The displacement by 10 digits was probably due to over-carrying 10 ; the displacement by 80 digits due to further over-carrying of 10 and a failure to carry 100 . The digital display had been showing faults of this nature ; they were usually noticed and overcome by re-zeroing, but evidently escaped notice on this occasion. The fault was ultimately traced to overheating of the power supply for the digital unit causing voltage drift, and was completely cured by the installation of a cooling fan. No further errors of this kind have occured. The necessary corrections were made to the data for plate No136 , which was the first to be measured. Plate Nos.136 and 149 were then reduced by hand for B-magnitudes .

In order to avoid the possibility of the punching errors affecting the calibration curves, a number of standard stars and of program stars in the outer sectors were remeasured on these two plates after the photometer fault had been removed. The iris readings were plotted against standard magnitudes, and the envelope on the side of low iris readings drawn (note : the calibration curve must be assymptotic to the background fog iris reading ; this condition is not included in Mr. Argue's program, but it was applied to the hand reductions. It may influence the shape of the lower end of the calibration curve, particularly where any extrapolation is

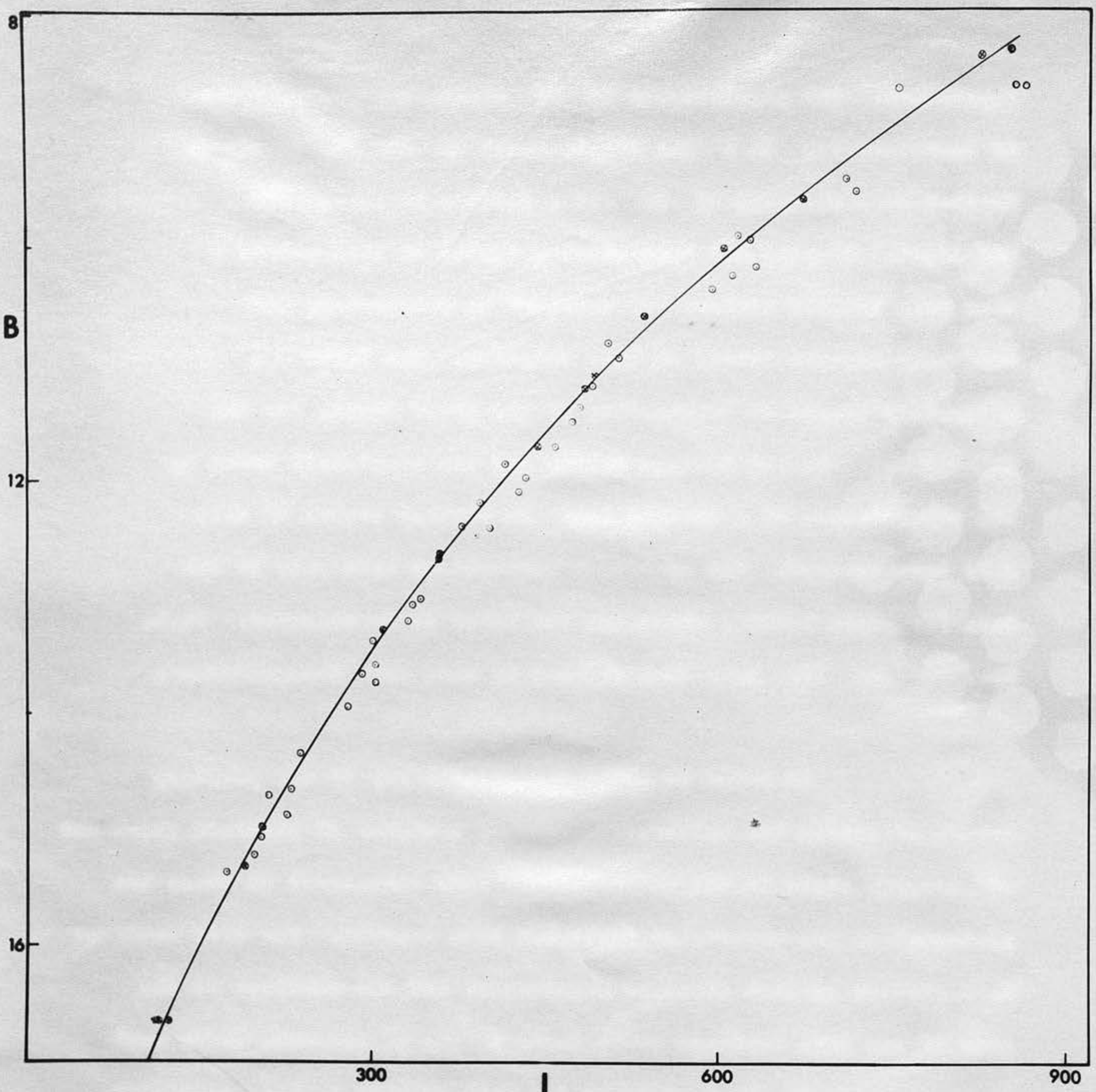

Fig. 14. - The primary calibration curve obtained for B-magnitudes for plate No.149 in the manner described in the text. Circled crosses are standards in regions clearly free from nebulosity.

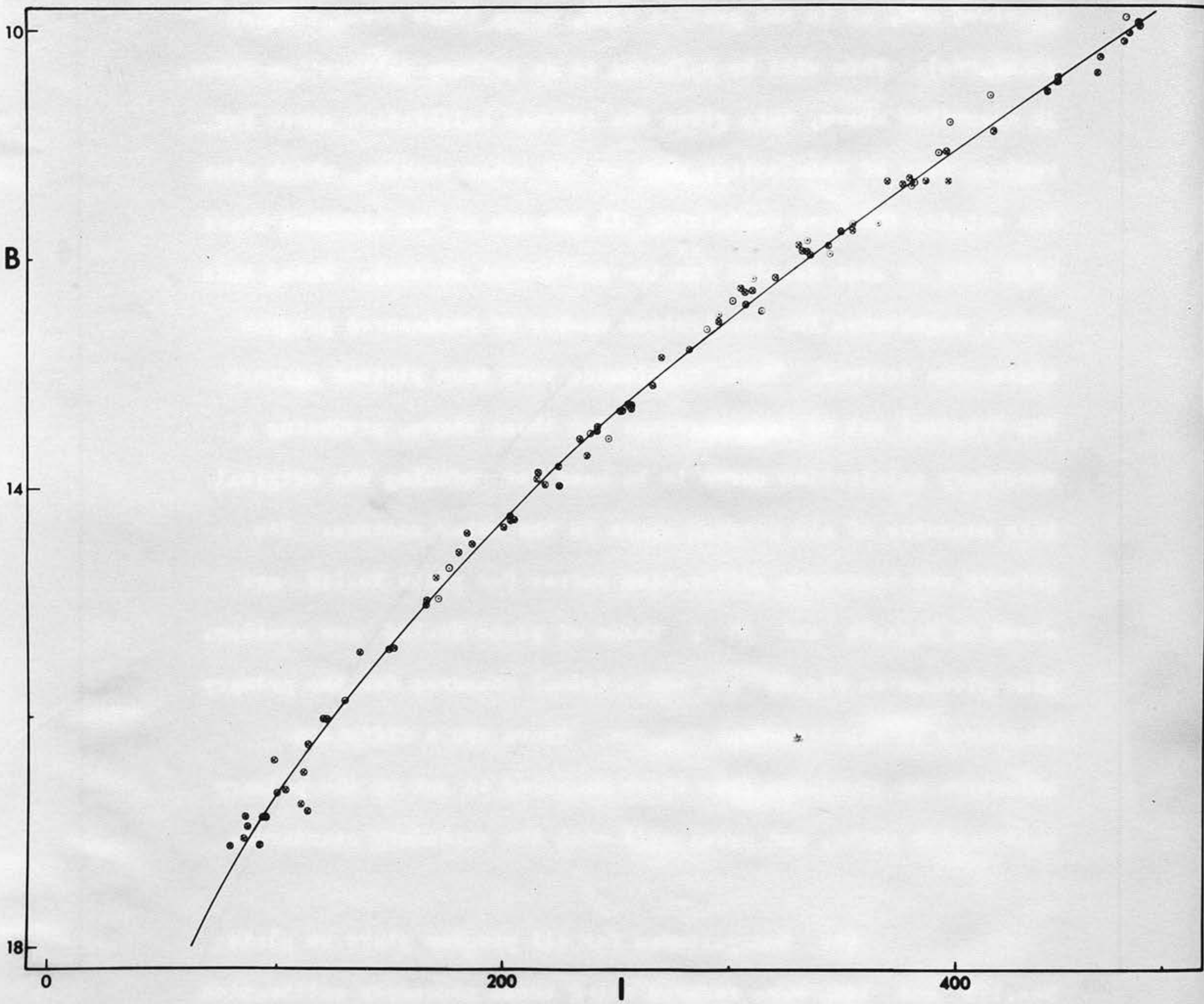

Fig. 15. - The secondary calibration curve for B-magnitudes for plate No.149. Circled crosses, secondary standards. Open circles, primary standards in regions clearly free from nebulosity.

involved and, as in the present case, where there are few faint standards). This will be referred to as primary calibration curve. As described above, this gives the correct calibration curve for regions free of nebulosity, such as the outer sectors, which also lie outside the area containing all but one of the standard stars (H II 3122 or star No.2320 is in the north-east sector). Using this curve, magnitudes for the limited number of remeasured program stars were derived. These magnitudes were then plotted against the original set of iris readings for these stars, producing a secondary calibration curve to be used for reducing the original iris measures of all program stars in the outer sectors. The primary and secondary calibration curves for plate No.149 are shown in Figs.14 and 15 ; those of plate No.136 are similar. Also plotted on Fig.14 are the original measures for the primary standards in nebulous-free regions. There are a different selection of standards from those measured to set up the primary calibration curve, and agree well with the secondary standards.

The B-magnitudes for all program stars on plate Nos.136 and 149 were reduced using these secondary calibration curves, averaged, and together with the V and U magnitudes reduced by the computer (using standards well outside the nebulous region), gave the magnitudes and colours for the outer sectors listed in Appendix I .

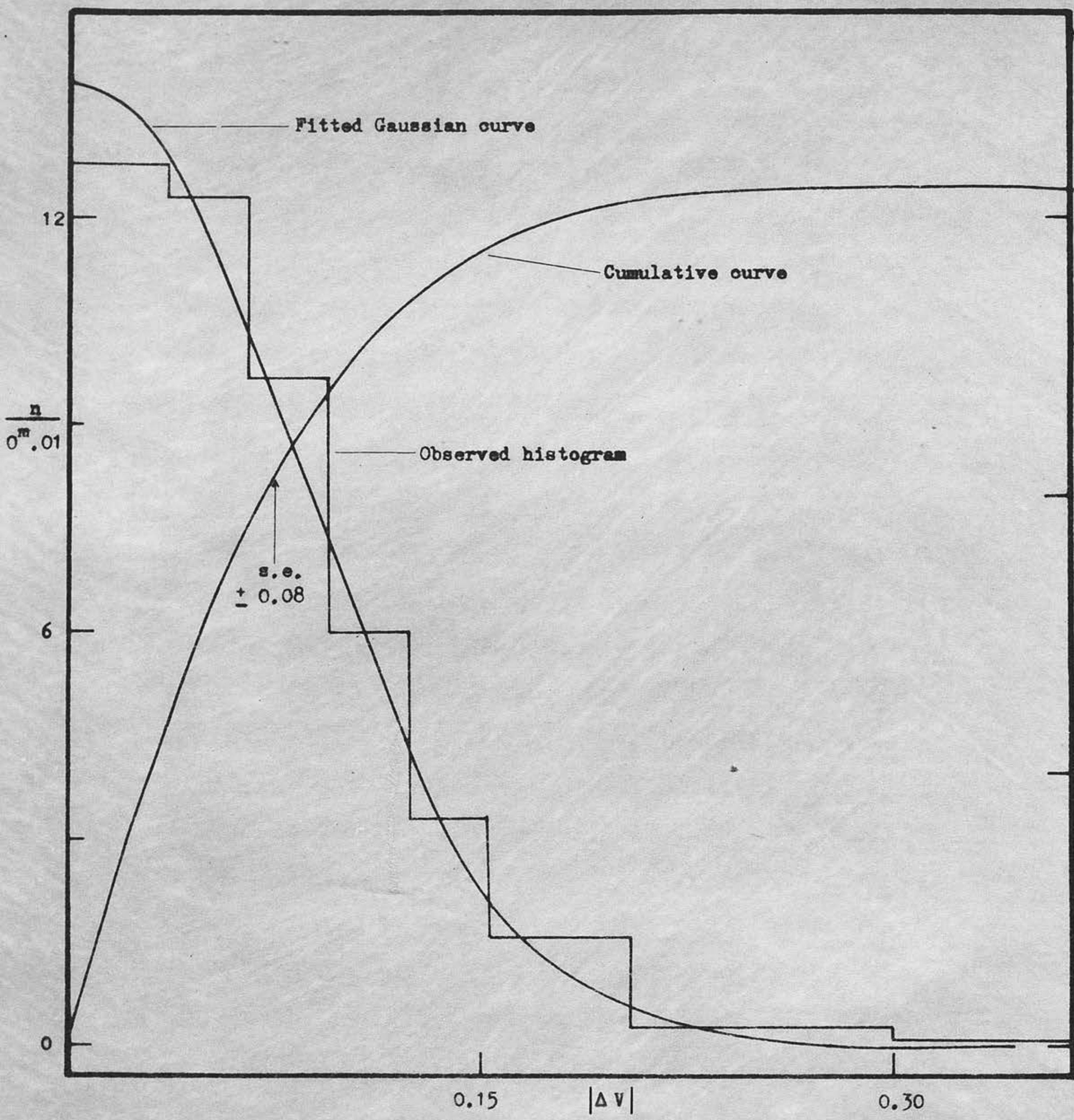

Fig. 16. - Histogram of errors in V .

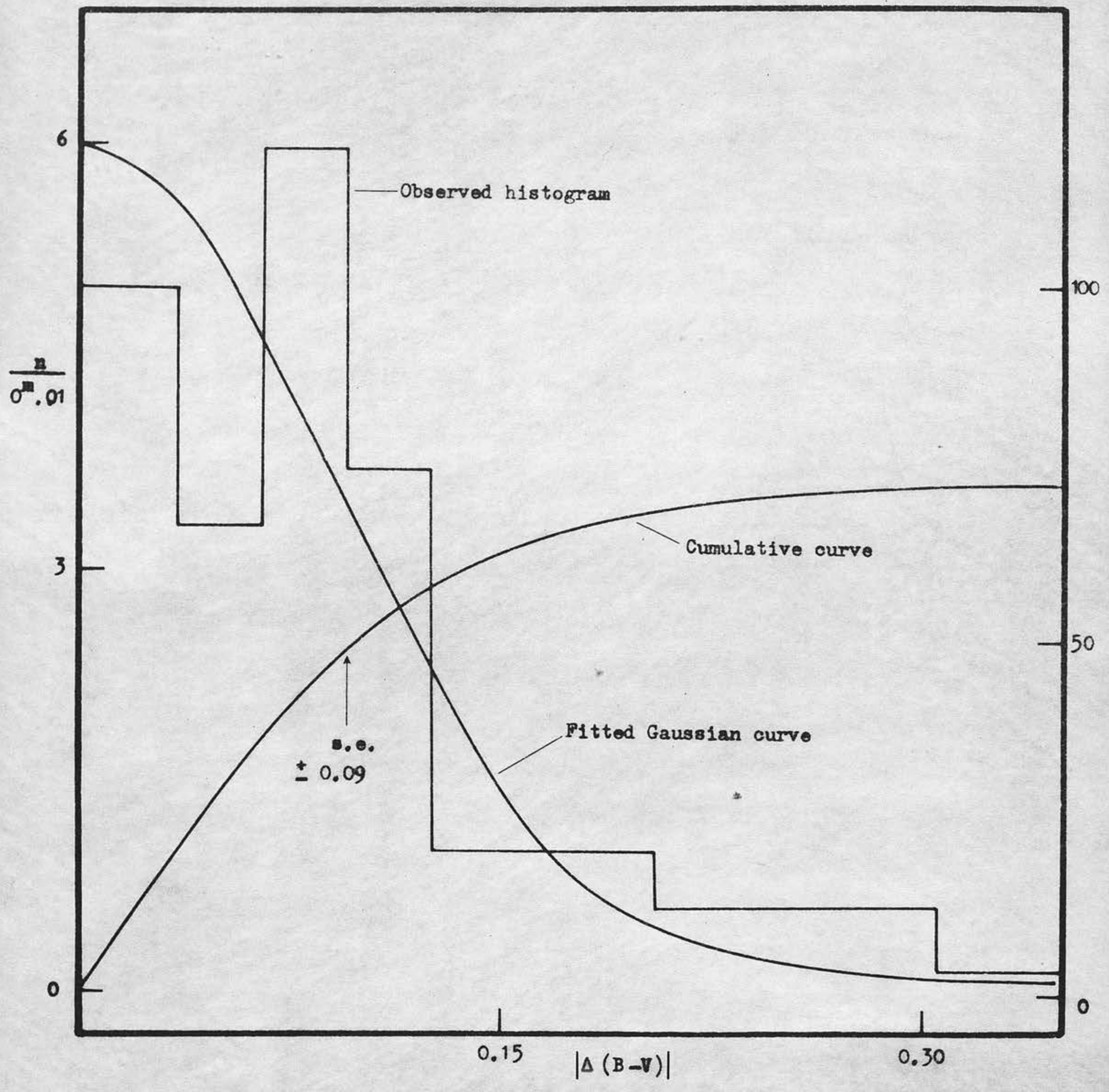

Fig. 17. - Histogram of errors in (B-V).

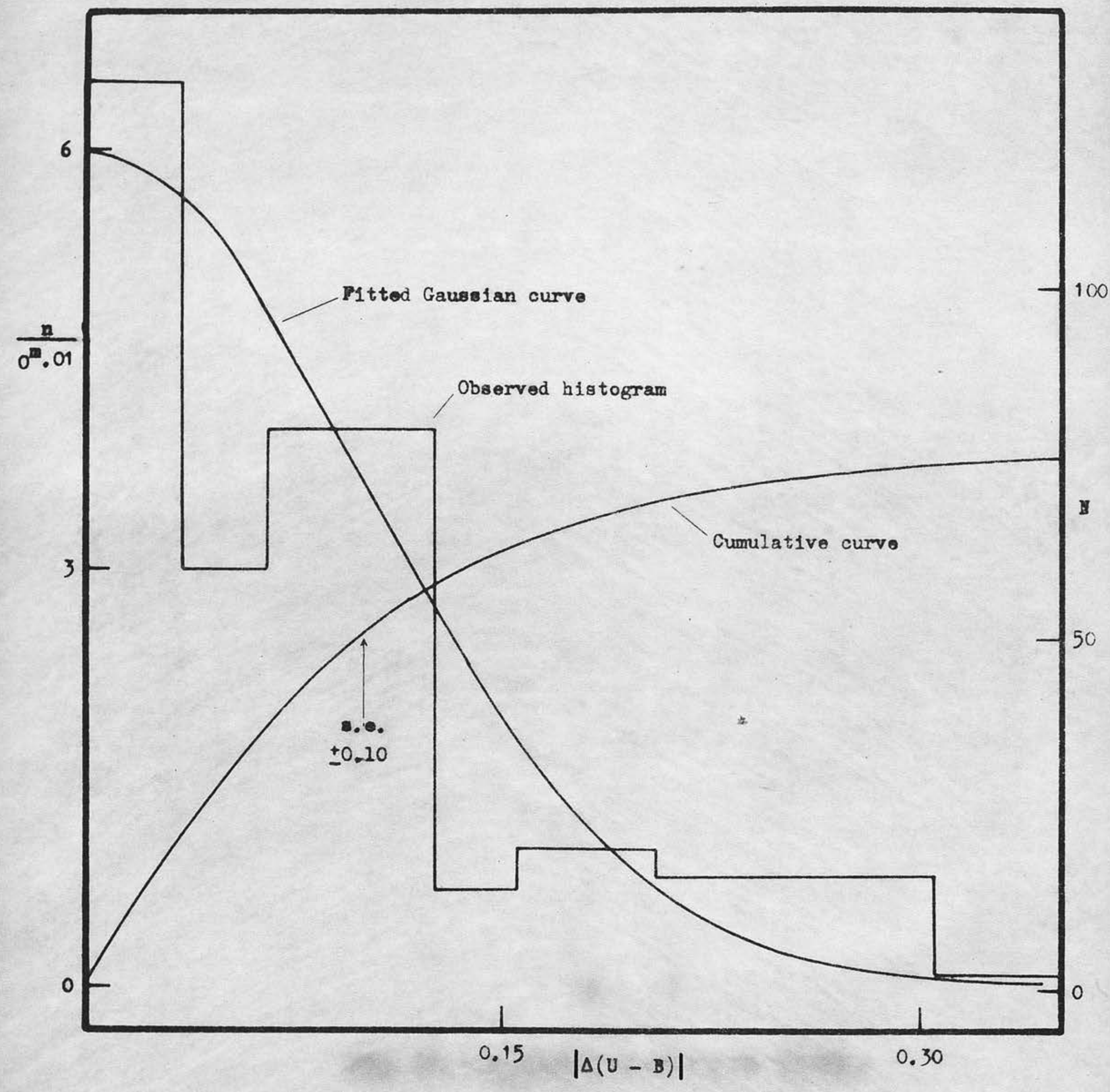

Fig. 18. - Histogram of errors in (U-B) .

d) Errors. The distributions of the errors of measurement of the computer reduced magnitudes and colours of the standard stars in the nebulous and circular regions are given in Figs.16, 17 and 18. $|\Delta|$ signifies 'standard - observed' for the algebraic considered. The average standard error in each case has been derived from a best fitting Gaussian curve, and also from the cumulative error curve. The errors thus found are $\pm\ 0^m.08$ in V, $\pm\ 0^m.09$ in B-V, and $\pm\ 0^m.10$ in U-B. These also give the errors of the computer reduced V and U magnitudes in the outer sectors.

The errors of the hand reduced B-magnitudes in the outer sectors have been estimated in two ways. The dispersion of the points on Fig.12 (after corrections for systematic errors found) corresponds to $\pm\ 3$ digits in the iris measures on each plate. The corresponding errors in magnitude may be obtained from this by using the slope of Fig.14 at any given magnitude. Dividing by $(2)^{1/2}$ gives the errors of the mean magnitudes derived from two plates as follows ; $10 < B < 13$, $\pm\ 0^m.06$; $13 < B < 15$, $\pm\ 0^m.09$; $15 < B < 16$, $\pm\ 0^m.11$; $16 < B < 17$, $\pm\ 0^m.13$. Bearing in mind the fact that the secondary standards have similar errors, the errors have also been estimated from the dispersion of the points about the secondary calibration curves ; the values so obtained agree with those given above. The average

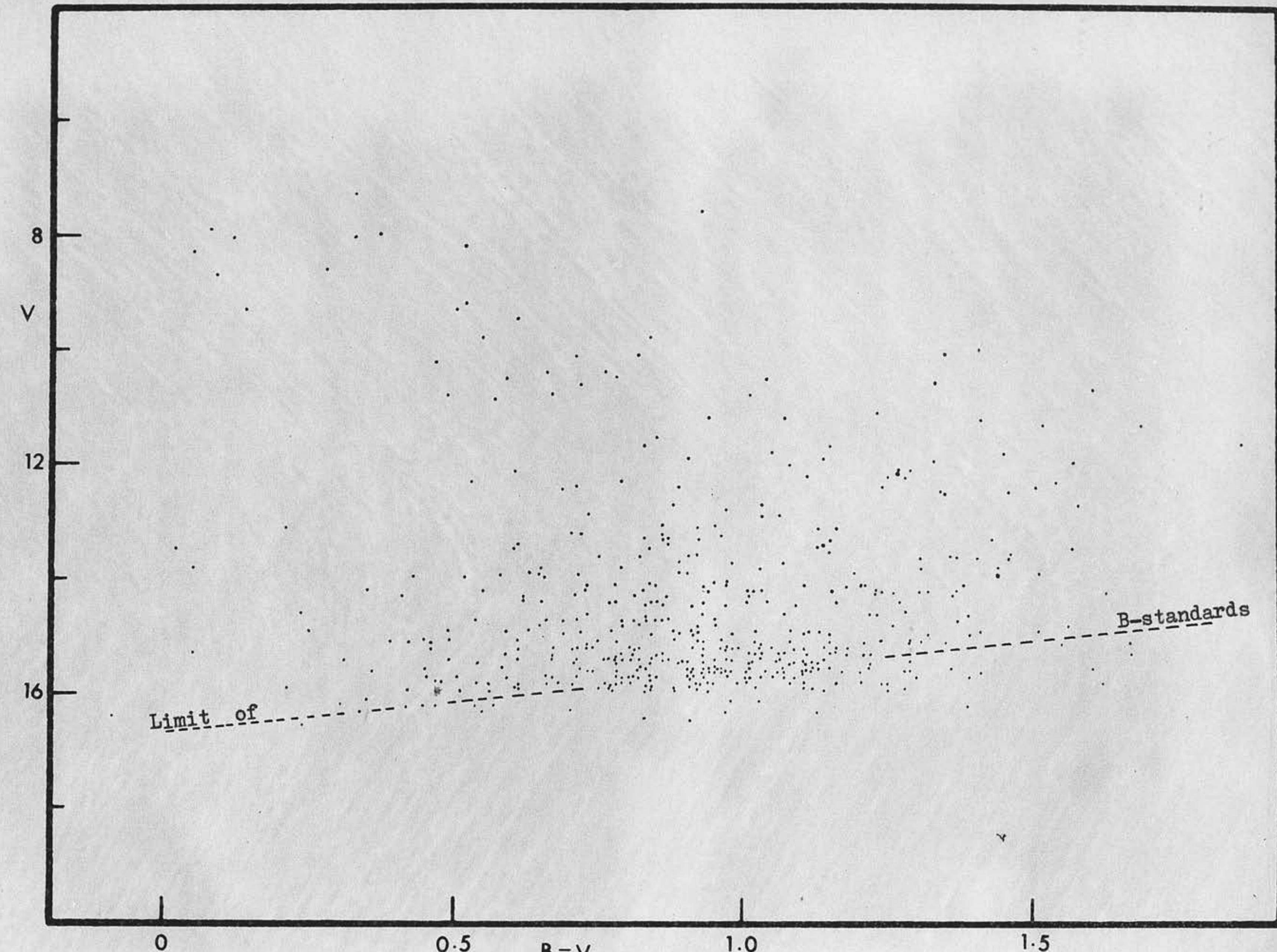

Fig. 19. - The colour-magnitude diagram of the nebulous region of the Pleiades.

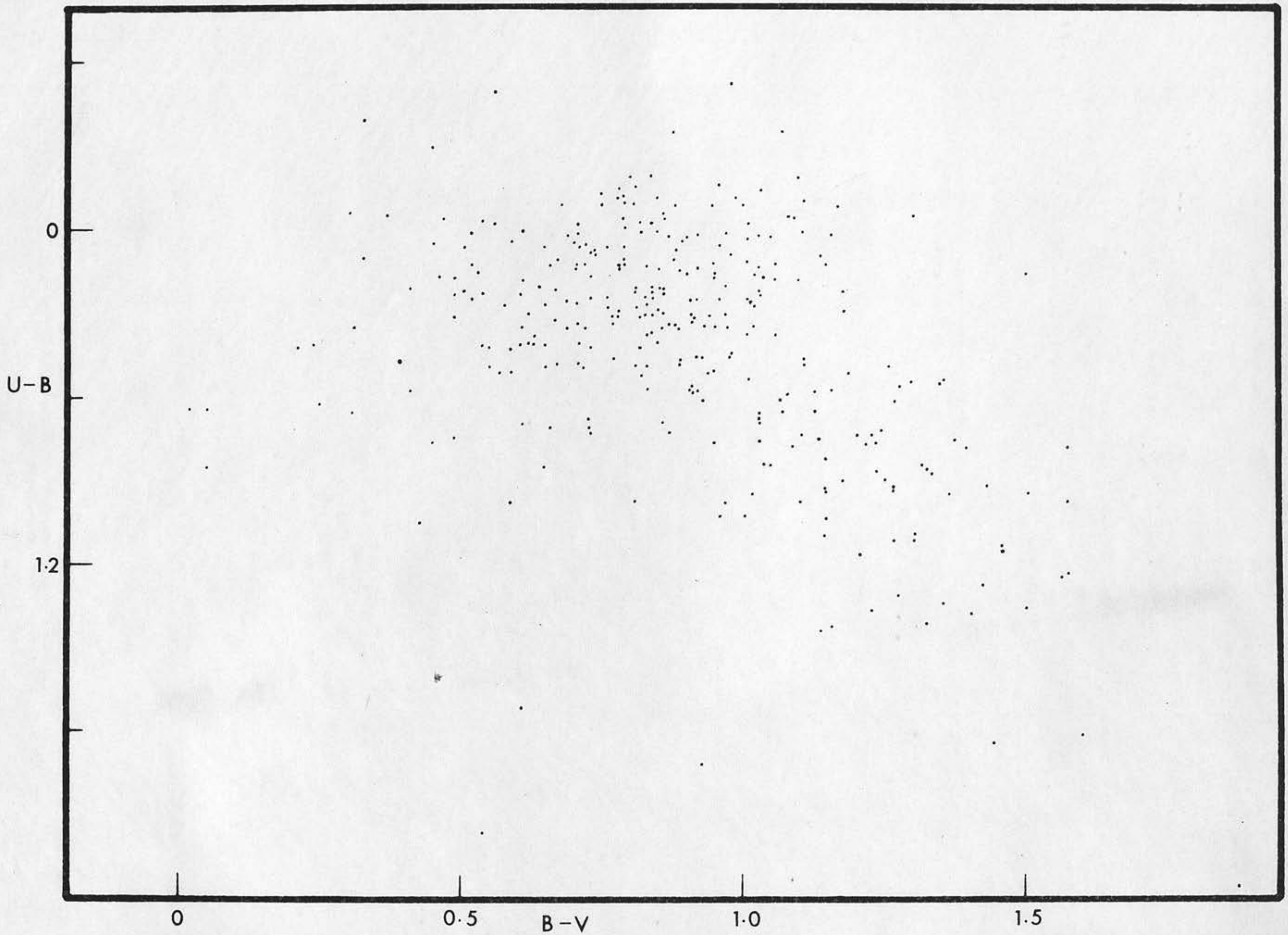

Fig. 20. - The two-colour plot of the nebulous region of the Pleiades.

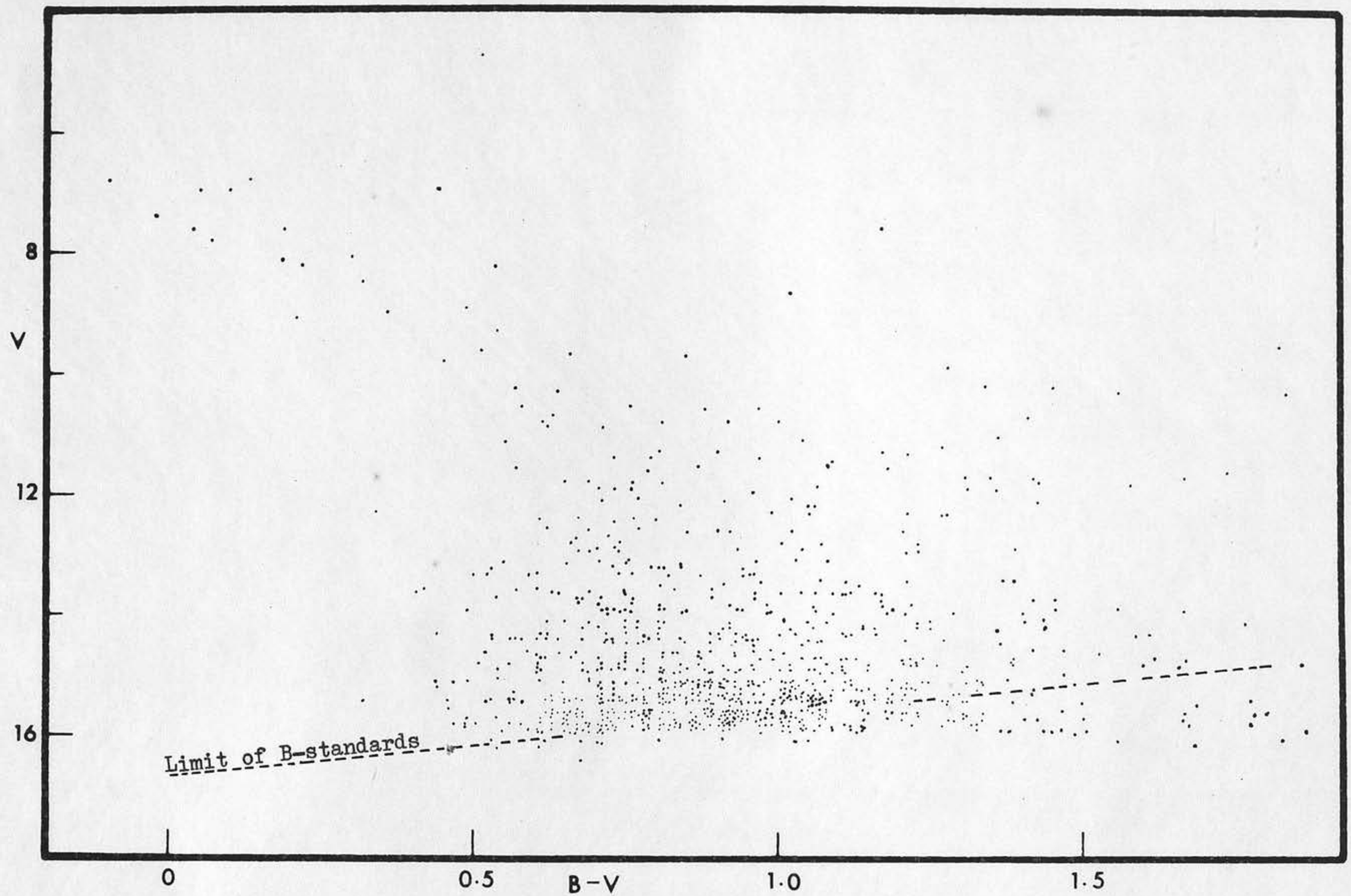

Fig. 21. - The colour-magnitude diagram of the circular region of the Pleiades.

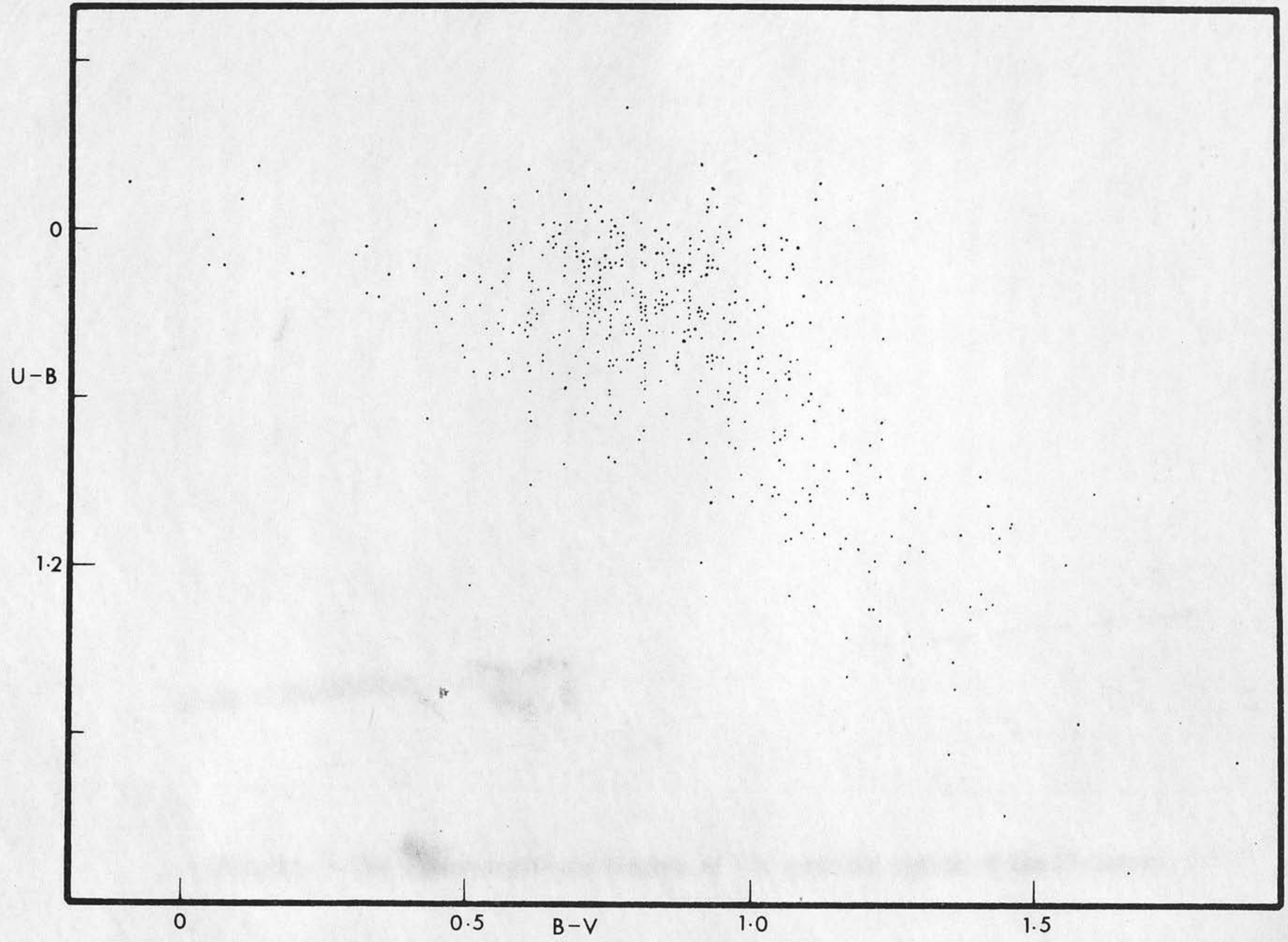

Fig. 22. - The two-colour plot of the circular region of the Pleiades.

errors for the outer sectors are thus $\pm 0^m.08$ in V , $\pm 0^m.13$ in B-V and $\pm 0^m.14$ in U-B .

(e) Discussion of results. In colour-magnitude diagrams the cluster members generally fall along the main sequence and in the red-giant region. In the Pleiades a large number of the members chosen, by Johnson and Mitchell (1958) from proper motion data of Hertzsprung (1947), fall in regions of the colour-magnitude diagram above and below the faint end of the main sequence where the cluster stars are not normally found (Herbig 1962).

Figs.19 , 20 , 21 and 22 show respectively the colour-magnitude and two-colour diagrams of the nebulous and circular regions which include all the stars (members as well as field). The results of the star counts discussed earlier for Figs.1 , 2 , 3 , 4 and 5 show that the vast majority of the points (90 percent or more) are field stars. In the colour-magnitude arrays of Figs.19 and 21 the distribution is closely similar to that of Herbig's (1962), the field stars lying below the main sequence. To examine further the view that the stars lying below the Pleiades main sequence are field stars, the colour-magnitude and two-colour diagrams of the outer north-east and south-west sectors containing only field stars are shown in

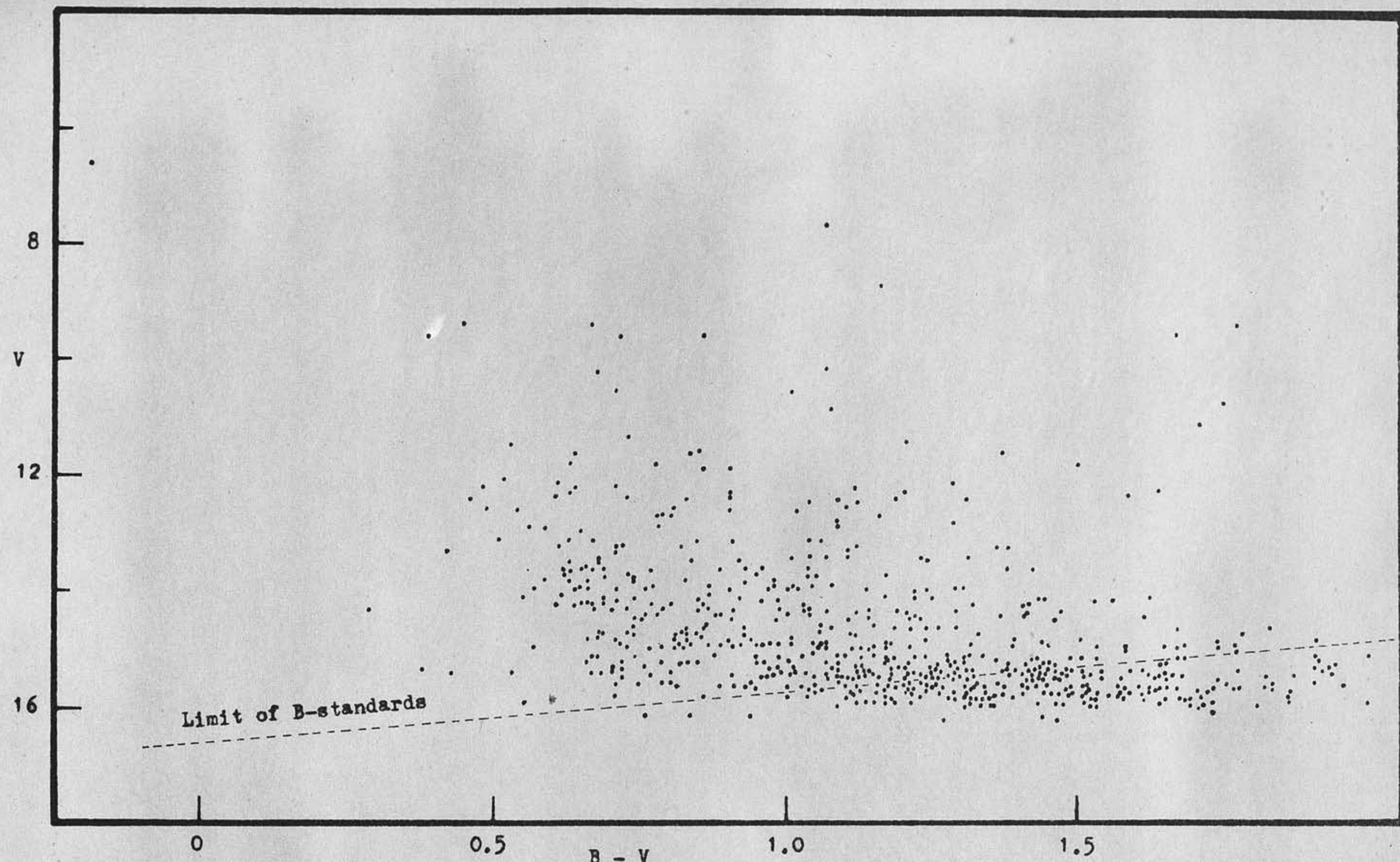

Fig. 23. - The colour-magnitude diagram of the outer north-east sector of the Pleiades region.

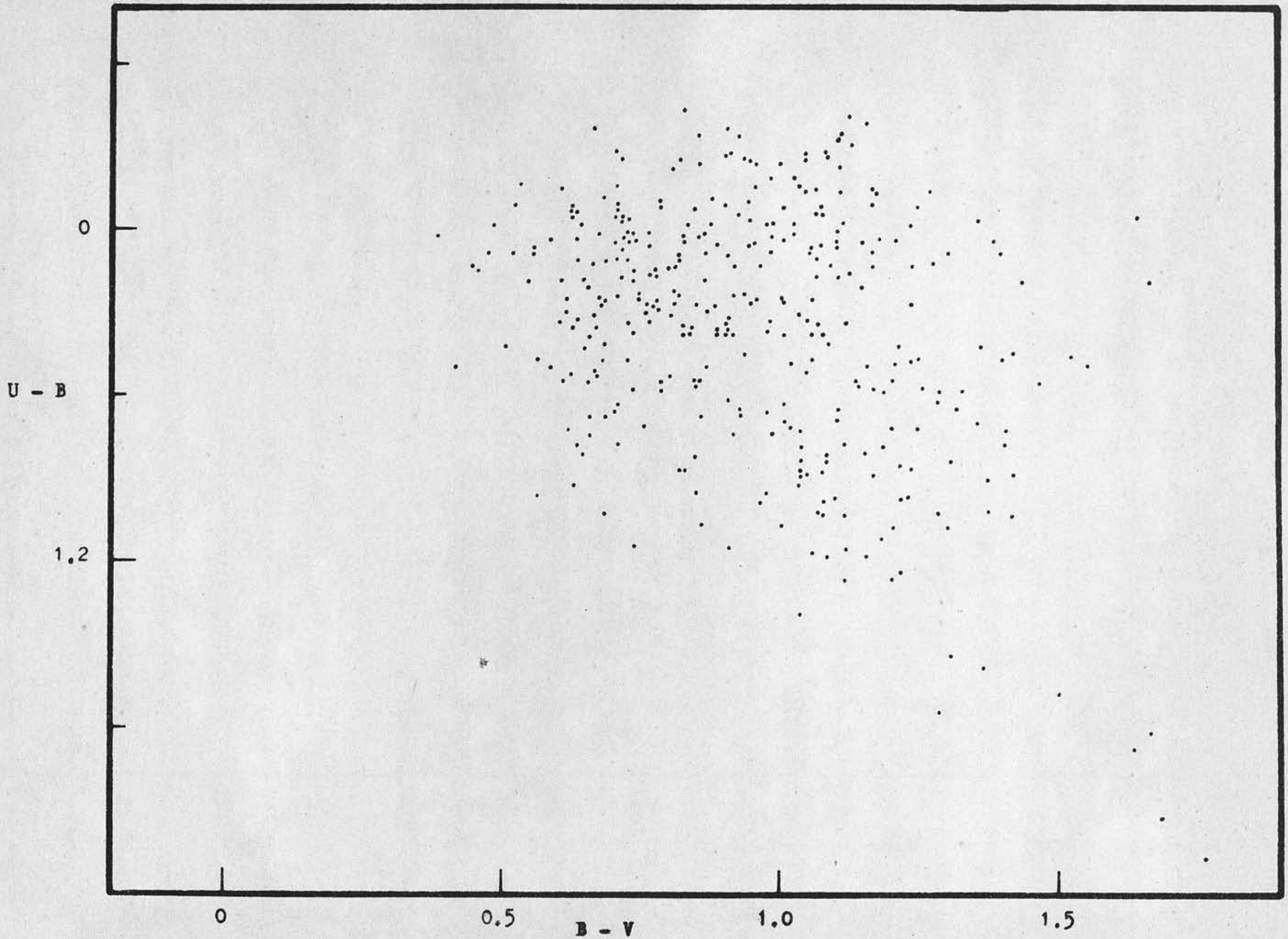

Fig. 24. - The two-colour plot of the outer north-east sector of the Pleiades region.

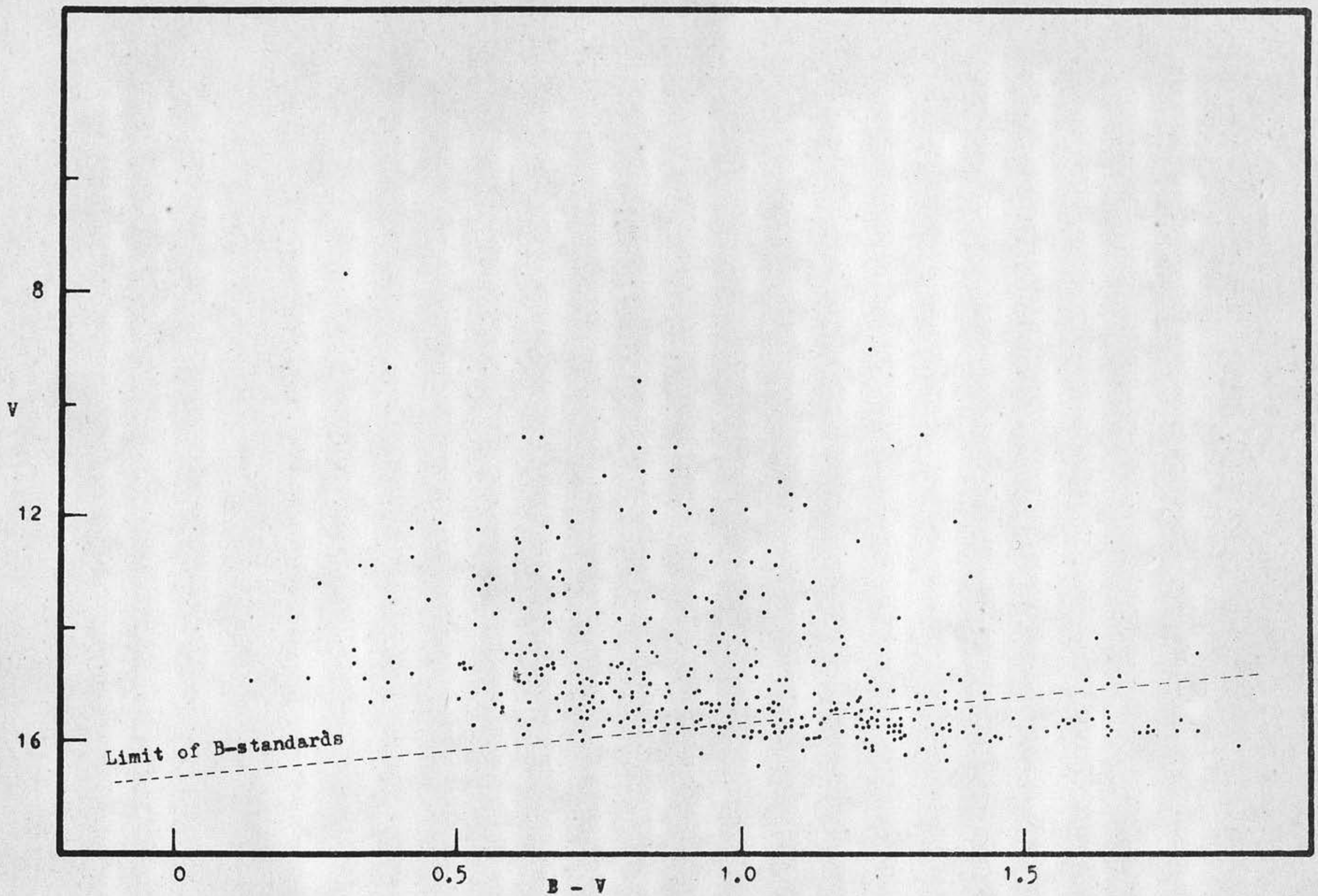

Fig. 25. - The colour-magnitude diagram of the outer south-west sector of the Pleiades region.

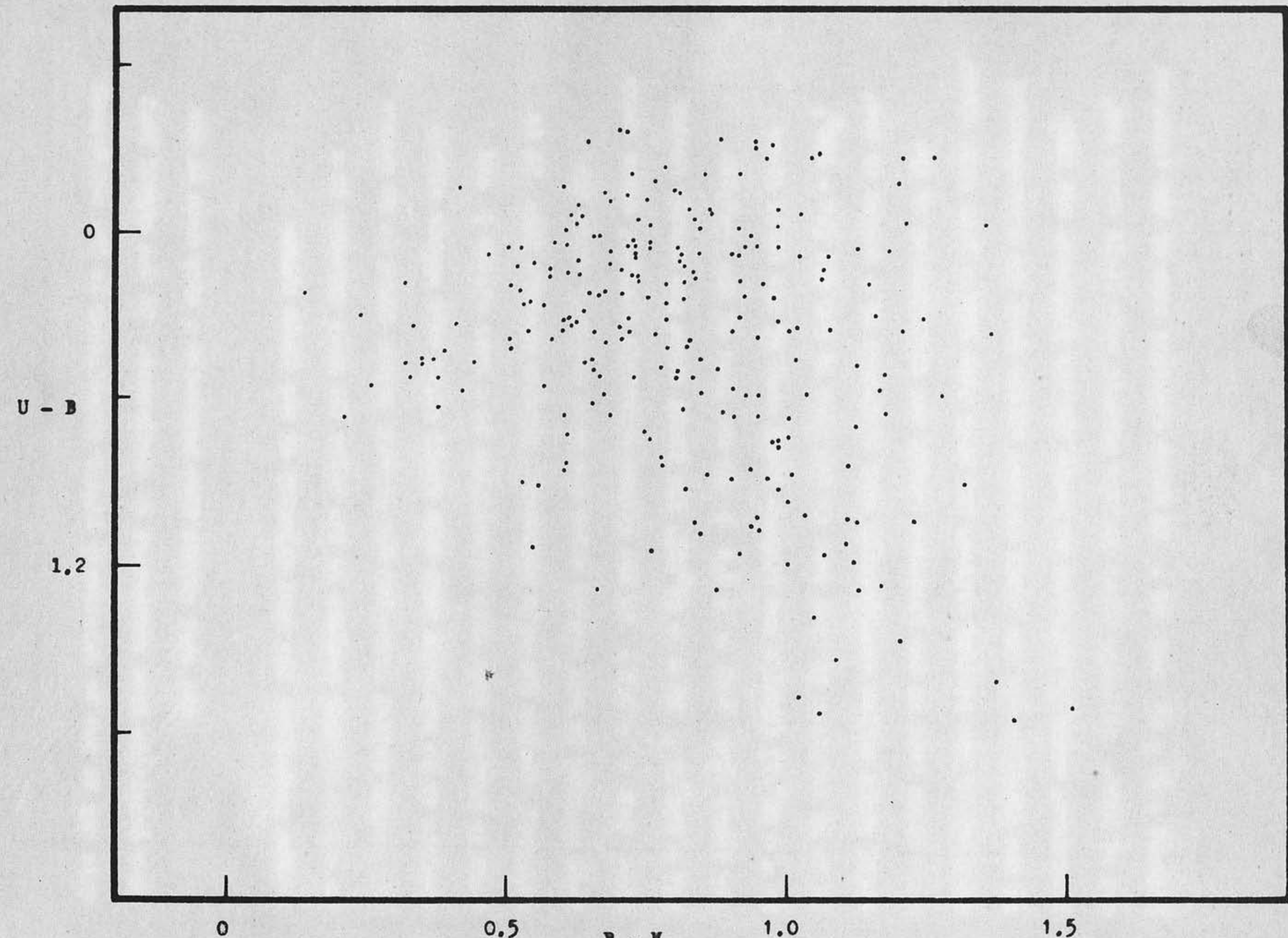

Fig. 26. - The two-colour plot of the outer south-west sector of the Pleiades region.

Figs.23 , 24 , 25 and 26 . In these diagrams some of the features are of note. Although these sectors contain only field stars and, therefore, would be expected to yield similar diagrams, not only do the diagrams for the outer sectors differ from the corresponding diagrams of the central region, but they also differ from each other. This shows that in the Pleiades region the distribution of the field stars varies considerably over distances of a degree or two. It is of interest to note that in the case of NGC 752 ($l' = 105^{o}$, $b' = -22^{o}.7$) (Rohlfs and Vanysek 1961) most of the field stars are bluer than $B-V = +0.8$; in the case of the Pleiades ($l' = 134^{o}.5$, $b' = -22^{o}.3$), the field stars are mostly redder than $B-V = +0.8$. In the colour-magnitude diagram, these stars fall exactly in the region below the main sequence where the supposed 'below the main sequence' cluster members lie. It is hard to believe that this coincidence is a mere chance ; and whereas it is expected that some field stars will appear within the proper motion criterion for cluster stars, there is no reason to expect cluster members to lie below the main sequence in a region containing the vast majority of the field stars.

The star counts have indicated a step down in the star densities from north-east to south-west. It was argued that this may be due to relatively higher obscuration in the south-west

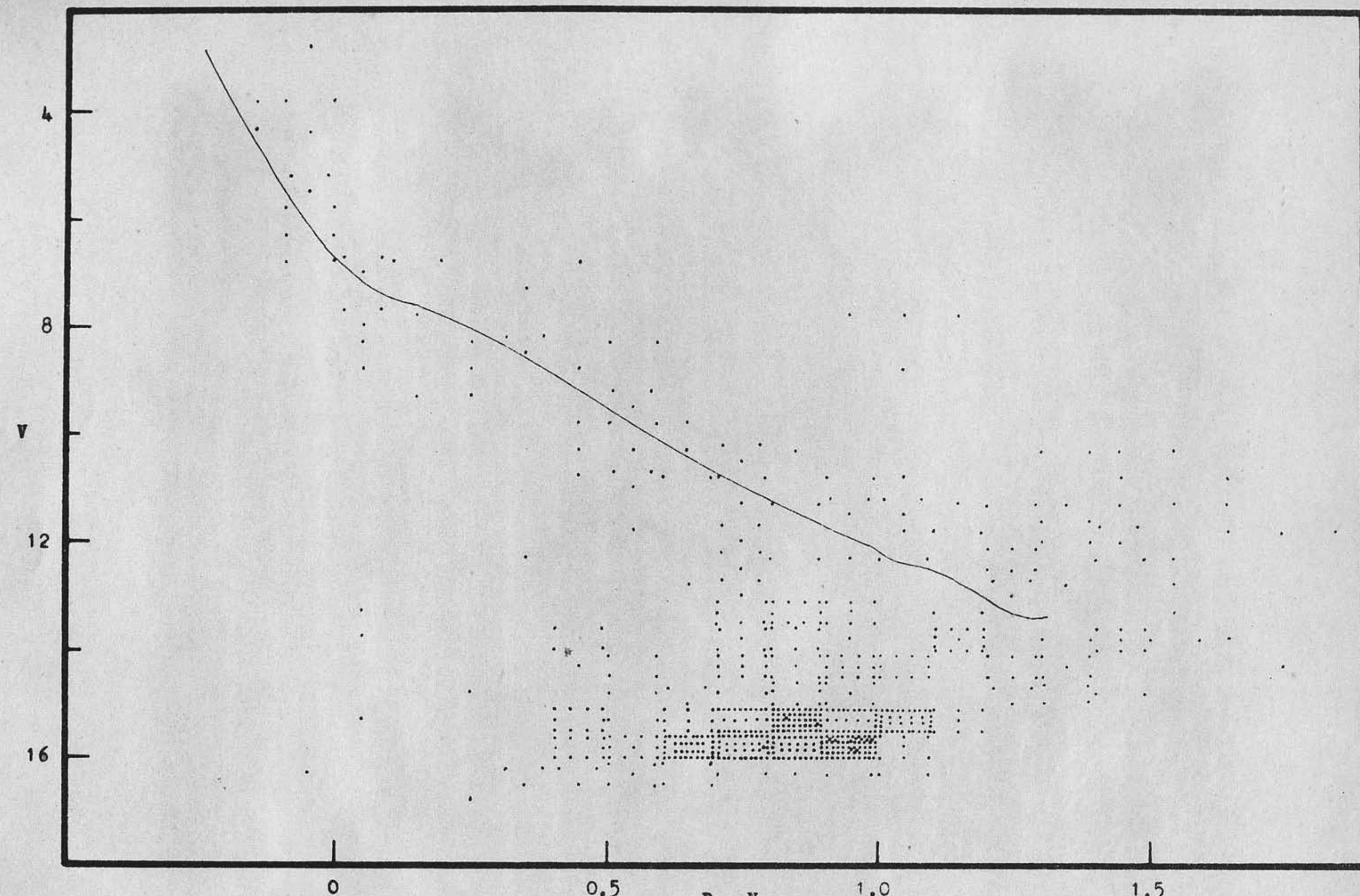

Fig. 27. - The colour-magnitude diagram of positive numbers only for the difference between nebulous plus circular regions and the outer north plus south comparison sectors. The solid line represents the fitted main sequence.

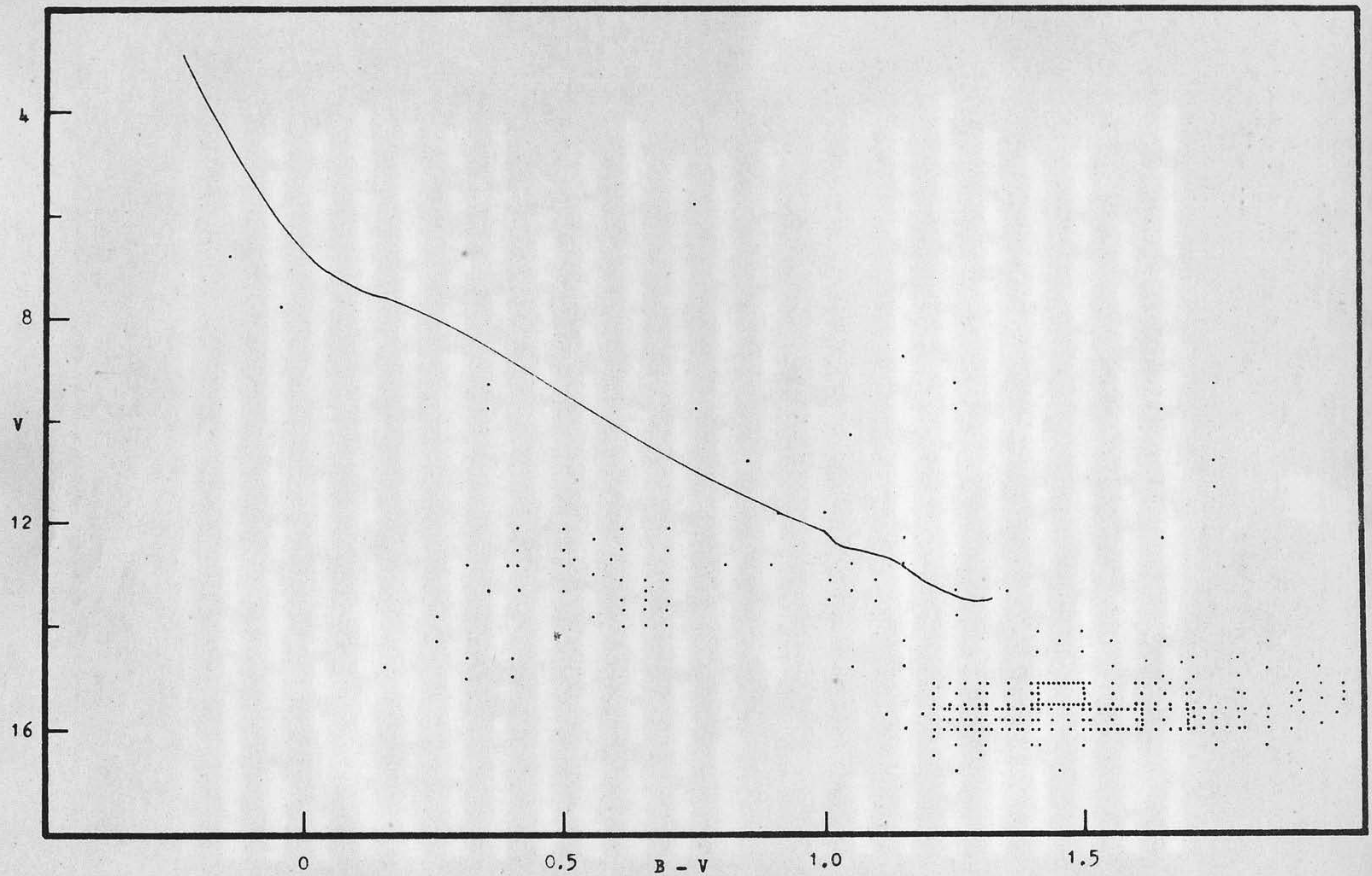

Fig. 28. - The colour-magnitude diagram of negative numbers only for the difference between nebulous plus circular regions and the outer north plus south comparison sectors. The solid line represents the fitted main sequence.

sector than in the north-east. Fig.23 and 24 show, however, that the higher star density in the north-east is due to a concentration of faint red stars which do not appear in other regions. In view of the lack of adequate faint photoelectric standards, however, and the consequent uncertainty in the faint ends of the photometric calibration curves, too much weight should not be placed on differences between the diagrams at such faint levels.

Figs.27 and 28 show the schematic plots of the colour-magnitude array obtained after statistical subtraction of the combined outer sectors from the nebulous plus circular regions. Net positive numbers (Fig.27) and net negative numbers (Fig.28) are plotted on separate diagrams. The points in the colour-magnitude arrays were counted in the areas half a magnitude in V (which is roughly four times the standard error in the histogram of errors in V of Fig.16) by $0^m.1$ in B-V (which is nearly equal to the standard error in the histogram of errors in B-V of Fig.17). Had the field of the Pleiades region been uniform, the positive number would represent the number of probable cluster members, but such a conclusion is ruled out by the variations in the field star densities.

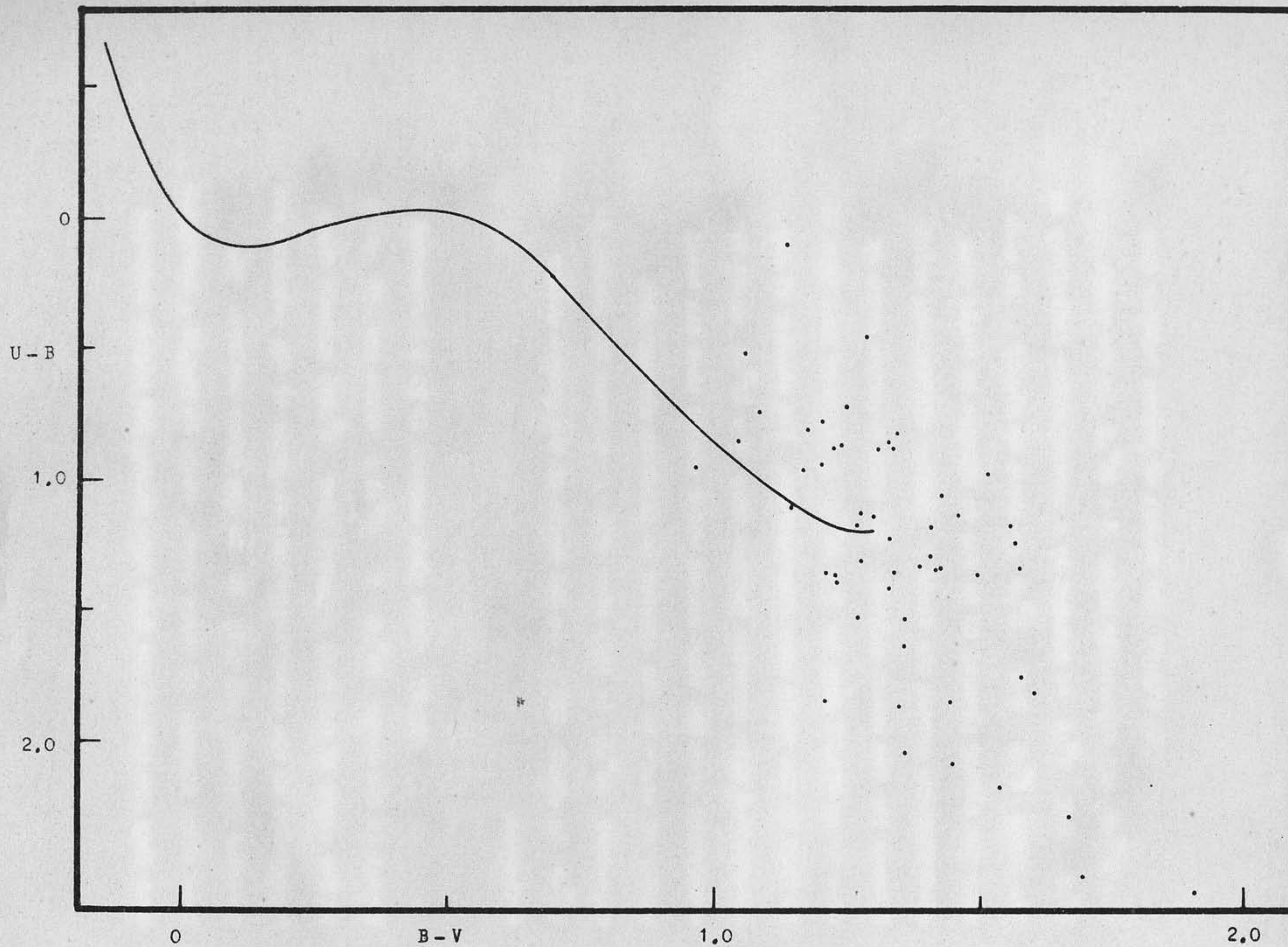

Fig. 29. - Two-colour diagram of the stars lying to the right of the main sequence in the magnitude range $10 < V < 12$, on Figs.19 and 21. Solid curve represents the unreddened main sequence.

On Fig.27 the excess of points fainter than $V = 13^m.0$ and especially below $V = 15^m.0$ in the range $0^m.4 < B-V < 1^m.1$ is matched by a corresponding deficiency in the range $1^m.2 < B-V < 2^m.0$ as shown by Fig.28 . In each case the effect appears to be due to changes in field star distributions across the field ; similar differences exist between the two outer sectors. The main sequence shows up clearly on Fig.27 down to $V = 12^m.0$; fainter than that it is lost in the field star fluctuations. The absence of any substantial main sequence fainter than $V = 16^m.0$ would be consistent with the star counts which showed that the total number of stars in the cluster to limiting photographic magnitude $21^m.5$ is less than 500 , whereas the number to $16^m.0$ is about 260 , on the basis of the proper motion criterion.

Fig.27 shows what appears to be a horizontal branch in the range $10^m.0 < V < 12^m.5$; there are 48 stars to the right of the main sequence ($B-V > 1^m.15$) between these magnitudes on the colour-magnitude diagrams of the nebulous and circular regions, and only 17 in the outer sectors. The two-colour diagram of these stars, shown in Fig.29 , indicates that they are unreddened late type stars, not highly reddened

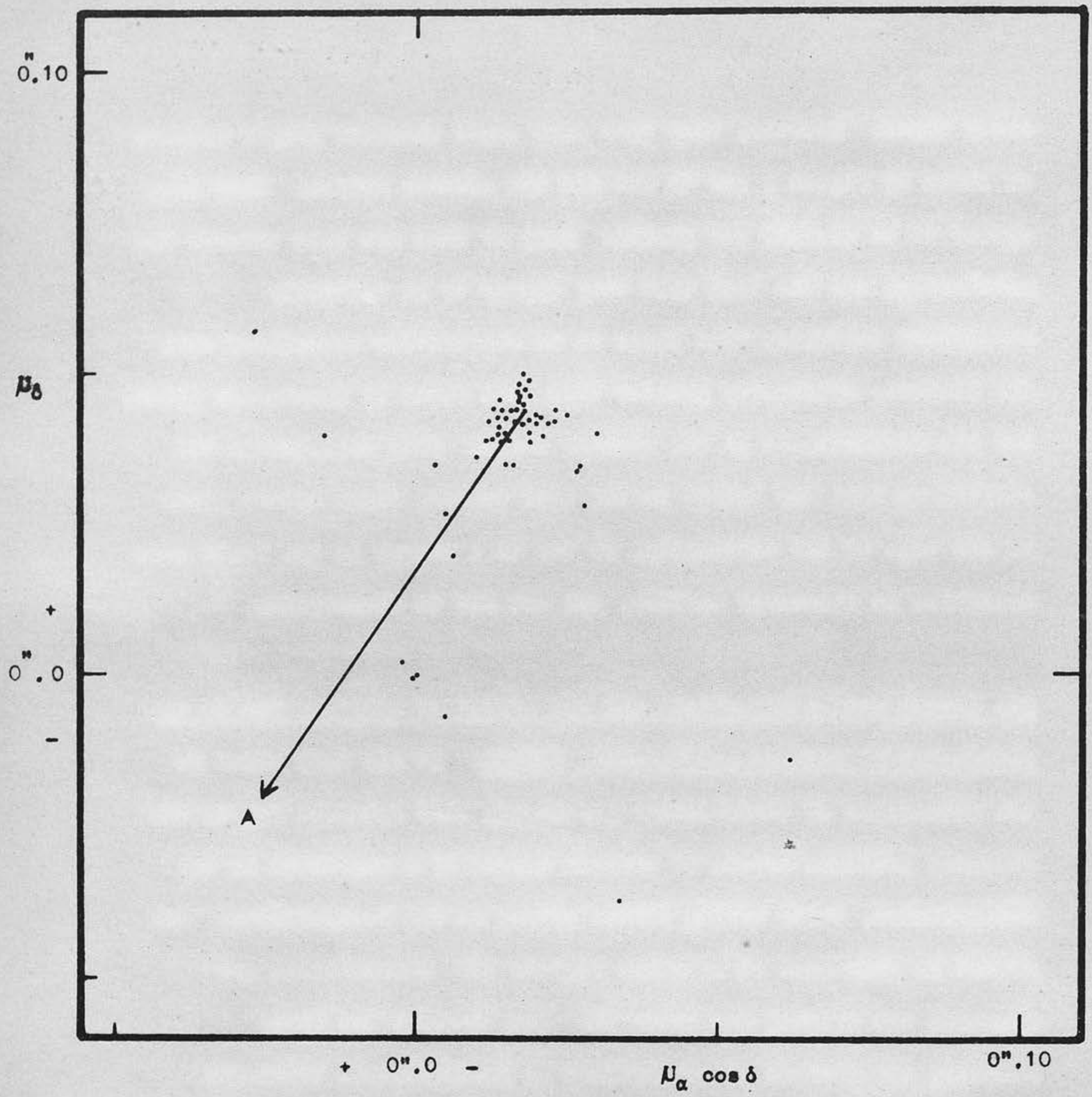

Fig. 30. - Proper motion diagram of stars lying to the right of the main sequence in the magnitude range $10 < V < 12$ on Figs. 19 and 21. A represents the direction of antapex.

early types. However, they have very small absolute proper motions as shown by Fig.30 , and do not fit the cluster motion. They thus appear to be distant red giants. Many of them are seen through the nebulosity, and the fact that they appear to be virtually unreddened indicates that there is no obscuration associated with the Pleiades nebulosity greater than that found by Binnendijk (1946) for his measurements of the cluster stars. This strengthens the conclusion that the 'step' in the star counts, which occurs close to the edge of the nebulosity, is due to a change in the field star densities as discussed earlier, and not due to obscuration.

<u>The proper motion criterion, and the effect of nebulous fog on the photometry of Johnson and Mitchell (1958)</u>. It has been shown in the discussion of three-colour photometry that nebulous fog in the Pleiades produces errors of several tenths of a magnitude in the B-magnitudes, while having little effect on the V-magnitudes. The effect is such that in nebulous regions the B-magnitudes are measured too bright, and hence the B-V colours too blue. However, the process of calibration by photoelectric standards involves drawing a mean curve through a plot of iris readings versus standard magnitudes : this mean curve will thus be representative of regions of intermediate nebulous fog ; by using it for all regions, not only will stars in nebulous areas be

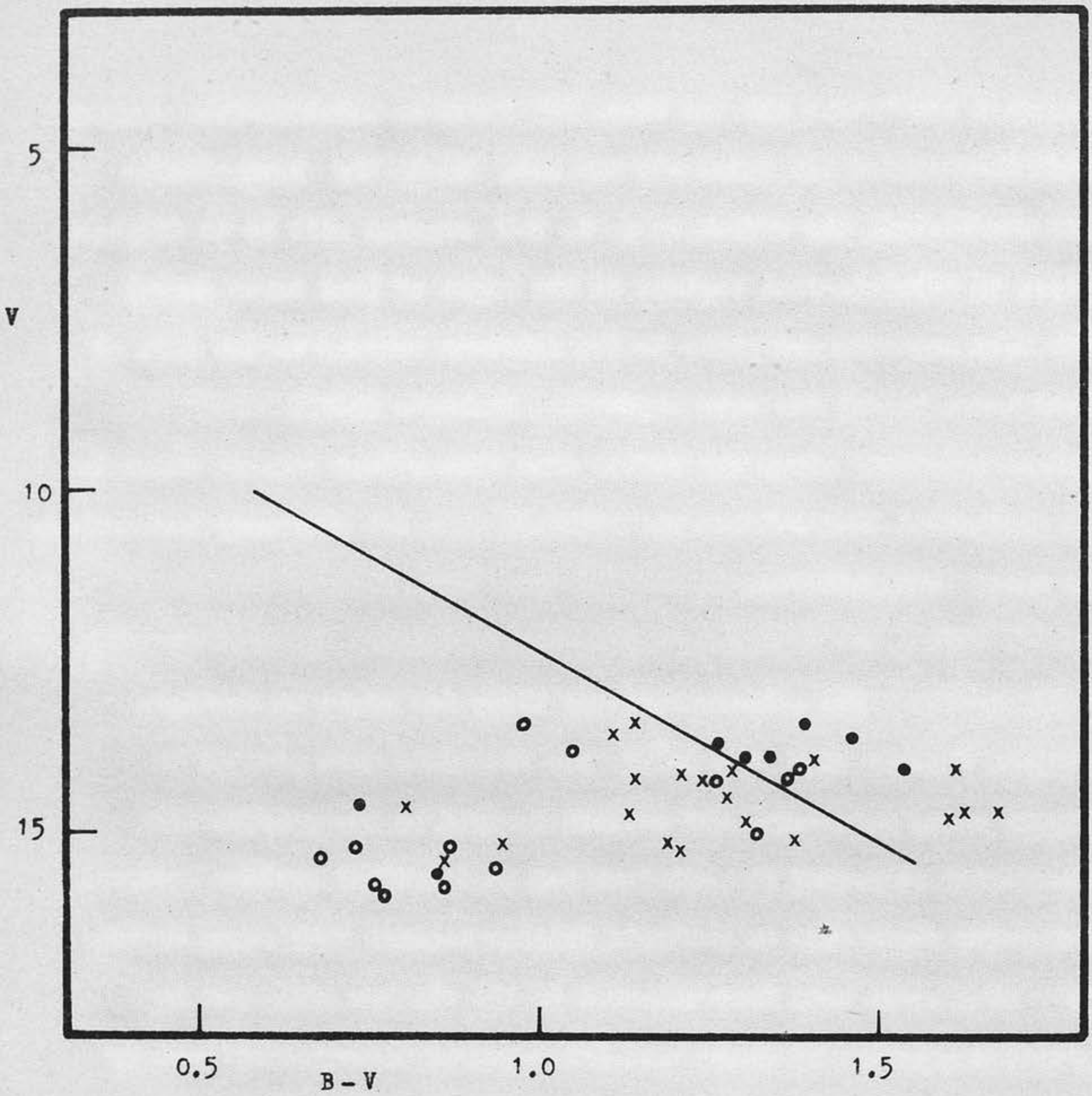

Fig. 31. - Colour-magnitude diagram of the Pleiades fainter than $V = 13^m.4$, using the magnitudes derived in the present photometry, corrected for the effects of nebulous fog. Open circles, Herbig's 'below the main sequence stars' ; crosses, Herbig's 'above the main sequence stars' ; filled circles, photoelectric standards.

measured too bright and too blue, but those in nebulous-free regions will be measured too faint and too red. Since the V-magnitudes are unaffected, the effect on a V, B-V diagram will be to displace stars in nebulous-free regions to the right of (and hence above) the main sequence and stars in the nebulous regions to the left of (and hence below) the main sequence. Herbig's (1962) colour-magnitude array may suffer from this effect because there is no indication that Johnson and Mitchell made the necessary corrections to their B-magnitudes.

The colour-magnitude array for stars on Herbig's diagram fainter than $V = 13^{m}.4$ has therefore been plotted in Fig.31 using magnitudes and colours derived in the present photometry corrected for nebulous fog as described earlier. There are fewer stars than on Herbig's diagram because only stars within 40' of Alcyone have been measured in the cluster area, and in addition a number of stars were not measured because they were in the dense nebulosity surrounding the bright stars. The use of magnitudes corrected for the effect of nebulosity produces a striking difference in the colour-magnitude diagram. The 'above the main sequence stars' are made bluer and brought on to the main sequence ; some of the 'below the main sequence stars' are made redder and go on to the main sequence, others are made bluer and

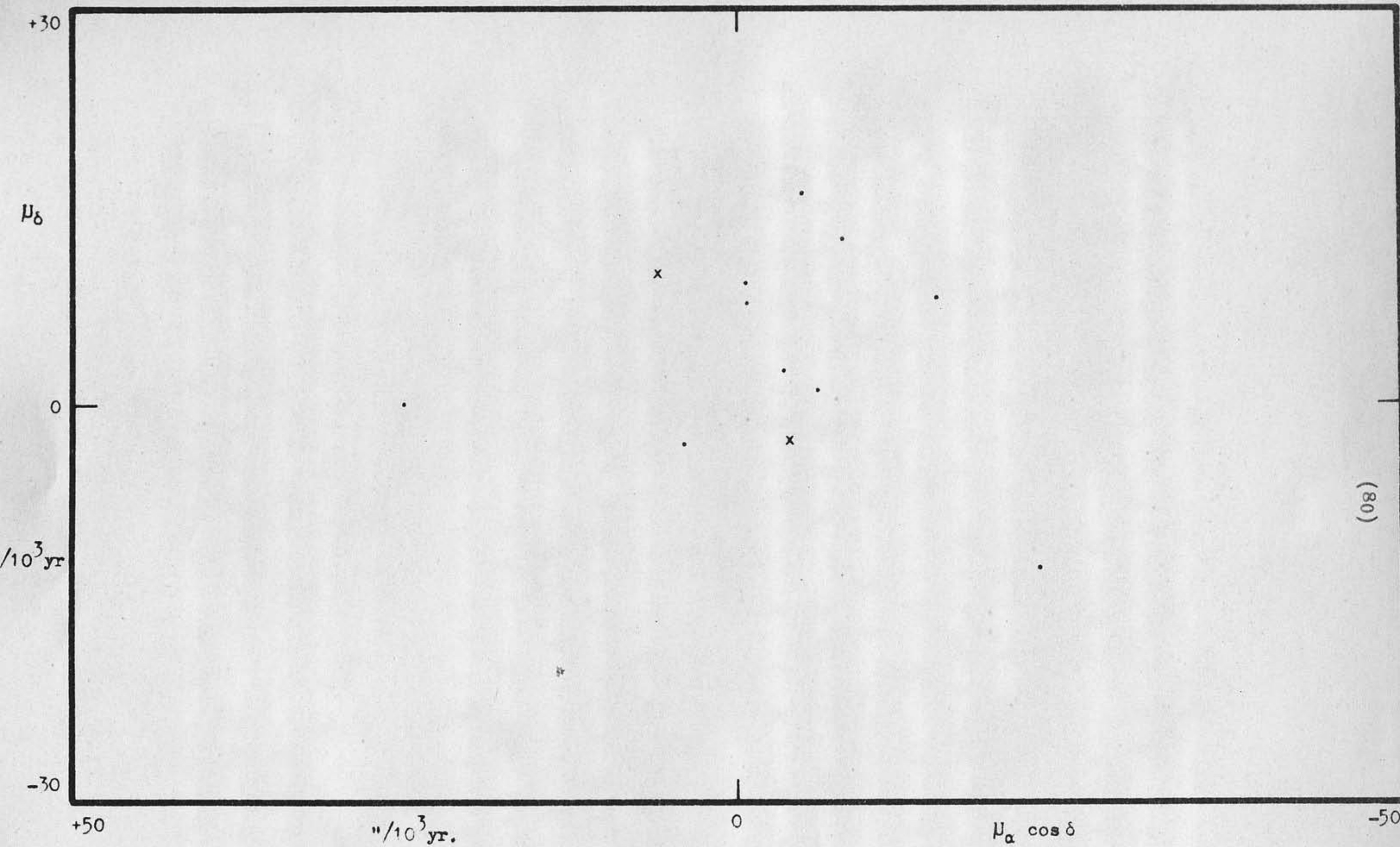

Fig. 32. - Proper motions of the "below the main sequence stars" on Fig.31 ; the two photoelectric standards, which are more than 40' from Alcyone, are marked by crosses.

together with points largely unchanged, form a distinct group in the region of the diagram which Fig.21 shows to be occupied by the great majority of field stars.

The proper motion diagram for this group is shown in Fig.32 , and in Fig.33 is given the proper motion diagram for all stars within 40' of Alcyone and fainter than $m_{pg} = 14^{m}.0$ whose proper motions lie within 0''.030/year of the cluster motion. Comparison of Figs.31 and 32 indicates that all the stars in the 'below the main sequence' group on Fig.31 are most probably field stars.

The dispersion of the remaining points about the line of the main sequence is $\pm\, 0^{m}.17$ in B-V ; in this magnitude range the predicted average standard error is $\pm\, 0^{m}.15$ in B-V (see p.64). Thus there is no evidence of any real dispersion in the faint end of the Pleiades main sequence exceeding $\pm\, 0^{m}.08$ in B - V .

Conclusions. It is shown that the apparent broadening of the faint end of the Pleiades main sequence (Herbig 1962) is spurious and has two causes : errors of several tenths of a magnitude in the photographically determined colours in the photometry by Johnson

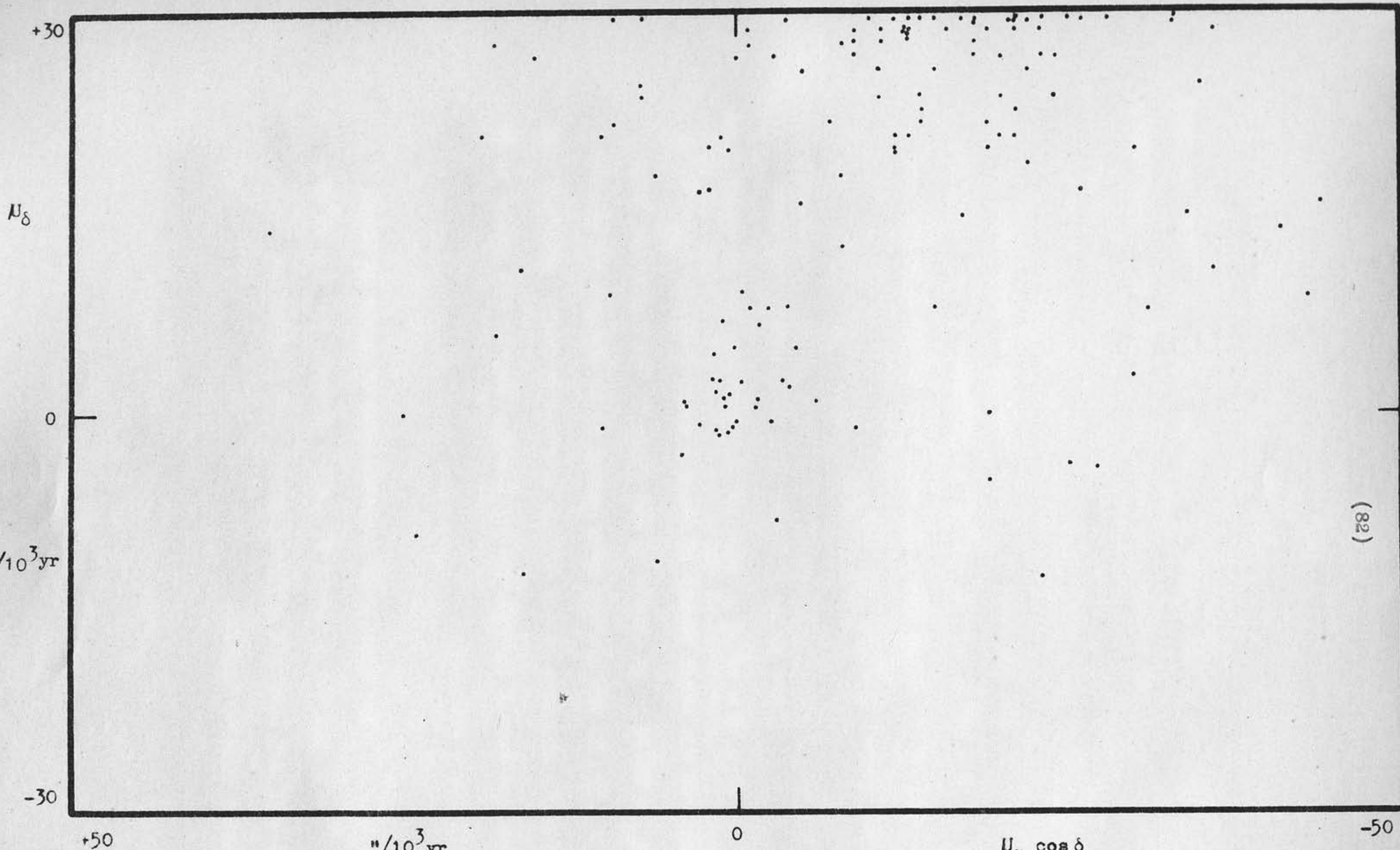

Fig. 33. - Proper motions of stars within 40' of Alcyone and fainter than $m_{pg} = 14^m.0$, from Hertzsprung's General Catalogue of the Pleiades region. The Pleiades is at (0,0) and the absolute zero of the proper motions at (-18, +43).

and Mitchell due to the effect of nebulous fog on the B-magnitudes ; and the inclusion of a number of field stars within the proper motion criterion.

The presence of a main sequence to magnitudes as faint as $V = 15^m.0$ or $M_V = 9^m.5$ is confirmed ; any intrinsic dispersion of the stars about the mean line of the main sequence does not exceed $\pm 0^m.08$ in B-V.

There is no evidence of a contracting sequence brighter than $V = 15^m.0$; star counts, however, put an upper limit of 500 to the total number of cluster stars down to $m_{pg} = 21^m.5$ or $M_{pg} = 16^m.0$. An excess of red stars in the magnitude range $10 < V < 12$ in the cluster area appear to be distant red giants, since their absolute proper motion is close to zero. Although some of them are viewed through the nebulosity, they do not appear to be significantly reddened.

The absence of a contracting sequence at about $V = 10^m.0$, and the presence of a main sequence to $V = 15^m.0$, is in conflict with all existing theories of contracting stars, including that of Hayashi.

S E C T I O N   II

Three-colour Photometry of the Southern Galactic Cluster NGC 3766.

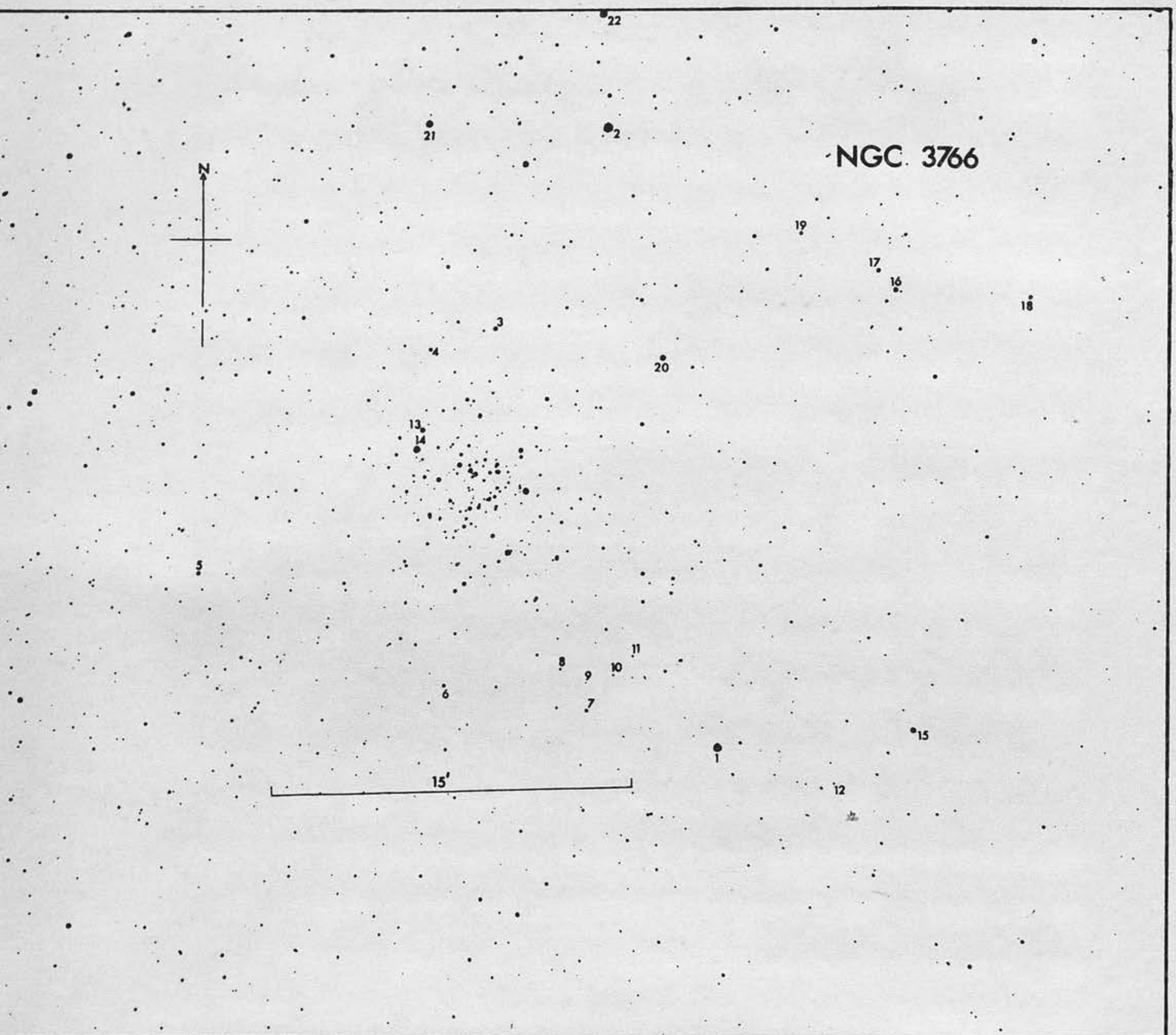

Plate I - The field of the cluster.

Introduction. NGC 3766 whose coordinates $(\alpha, \delta)_{1950}$ are $11^h\ 33^m.8$, $-61^\circ\ 20'$ is a detached rich galactic cluster in Centaurus classed by Trumpler (1930) as I 2 r . Plate I shows the field. Numbers indicate photoelectric standards. Plate II is an enlargement of the cluster region in which the three-colour photometry was carried out. The star numbers correspond to those given in the Catalogue at the end of this paper. The cluster region appears to be free from nebulosity.

The work is based on two sets of plates taken by different observers at different times; 12 plates were taken by Dr. H.E. Butler in 1952, 23 by Mr. M.J. Bester in 1960 by arrangement with Prof. H. Haffner.

Both sets of plates were obtained with the 32/36/119-inch Armagh - Dunsink - Harvard Baker-Schmidt telescope of the Boyden Observatory near Bloemfontein, South Africa. The photoelectric sequence was secured by Dr. J. Stock (private communication) using the 60-inch reflector of the Boyden Observatory. The entire photoelectric sequence, shown numbered on Plate I, lies within a region surrounding the cluster; it is the basis for the photographic photometry described below.

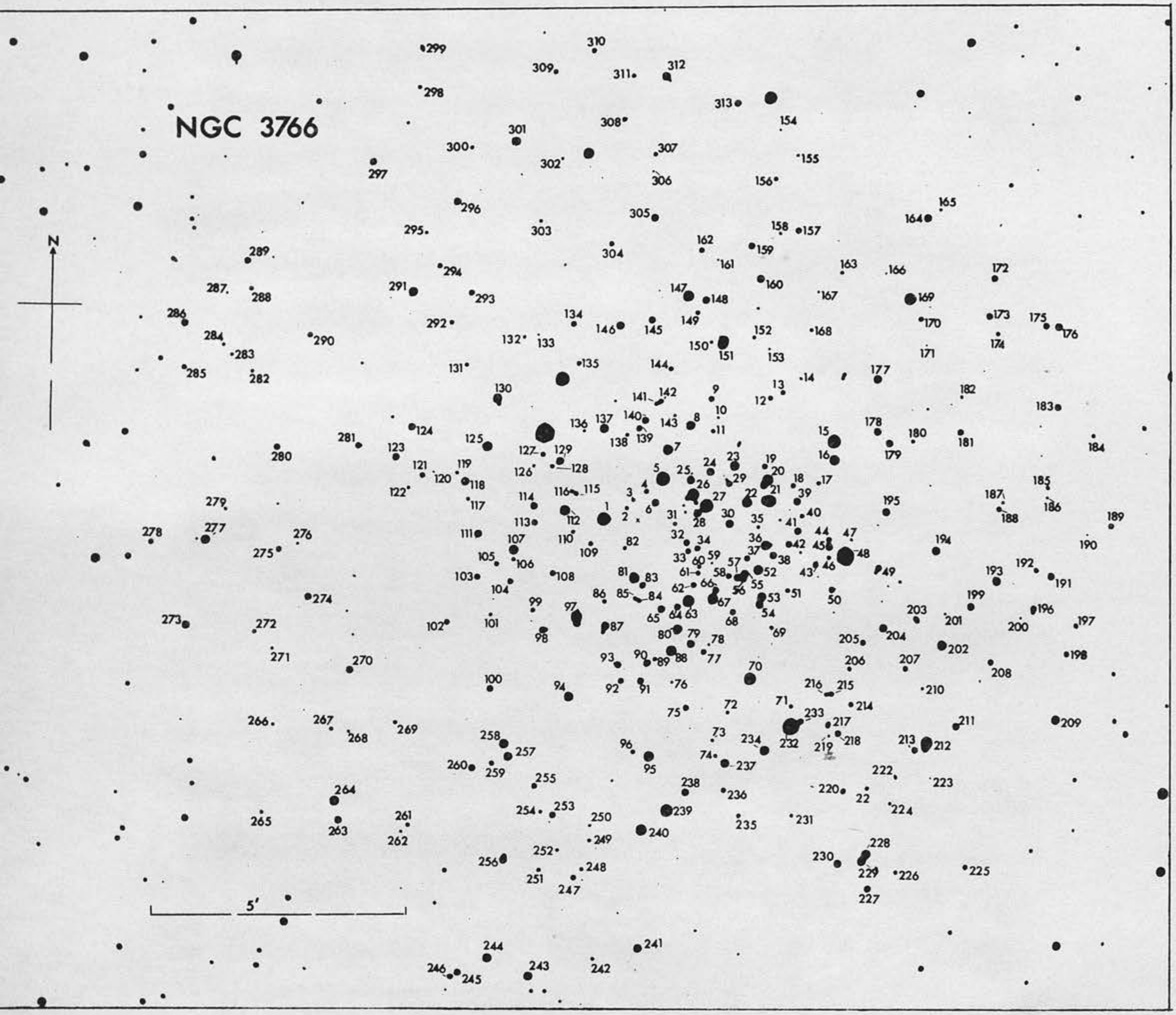

Plate II - An enlargement of the cluster region in which the three-colour photometry was carried out.

The position of the cluster on the plates is closely central. The plate scale is 52.9 mm to one degree, and the diameter within which the cluster stars were measured is 15'; hence the effects of vignetting and field errors (Lindsay 1953) become insignificant. Two circles were drawn so that the area of the outer annular ring was three times the area of the inner ring which is supposed to contain the majority of the cluster members. The scheme of colours in the two sets of plates is as follows;

(a) <u>1952 Series</u>

Plates and filters used were :

Ultra-violet U' :	103a 0 + OX1 (Chance)	: 4 plates
Blue B' :	103a 0 without filter	: 5 plates
Red R :	103a E + Wratten No. 25	: 3 plates

The ultra-violet and red colours were close to Becker's U and R colours.

The plates were measured in a digitized Becker iris photometer with punched tape output (Fellgett and Seddon 1962). Magnitudes on the plate-system were then determined from the photometer readings by the EDSAC 2 computer of Cambridge University using A.N. Argue's program (Argue 1961). Fuller details of the method of reduction are given in Paper I of this series (Smyth and Nandy 1962). In this paper, however, the relationships between the plate-system and the standard system were determined not by least squares, but graphically. With primes denoting plate system values, these relationships were found to be

$$U' = U$$

$$B' = B$$

$$R = V - 0.41\ (B - V) - 0.02$$

The inverse transformations were finally applied to all the plate system mean magnitudes.

(b) <u>1960 Series</u>

In this set an attempt was made to produce a photographic system equivalent to the standard <u>UBV</u> system. Plates and filters used were :

U"	:	103a 0	+ UG2 (2mm)	: 9 plates
B"	:	103a 0 or IIa0	+ BG12 (1mm) + GG18 (2mm)	: 6 plates
V"	:	103a D	+ GG11 (2mm)	: 8 plates

The reduction was carried out as described above, and the inverse transformations were finally applied to all the photographic mean magnitudes with the help of the equations :

$$U'' = U$$

$$B'' = B + 0.14\,(B - V) + 0^{m}.08$$

$$V'' = V$$

The mean magnitudes from the two series, weighted according to the numbers of plates, are given in the Catalogue at the end of the paper. The star numbers refer to those given in Plates I and II. The catalogue contains 302 stars of which 22 are photoelectric standards and the remaining 280 program stars. The magnitude range of the photoelectric standards together with that of cluster stars is given in Table I below.

TABLE I

	V	B	U
Standards	5.15 to 13.35	5.10 to 14.36	4.98 to 15.15
Cluster stars	6.82 to 13.85	7.00 to 14.36	6.37 to 14.97

With the exception of 11, the 280 stars have V magnitudes which lie within the range of the photoelectric standards. In constructing

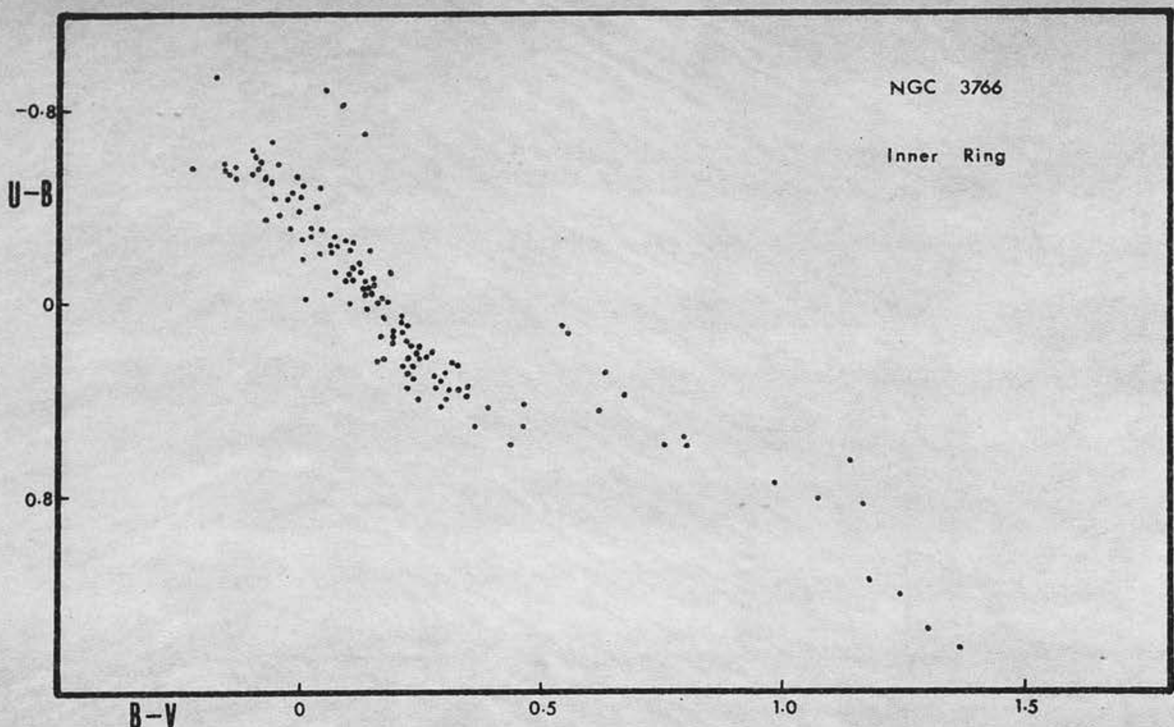

Fig. 1 - Two-colour plot of the inner ring for NGC 3766.

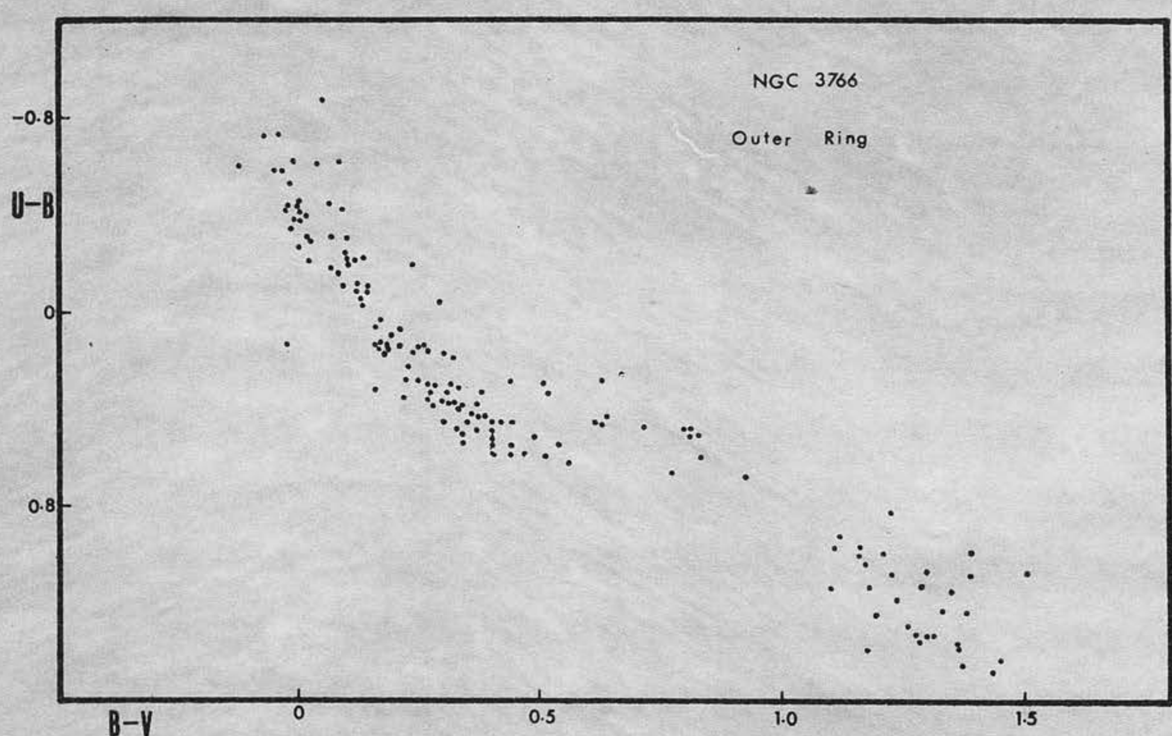

Fig. 2 - Two-colour plot of the outer ring for NGC 3766.

colour-magnitude and two-colour plots no extrapolated values were included. Since proper motions for the cluster are not yet available, it is not yet possible to ascertain the membership of the stars.

Reddening. A preliminary fitting of the standard curve to the two-colour plot U-B/B-V gave the colour excess $E_{B-V} = 0^m.16$. There are 99 stars with colour indices equal to or less than $0^m.16$. The intrinsic colours and colour excesses of these stars were read from Johnson's nomogram (Johnson 1958). The mean colour excess for 99 stars with its standard error is :

$$E_{B-V} = 0^m.159 \pm 0^m.005 \text{ (s.e.)} .$$

This is the same as found by the sliding-fit method. In an attempt to sepárate cluster members from field stars, the stars of the inner and outer circles are plotted sepárately in Figs. 1 and 2. The inner circle is expected to contain chiefly cluster members. The outer circle, having three times the area of the inner one, is expected to contain predominantly field stars. In an attempt to eliminate field stars from the inner circle (cf. Ozsvath 1960), the U-B/B-V plane in each plot was divided into small squares with an area

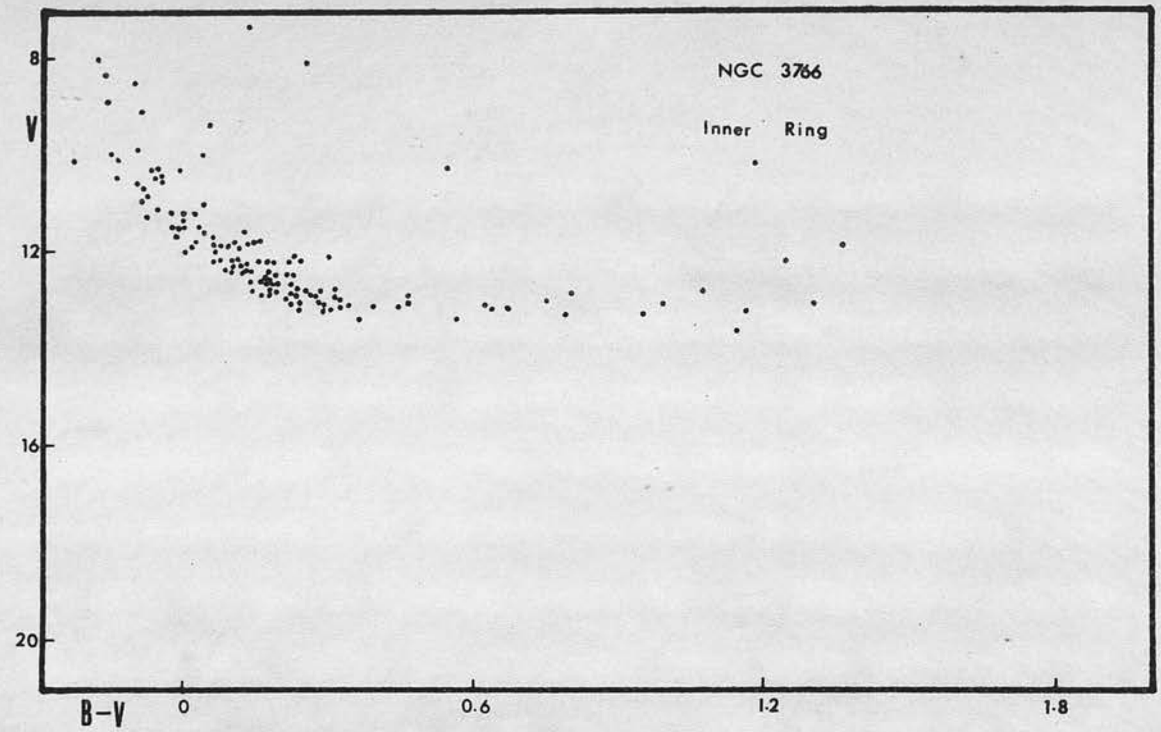

Fig. 3 - Colour-magnitude diagram of the inner ring for NGC 3766.

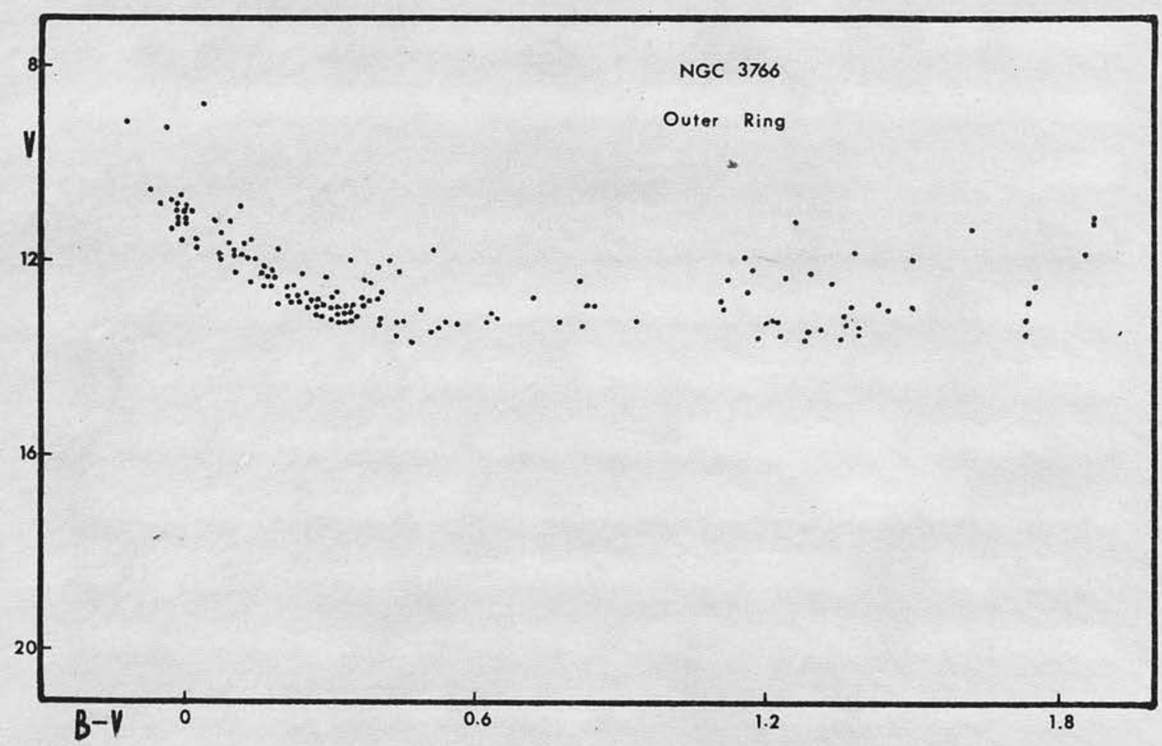

Fig. 4 - Colour-magnitude diagram of the outer ring for NGC 3766.

of 0.02 square magnitudes. One-third of the number of stars per square in Fig.2 was subtracted from the number in the corresponding square of Fig.1 , giving statistically the net number of stars in the plane which are likely to be members of the cluster. The result is shown in Fig.5 , where the crosses, whose positions were calculated from the respective histograms, represent centroids for the distribution of points for each value of U-B . The solid curve represents the fitted main sequence, giving a corrected colour excess $E_{B-V} = 0^m.16$. This was then accepted as the final value of the so-called normal reddening. The dotted line represents the normal reddening line. As is clear from the Figure, little weight was given to the points having U-B $> 0^m.04$. The distribution of crosses in the Figure indicates a different or abnormal slope for the reddening line.

Distance. The colour-magnitude diagrams of the inner and outer rings are shown in Figs.3 and 4 , and the result of their "statistical subtraction", similar to that mentioned above, is given in Fig.6 . The crosses have the same significance as in Fig.5 ; the dotted line represents the lower limit of the photoelectric standards. The solid curve, representing the fitted standard age-zero main sequence (Johnson and Iriarte 1958) to which the final value of colour excess has been applied,

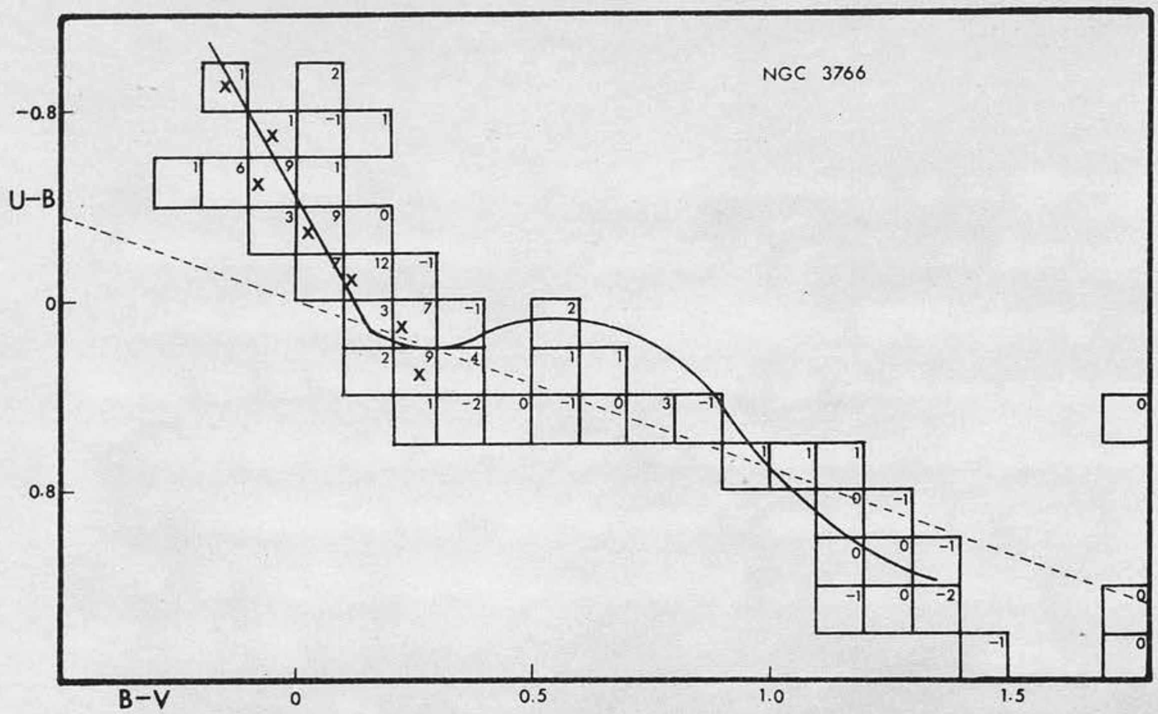

Fig. 5 – Two–colour plot of NGC 3766 obtained from Figs.1 and 2 after statistical subtraction. The solid curve represents the fitted main sequence.

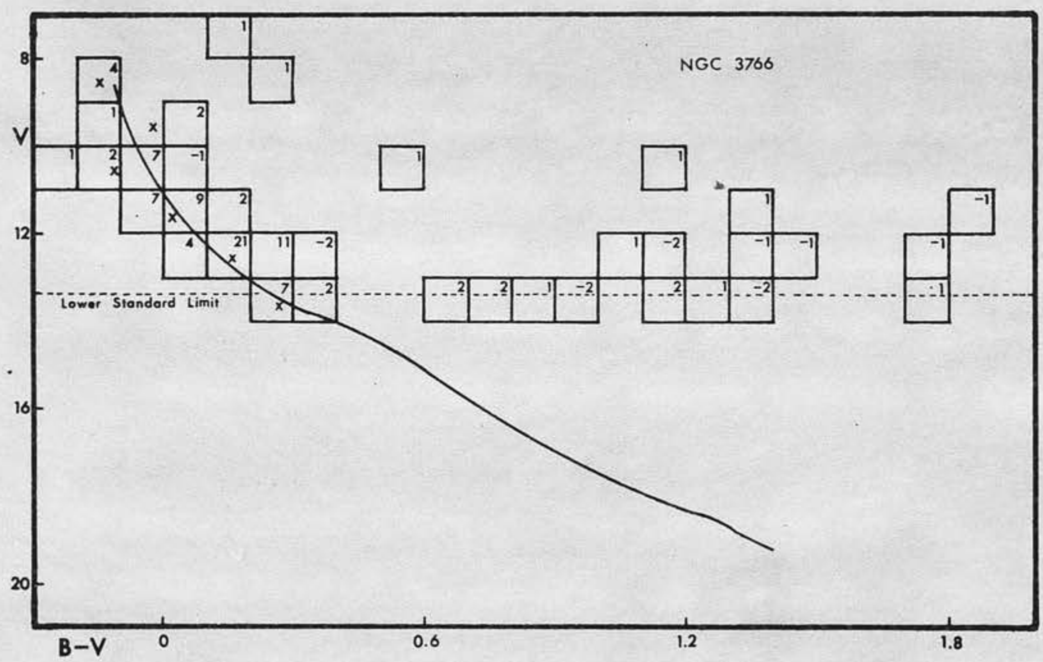

Fig. 6 – Colour–magnitude diagram of NGC 3766 obtained from Figs.3 and 4 after statistical subtraction. The curve represents the fitted standard age–zero main sequence. The dotted line represents the lower limit of the photoelectric standards.

corresponds to an apparent modulus of $11^m.28$. Evolutionary effects were allowed for by fitting the evolutionary deviation curve (Johnson 1960) as shown in Fig.9 . As previously, this figure is a result of the "statistical subtraction" of two graphs representing the distribution of stars of the inner and outer rings shown in Figs.7 and 8 respectively. The photometric distance corresponding to the final modulus of $10^m.80$ is 1450 parsecs.

Figs.6 and 9 would suggest the existence of a pre-main sequence for the cluster, were it not for the fact that the break-off point lies close to the photometric limit.

Age. Owing to the uncertainty in membership, the upper end of the main sequence cannot be closely determined ; it appears to thin out at about $M_v = -3^m.0$. The corresponding age on the Sandage (1957) scale lies between 1 and 2×10^7 years ; it would be slightly greater on the Limber (1960) scale.

Conclusion. The age agrees with the recent determination by Sher (1962) . However, the reddening and distance modulus differ appreciably. Table II lists some previous determinations of the distance.

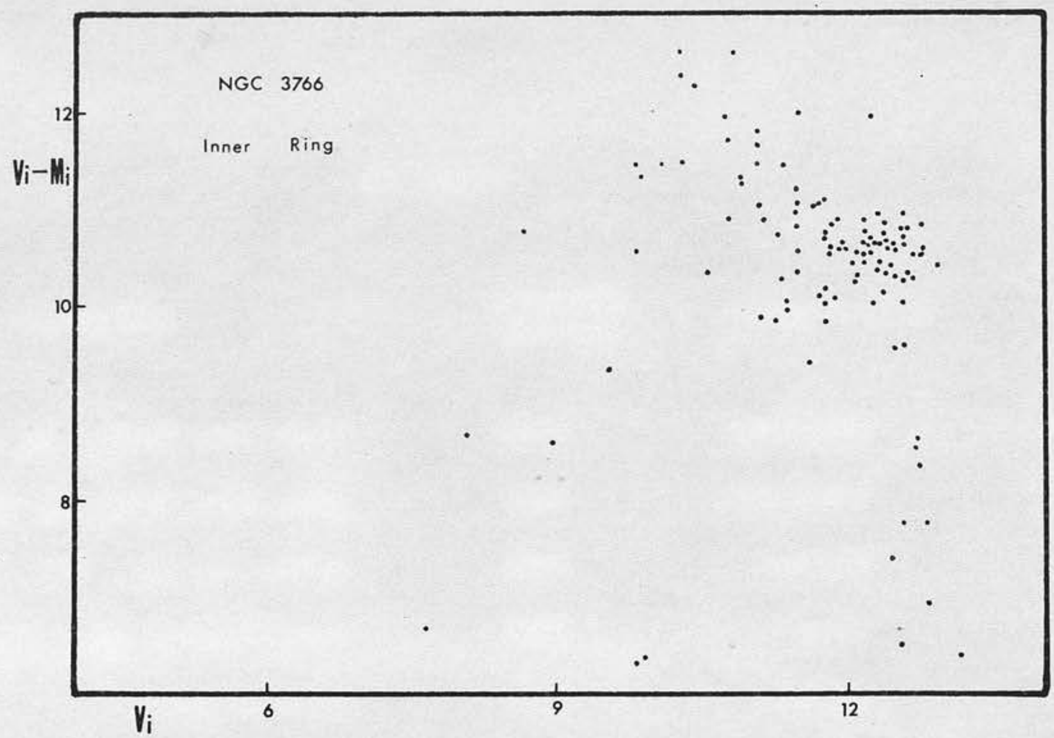

Fig. 7 - The evolutionary deviation curve for the inner ring of NGC 3766.

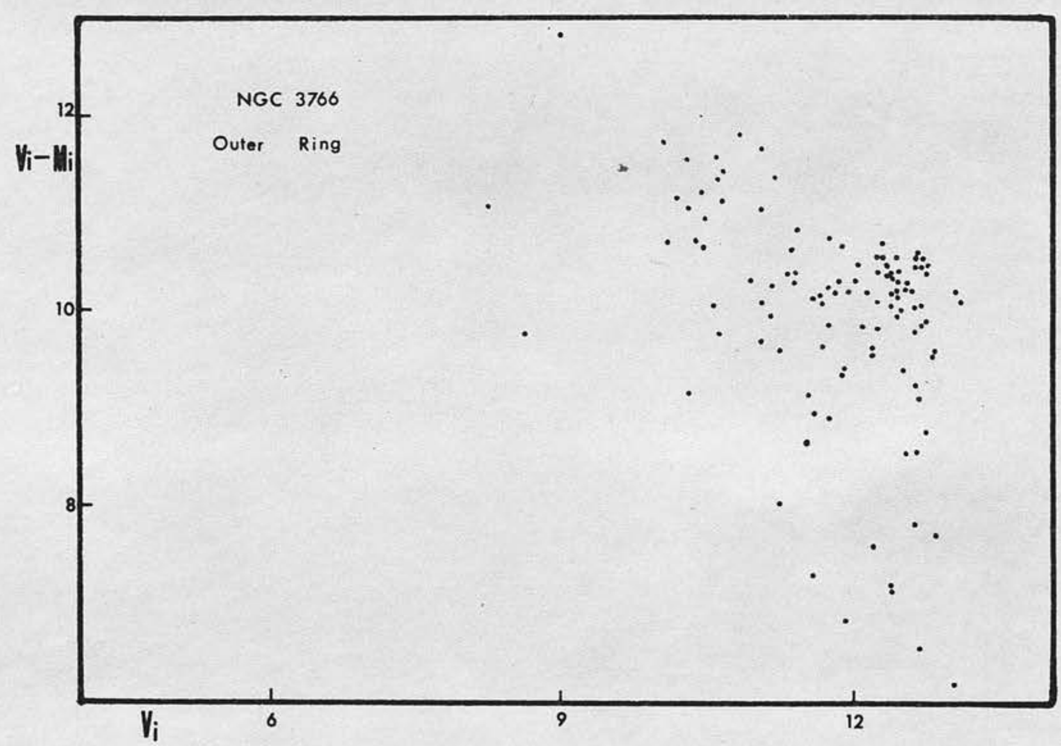

Fig. 8 - The evolutionary deviation curve for the outer ring of NGC 3766.

TABLE II

Investigator	Distance Parsecs	Reference
Trumpler	1220	Lick Obs. Bull., 14 , 173, 1930
Collinder	1020	Ann. Obs. Lund, 2, 312, 1931
Weaver	1300	Astr. J., 58 , 179, 1953
Sher	1900	Observatory, 82 , 63, 1962
Ahmed	1450	Present paper

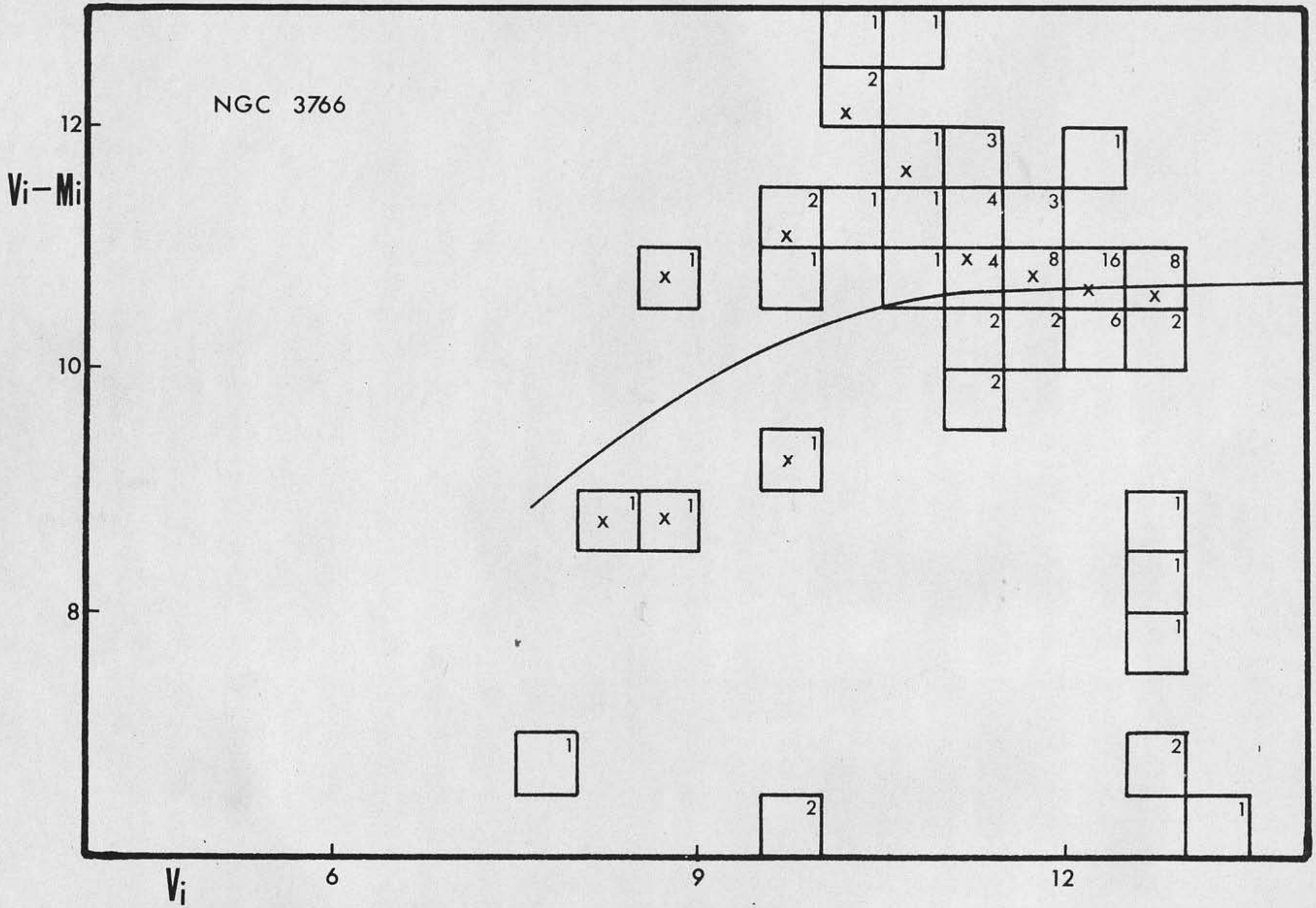

Fig. 9 - The fitted evolutionary deviation curve for NGC 3766 obtained from Figs.7 and 8 after statistical subtraction. The suffix 'i' denotes intrinsic values.

CATALOGUE

Data for Photoelectric Standards
Star Nos. refer to Plate I

Star No.	V	B – V	U – B
1	5.16	–0.06	–0.12
2	5.15	+1.13	+1.15
3	8.57	–0.04	–0.68
4	9.67	–0.04	–0.62
5	9.63	–0.02	–0.57
6	10.08	+0.33	+0.20
7	9.98	–0.03	–0.58
8	11.44	+0.04	–0.30
9	12.54	+0.07	–0.18
10	12.41	+1.31	+1.42
11	13.28	+1.08	+0.34
12	13.35	+0.24	+0.39
13	8.18	–0.02	–0.66
14	7.18	+2.02	+2.40
15	7.60	+1.28	+1.27
16	8.58	+1.31	+1.52
17	8.92	+0.17	+0.23
18	9.13	+0.32	+0.08
19	9.89	+0.02	–0.30
20	7.19	–0.04	–0.65
21	6.29	+0.09	–0.25
22	7.02	+1.82	+1.18

Star Nos. refer to Plate II

Star No.	V	B – V	U – B
1	8.39	–0.16	–0.58
2	12.92	+0.26	+0.21
3	13.29	+0.95	+0.64
4	12.62	+0.14	+0.02
5	7.97	–0.18	–0.94
6	11.53	–0.02	–0.46
7	10.08	–0.14	–0.52
8	10.73	–0.09	–0.58
9	12.31	+0.21	+0.11
10	13.22	+0.24	+0.39
11	12.85	+0.16	+0.23
12	12.64	+0.13	+0.02
13	12.67	+0.19	+0.08
14	13.13	+0.29	+0.31
15	8.51	–0.10	–0.63
16	10.07	–0.23	–0.57
17	12.81	+0.19	+0.15
18	12.61	+0.16	–0.01
23	10.50	–0.14	–0.56
24	11.33	00.00	–0.44
26	8.14	+0.25	+1.05
27	7.44	+0.13	–0.70
28	10.97	–0.09	–0.56
30	11.17	–0.05	–0.37
31	12.81	+0.17	+0.22
32	12.17	+0.06	–0.22
33	12.38	+0.09	–0.11
34	12.21	+0.15	–0.11
35	13.00	+0.21	+0.25
36	10.30	–0.01	–0.52
37	12.28	+0.12	–0.17
38	11.68	–0.02	–0.31
39	11.59	+0.04	–0.31
40	12.72	+0.18	+0.12
41	11.73	+0.06	–0.22
42	11.95	+0.06	–0.04
43	12.21	+0.10	–0.01
45	11.58	+0.12	–0.16
46	12.65	+0.22	+0.08
47	13.01	+0.46	+0.42

Star No.	V	B − V	U − B
48	6.82	+1.41	+2.31
50	12.15	+0.07	−0.25
51	12.68	+0.18	+0.13
52	10.28	−0.06	−0.67
53	11.00	+0.04	−0.48
58	12.38	+0.10	−0.13
59	13.10	+0.44	+0.58
60	12.93	+0.22	+0.28
61	12.60	+0.17	−0.02
62	12.23	+0.21	+0.04
63	9.14	−0.09	−0.83
64	11.95	+0.11	−0.15
65	11.53	+0.03	−0.40
67	9.90	−0.10	−0.53
68	12.17	+0.18	−0.12
69	12.80	+0.25	+0.21
70	8.92	−0.16	−0.57
71	12.76	+0.18	+0.01
72	12.96	+0.31	+0.24
73	13.01	+0.23	+0.30
74	13.04	+0.75	+0.57
75	12.22	+0.24	+0.19
76	13.17	+0.30	+0.28
77	12.77	+1.07	+0.80
78	13.23	+0.29	+0.41
79	11.32	00.00	−0.49
80	10.51	−0.06	−0.44
81	10.00	−0.15	−0.53
82	12.97	+0.23	+0.25
83	11.94	+0.01	−0.02
86	12.86	+0.22	+0.22
87	11.27	−0.08	−0.34
88	10.00	+0.04	−0.21
89	12.77	+0.23	+0.16
90	11.75	+0.15	−0.19
91	11.91	+0.09	−0.26
92	12.39	+0.13	−0.07
93	11.90	+0.07	−0.29
94	10.64	−0.05	−0.59
95	10.28	+0.54	+0.08

Star No.	V	B – V	U – B
96	13.01	+0.98	+0.73
98	12.00	00.00	–0.19
99	12.81	+0.28	+0.33
100	12.09	+0.30	+0.39
101	13.01	+0.32	+0.25
102	12.52	+0.21	+0.04
103	12.30	+0.10	–0.25
104	12.36	+0.13	–0.04
105	13.16	+1.16	+0.81
107	10.62	–0.10	–0.60
108	12.30	+0.13	–0.09
109	12.75	+0.31	+0.35
110	12.86	+0.27	+0.20
111	11.50	–0.01	–0.39
112	10.37	+0.56	+0.11
113	12.21	+0.10	–0.11
114	11.76	+0.02	–0.29
115	12.80	+0.14	+0.05
116	13.07	+0.22	+0.34
117	13.13	+0.62	+0.43
118	11.23	–0.03	–0.42
119	13.02	+0.23	+0.17
120	13.61	+1.14	+0.63
121	12.48	+0.17	+0.05
122	13.19	+0.67	+0.37
123	11.83	+0.14	–0.22
124	12.17	+1.24	+1.19
125	10.34	–0.06	–0.50
126	13.26	+0.79	+0.47
127	12.51	+0.22	+0.15
128	12.94	+0.80	+0.58
129	11.88	+1.36	+1.41
131	12.99	+0.46	+0.50
132	13.10	+0.32	+0.35
133	13.38	+0.36	+0.50
134	12.36	+0.13	–0.07
135	12.70	+0.17	+0.10
136	13.14	+0.34	+0.33
137	10.90	–0.08	–0.51
139	12.21	+0.07	–0.12

Star No.	V	B – V	U – B
140	11.83	+0.13	–0.05
143	13.10	+0.39	+0.42
144	12.60	+0.17	+0.13
145	11.78	+0.10	–0.23
146	11.22	+0.02	–0.31
147	10.16	+1.18	+1.13
148	11.50	00.00	–0.27
149	13.05	+1.30	+1.33
150	13.17	+0.63	+0.28
151	9.41	+0.05	–0.88
152	13.04	+0.28	+0.30
154	13.52	+1.23	+1.07
155	13.15	+0.54	+0.53
156	12.82	+0.38	+0.32
157	12.79	+1.74	+0.53
158	13.47	+1.73	+1.19
159	11.86	+0.10	–0.22
160	11.85	+1.16	+0.96
161	12.68	+0.72	+0.45
162	13.51	+0.44	+0.55
163	12.95	+0.32	+0.29
164	11.78	+1.38	+1.23
165	13.03	+0.33	+0.48
166	13.52	+1.18	+1.39
167	13.16	+0.40	+0.48
168	12.94	+0.27	+0.16
169	9.07	–0.12	–0.60
170	12.81	+1.43	+1.48
171	13.22	+0.33	+0.39
172	12.27	+1.12	+0.91
174	12.72	+0.23	+0.22
175	11.95	+0.07	–0.19
176	11.32	–0.03	–0.41
177	11.07	00.00	–0.43
178	11.53	–0.01	–0.39
179	11.54	+0.02	–0.21
180	13.22	+1.20	+1.23
181	11.97	+0.14	–0.09
182	13.16	+0.30	+0.44
183	12.26	+1.24	+1.18

Star No.	V	B − V	U − B
184	12.76	+0.18	+0.18
185	12.74	+0.21	+0.14
186	13.13	+0.64	+0.42
187	12.89	+0.27	+0.33
188	12.76	+1.10	+1.12
189	12.20	+0.18	+0.18
190	13.16	+0.44	+0.44
191	11.62	+0.12	−0.11
192	12.45	+0.22	+0.35
193	10.89	+0.01	−0.40
194	11.09	+0.09	−0.43
195	11.42	+0.07	−0.26
198	12.22	+0.10	−0.20
199	11.72	+0.51	+0.28
200	13.42	+1.29	+1.35
201	13.15	+0.77	+0.66
202	11.13	+1.87	+1.73
203	12.23	+0.44	+0.28
204	11.13	−0.02	−0.35
205	12.28	+0.18	+0.15
206	12.74	+0.36	+0.41
207	12.32	+0.17	+0.03
208	12.11	+0.16	+0.13
209	10.76	−0.05	−0.58
210	12.95	+0.25	+0.27
211	11.69	+0.02	−0.30
212	8.74	+0.04	−0.62
213	11.90	+0.11	−0.21
214	12.48	+0.16	+0.06
215	12.53	+0.17	+0.15
217	12.26	+0.29	−0.04
218	11.88	+0.13	−0.23
219	12.92	+0.37	+0.37
220	12.24	+0.16	+0.31
221	12.74	+0.30	+0.16
222	12.66	+0.40	+0.57
223	12.25	+1.41	+0.04
224	12.95	+0.32	+0.37
225	12.99	+1.50	+1.06
226	13.15	+1.36	+1.36

Star No.	V	B – B	U – B
227	11.74	+0.19	+0.10
228	11.17	+1.26	+1.29
229	11.08	–0.02	+0.13
230	11.96	+1.50	+1.57
231	12.83	+0.26	+0.14
232	6.92	+0.09	–0.63
234	10.50	–0.07	–0.73
235	12.63	+0.25	+0.14
237	10.92	00.00	–0.41
238	11.63	+0.09	–0.11
239	9.15	–0.04	–0.74
241	11.12	00.00	–0.43
242	12.98	+0.49	+0.51
243	11.05	+0.06	–0.45
244	10.80	+0.12	–0.10
245	12.07	+0.40	+0.44
246	12.76	+1.30	+1.07
247	12.40	+0.13	–0.02
248	13.20	+1.22	+0.82
249	13.26	+1.31	+1.32
250	13.45	+1.35	+1.14
251	13.15	+1.21	+0.98
252	13.02	+0.63	+0.45
253	13.58	+0.47	+0.58
257	10.98	00.00	–0.38
258	11.34	+1.62	+1.74
259	12.96	+1.45	+1.42
260	11.85	+0.10	–0.25
261	13.07	+0.35	+0.44
262	13.47	+1.28	+1.32
263	12.15	+1.29	+1.12
264	10.58	–0.01	–0.63
265	13.04	+0.33	+0.10
266	13.16	+0.31	+0.30
267	13.25	+1.39	+1.08
268	13.15	+0.40	+0.53
269	12.88	+0.34	+0.35
270	12.08	+0.67	+0.25
271	13.48	+1.39	+0.99
272	12.95	+0.32	+0.19

Star No.	V	B – V	U – B
273	12.10	+1.75	+2.03
274	11.87	+0.08	–0.17
275	12.39	+0.37	+0.42
276	13.31	+0.52	+0.33
277	10.70	–0.03	–0.59
278	12.57	+0.31	+0.37
279	13.18	+0.56	+0.61
280	12.61	+1.16	+0.99
281	12.22	+0.24	+0.16
282	13.21	+0.62	+0.45
283	13.13	+0.28	+0.39
284	13.13	+0.31	+0.32
285	12.70	+0.40	+0.54
286	12.35	+1.33	+1.22
287	13.32	+0.51	+0.59
289	12.43	+0.81	+0.48
290	13.02	+1.36	+1.38
291	10.77	–0.02	–0.53
292	12.81	+0.23	–0.20
293	12.40	+0.37	+0.47
294	13.20	+1.73	+1.57
295	13.24	+0.44	+0.56
296	12.06	+1.17	+1.03
297	11.98	+0.42	+0.44
298	13.31	+0.82	+0.48
299	12.96	+0.30	+0.36
300	12.80	+0.27	+0.30
301	10.91	–0.02	–0.44
302	13.11	+0.27	+0.30
303	13.20	+0.93	+0.67
304	12.90	+1.11	+0.96
305	11.53	+0.14	–0.10
306	13.23	+0.34	+0.53
307	12.77	+0.22	+0.28
308	12.50	+0.21	+0.07
309	12.87	+0.83	+0.50
310	12.94	+1.37	+1.45
311	12.90	+0.83	+0.60
312	11.78	+1.85	+1.33
313	11.99	+0.34	+0.28

S E C T I O N III

Optical Alignment of the Edinburgh Schmidt Telescope.

Following the provision of new plateholders and plateholder loading mechanism, and the removal of the mirror for real~~l~~uminising, it was necessary to square-on the plateholder and to redetermine the focus.

Elementary considerations suggest that the focus and squaring-on need to be accurate to several microns. That focussing errors of this order do produce measurable photometric errors will be shown in this section, where it will also be shown that the focus can be determined with the required accuracy.

Preliminary squaring-on of the plate-holder was carried out by Dewhirst's (1957) method. Subsequent measurements of focus plates showed, however, that a squaring-on error still remained.

<u>Determination of Best Focus</u>. A typical focus plate has 10 or 12 exposures, each of duration 60 $\pm$ ($\leq$ 0.5) seconds, at intervals in focal distance of say 50 μ or less. In order to have images with the sharpest edges so that diameter measurements will be accurate, a plate of high contrast and fine grain is used. Plate No.131 used for this purpose was an Ilford R40 plate satisfying these conditions. Measurements of image

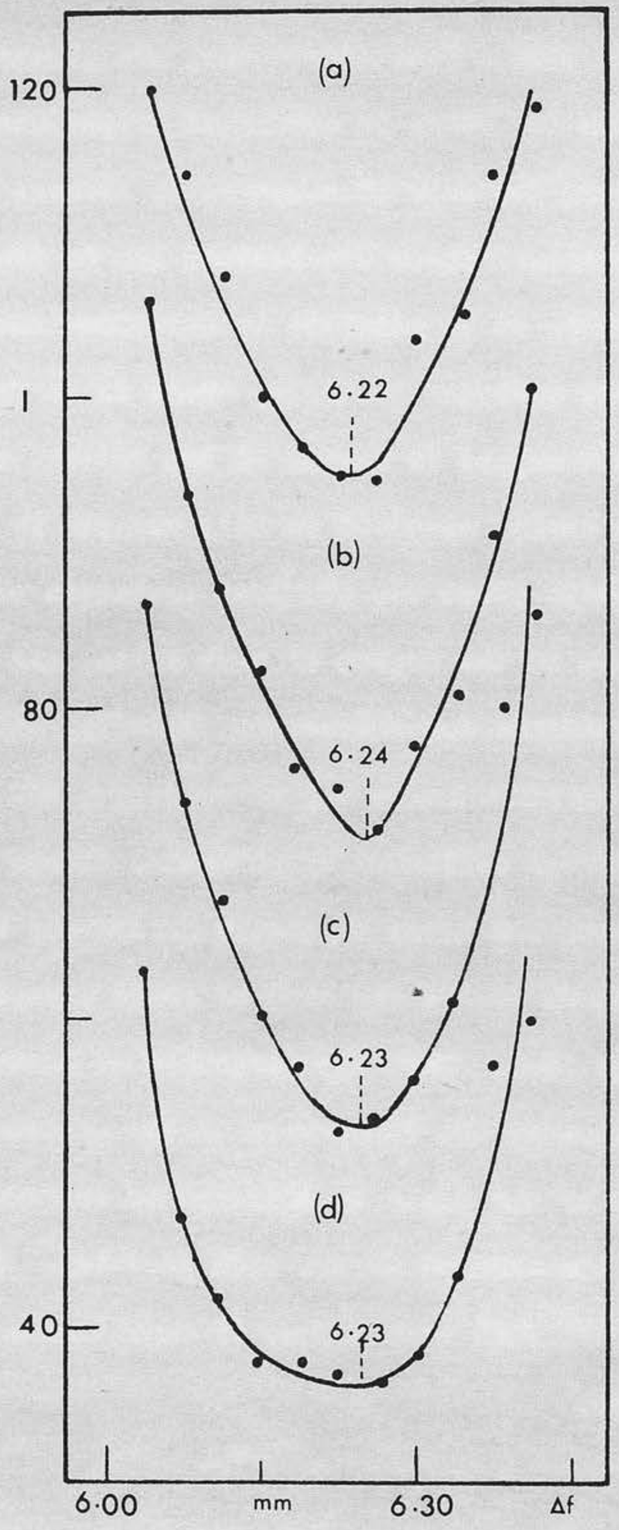

Fig. 1. – Diameter measures against error in focal distances for stars of different brightnesses. Each curve is a mean of measures on several similar stars.

diameter, made with a fine micrometer, are plotted against focal distances for stars of different brightnesses in Fig.1 . Each curve gives the mean of measures on several stars of similar brightness. Three conclusions can be drawn from these curves. Firstly, it is possible to determine the focus to $\pm$ 10 μ by this method. Secondly, there is an optimum brightness (which we would expect to depend on the optical system and the type of plate used), measured in this example by the in-focus image size, which gives the sharpest variation of the image size with focus in the region of best focus, and hence leads to its most accurate determination. Thirdly, although this is in effect an alternative way of regarding the second point - images of stars of different brightnesses change with focus at different rates, and hence focussing errors may be expected to produce magnitude errors the size of which depends also on the in-focus image size. Thus any variation of focus across the plate will increase the dispersion of the photometric errors in any region of the plate in addition to introducing a systematic variation of the average errors with position. Correction for focussing errors will thus depend on magnitude as well as on focal distance.

By measuring stars widely distributed over the

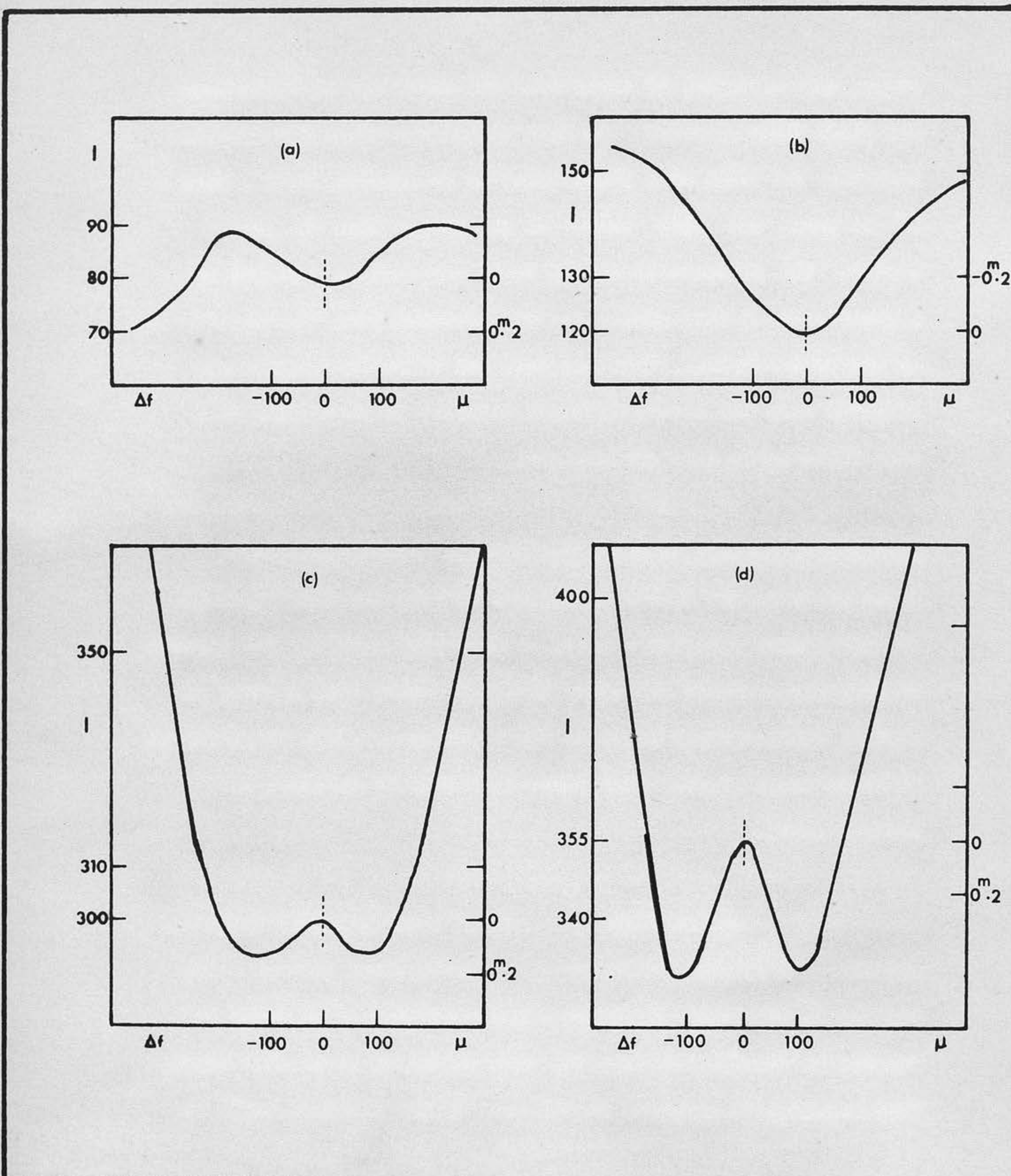

Fig. 2. - Iris photometer measures against focal distances for stars of different brightnesses.

plate, any variation of focus over the plate can be determined and plate tilt measured. In this way it was found for example that the NE edge of a plate taken in plateholder No.2 , east of the pier, was 160 μ nearer to the mirror than the plate centre. The photometric errors to be expected as a result of a plate tilt of this amount can be predicted from the measurements of the focus plates. This was done and below the results are compared with the errors actually occuring in photometry of a star field using this plateholder.

<u>Photometric Effects of Focussing Errors</u>. Measurements of a focus plate in the Becker photometer provide the iris readings of star images covering a range of focussing errors. The results of such measurements are shown in Fig.2 where iris reading is plotted against focal distance for a number of stars of different in-focus image sizes. Each curve is a mean of measures on several stars.

As the image goes out of focus its gets larger and the iris opening increases ; as defocussing continues the density in the image falls and a point is reached at which it becomes so transparent that the iris begins to close down again. This sequence is apparent in the case of the faintest image in

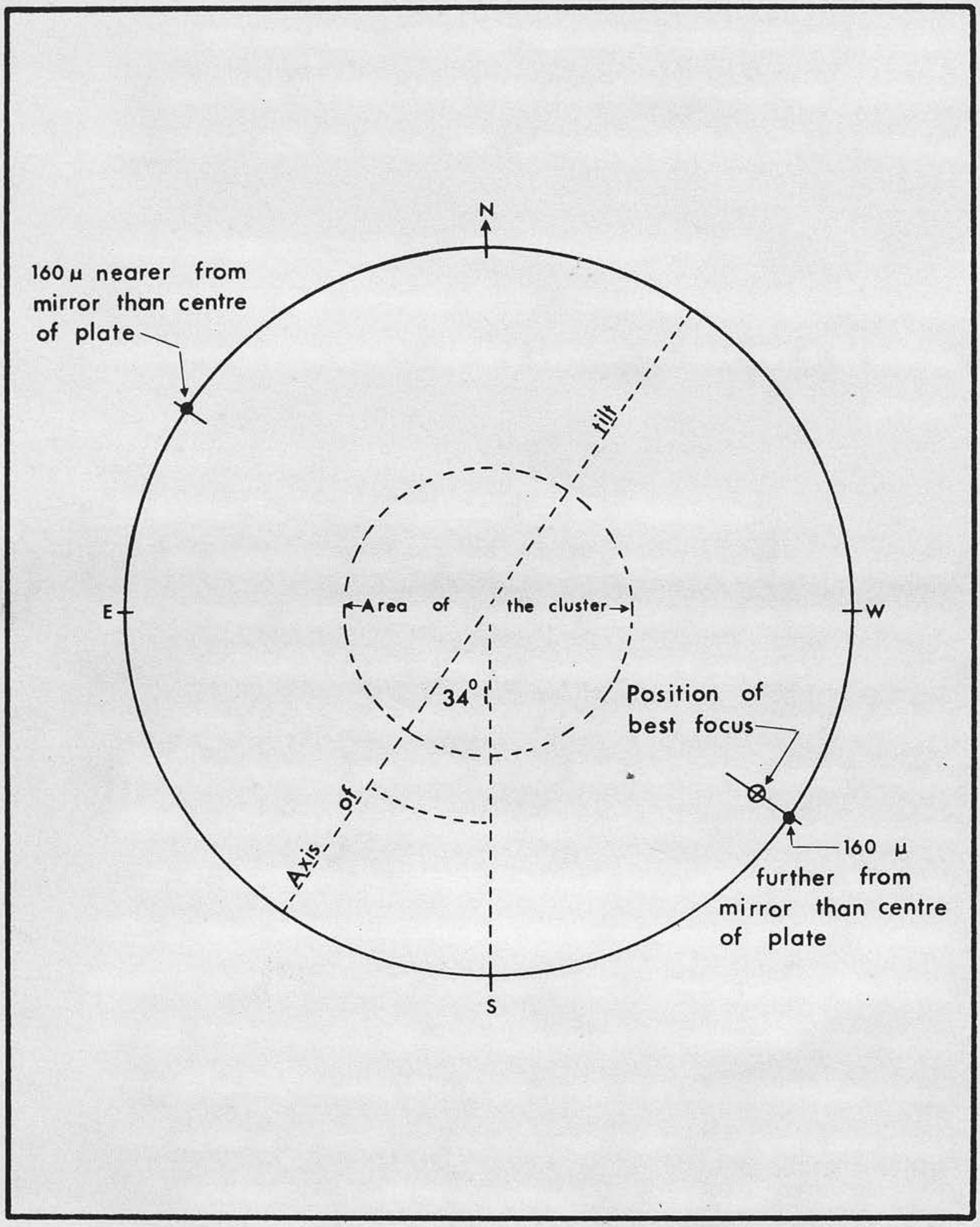

Fig. 3. - Tilt and focus of plate No. 122 in plateholder 2 .

Fig.2 . In the other curves the turn-over point has not been reached. The brightest images show in addition a secondary maximum at the in-focus position. The cause of this is not known.

On the right-hand side of Fig.2 an approximate magnitude scale is indicated. It is apparent that focussing errors of a few tens of microns produce substantial magnitude errors.

An example of the combined effects of errors in focussing and squaring-on is provided by the photometry of plates taken on the Praespe cluster in March 1962, particularly the plates for the B magnitudes taken using plateholder 2 . The focus was set at 6.30, but measurements of focus plate No.122 taken in August 1962 showed that the correct focus of the centre of the plate in this plateholder (with filter GG13) was 6.45 and further, as described above, it was found to be tilted. The situation is shown diagramatically in Fig.3 . The combined effect of tilt and focus error caused the best focus to occur near the edge of the plates, and the cluster stars are at a distance from the best focus where the photometric errors are increasing rapidly with focus errors, as shown by a thick line on Fig.2 d . This line is reproduced on Fig.4 , which for

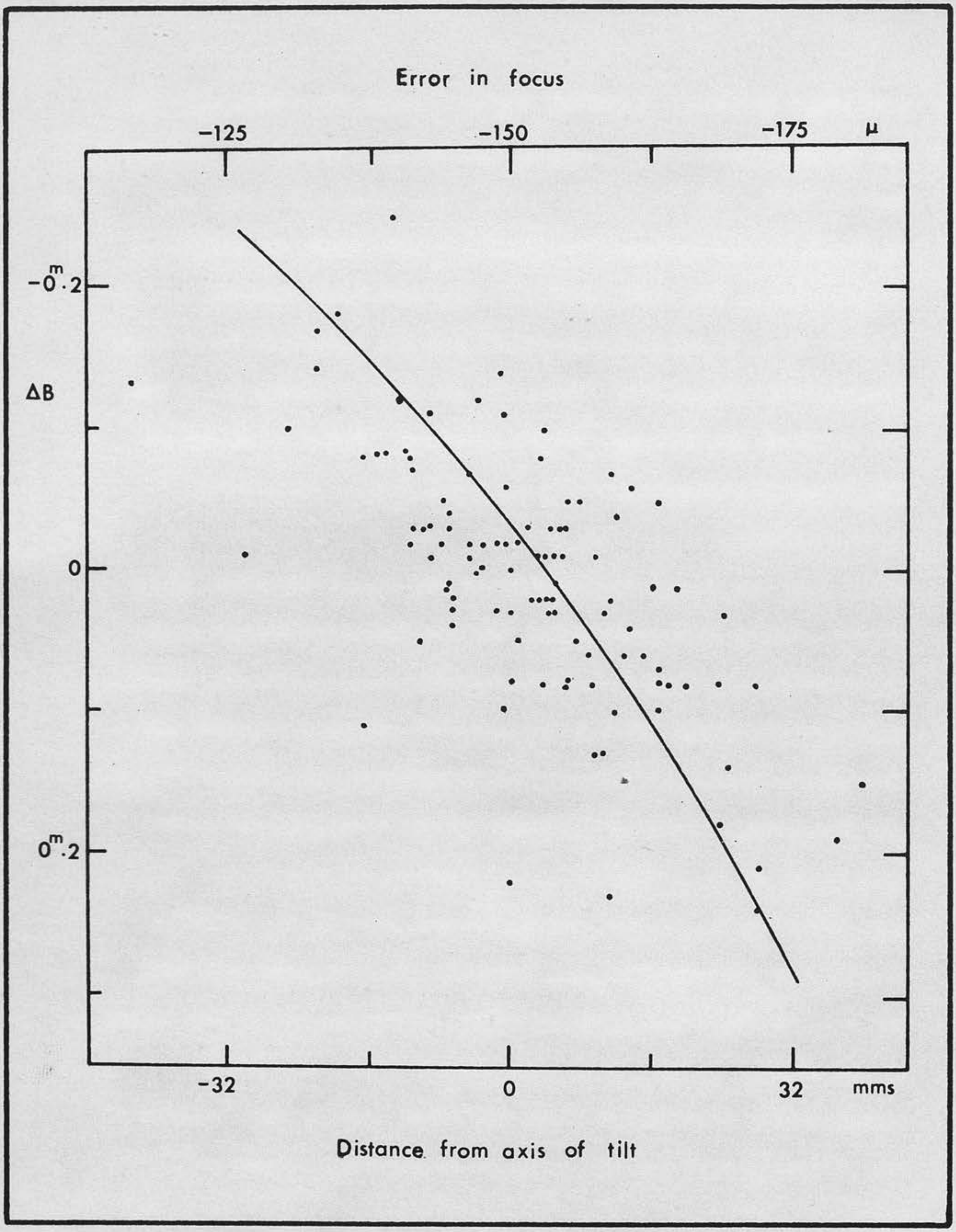

Fig. 4. - Dots represent 'standard - observed' magnitudes of stars in the Praesepe cluster against distances across the plate from axis of tilt. Solid curve represents the predicted magnitude errors in focal distance derived from measurements of focus plate.

comparison shows the magnitude errors (standard - observed) of the cluster stars plotted against distance on the plate from the axis of tilt.

The curve on Fig.4 has thus been obtained entirely from focus plates by combining the variation of photometric measure with focus, Fig.2d (the relevant curve for the sizes of the Praesepe images involved) with a knowledge of the plate tilt, Fig.3 .

The plotted points on Fig.4 , on the other hand, are the errors of magnitudes of the cluster stars obtained in the usual manner from iris photometer measures calibrated by photoelectric standards. The process of calibration makes the average of these observed magnitudes equal to the average of the standards, so that the average of the errors is zero. The zero point of the predicted curve, however, is not fixed. One may, for example, measure the errors relative to the in-focus images. In the present case, however, the zero point has been taken where the focus error is $-160\,\mu$, corresponding to the centre of the cluster plate. Since the cluster stars are fairly symmetrically distributed about the plate centre, this enables the plotted points and the curve to be directly compared.

There is excellent agreement between the predicted and observed distributions of errors. They confirm the serious photometric errors which can result from errors in focus, and the need, as demonstrated by Fig.2 , to determine the focus and squaring-on so that the combined errors of the two do not exceed about $10\,\mu$. It is evident from Figs.1 and 2 that this order of accuracy is obtainable.

Loss of Limiting Magnitude due to Focus Error. On another plate (No.139) a search was made for rows of focus images in which only one, only two, only three etc. images from the best focussed image were available. The scheme is illustrated below in Table I , where the image of the 7th exposure from the start was the best focussed image of every row. Call the row in which only one image is available as of first order. The row having two images will be of second order and so on. In each row the best focussed image was measured by the iris photometer. Best images of standard stars on this focus plate were also measured to obtain the calibration curve for the required range. The V-magnitude thus determined for the in-focus image of each order is given in column 2 of Table I .

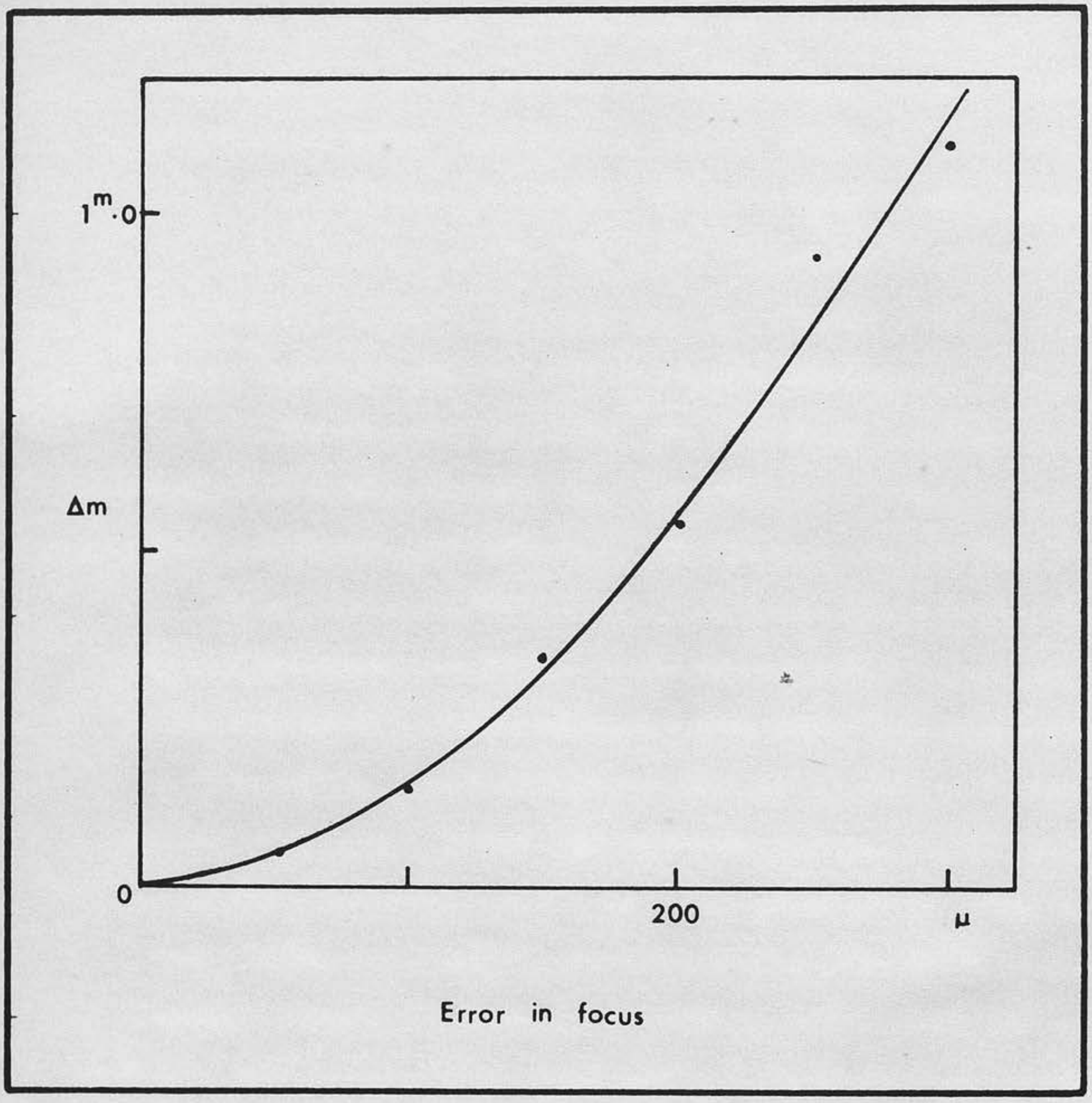

Fig. 5. - Loss of limiting magnitudes plotted against the errors in focus.

TABLE I

Order No.	V	Image appearing							
1	13.23	*							
2	13.17	*	*						
3	13.07	*	*	*					
4	12.89	*	*	*	*				
5	12.69	*	*	*	*	*			
6	12.30	*	*	*	*	*	*		
7	12.13	*	*	*	*	*	*	*	
		7	8	9	10	11	12	13	Exposures
		0	50	100	150	200	250	300	Focus error in μ

The loss of limiting magnitude due to focus error can now be determined from the Table. Order 1 shows that a star with $V = 13^m.23$ is just recorded in focus. A star with $V = 13^m.17$ is just recorded 50μ out of focus, $V = 13^m.07$ at 100μ out of focus and so on. Thus a focus error of 50μ loses $0^m.06$ in limiting magnitude, 100μ loses $0^m.16$, and so on. These losses of limiting magnitude are plotted against errors in focus in Fig.5 , from which it is apparent that efficient operation of the telescope demands that the focus be set to 20μ or better.

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A P P E N D I X I

General Catalogue of the Pleiades Region.

Description of the Catalogue

Column 1. Stars numbers which refer to charts given in Appendix II.

Column 2. Hertzsprung's 1947 General Catalogue numbers, given for photoelectric standards only. They also appear on the charts of Appendix II.

Columns 3 and 4. The coordinates of stars in units of 100 μ on the Schmidt plates.

Columns 5 , 6 and 7. Magnitudes and colours of stars from the UBV photometry.

Star No.	H II	X	Y	V	B - V	U - B
1		110	052	15.70	0.92	-----
2		109	055	15.70	1.25	-1.40
3		103	060	15.50	1.08	-0.04
4		103	065	16.28	0.34	-----
5		091	065	13.22	0.86	-0.02
6		086	065	13.75	0.79	-0.03
7		083	064	15.69	0.79	0.00
8		087	062	15.87	0.60	-----
9	2289	084	060	8.00	0.37	-0.04
10		079	061	13.64	0.90	0.04
11		079	058	12.05	1.29	0.56
12		075	052	11.93	1.14	0.10
13		078	052	15.72	1.03	-0.13
14		087	056	16.21	1.39	-1.04
15		085	052	14.58	0.73	0.43
16		078	044	15.24	0.70	0.06
17		083	044	14.40	0.78	0.14
18		085	044	15.35	0.78	0.14
19		088	040	14.39	0.85	0.30
20		087	037	14.46	0.86	0.24
22		079	024	14.22	1.03	0.67
23		070	029	11.51	0.85	0.01
24		064	036	14.67	0.95	0.36
25		066	029	16.29	0.97	-1.74
26		064	028	13.69	0.89	0.05
27		062	026	15.16	0.74	0.10
28		062	023	15.94	0.88	-0.34
31		058	025	15.54	0.89	0.16
32		052	023	15.04	1.24	----
33		049	022	15.92	0.61	----
34		047	020	15.60	0.74	0.09
35		049	020	15.79	0.99	----
36		049	018	16.21	0.30	-0.05
37		043	019	15.54	1.01	0.57
38		048	028	16.33	1.13	----
39		043	032	14.04	0.95	0.18
40		040	024	14.01	0.85	0.22
42		038	016	15.02	1.29	----
43	1726	035	014	9.23	0.52	0.26
44		029	020	14.74	0.81	0.29

Star No.	H II	X	Y	V	B - V	U - B
45		021	014	14.42	0.93	----
47		022	024	13.93	1.19	0.52
49		020	033	15.37	0.78	0.08
51		028	036	12.73	0.88	-0.08
52		023	043	14.25	0.81	0.50
53		014	042	13.74	0.98	0.45
54		004	041	14.45	0.91	0.34
56		990	048	15.58	1.28	----
57		984	052	15.25	0.05	0.86
58		983	050	13.87	1.51	0.94
59		981	049	15.15	0.93	----
60		977	048	15.74	1.39	----
61	1348	978	048	12.46	1.46	1.13
62		987	045	14.40	1.04	0.85
63		990	042	14.58	1.22	0.78
64		998	038	15.62	1.17	----
65		990	036	15.18	1.10	0.19
66		995	036	15.13	1.29	----
68		996	026	15.46	0.78	0.30
69		002	028	14.60	0.91	0.59
70		000	034	15.48	1.08	----
71	1516	002	037	13.86	1.44	0.92
72		004	036	15.89	0.90	----
73		006	034	11.87	0.90	0.17
74		008	035	15.74	0.93	-3.52
75		008	032	15.51	0.58	0.28
76		013	030	14.11	0.93	0.62
77		012	023	14.08	2.63	-1.02
78		013	023	14.26	0.71	0.34
79		015	020	15.39	0.79	----
80		006	019	12.35	1.24	0.87
81		002	018	14.86	0.77	0.47
82		999	019	14.78	0.92	0.60
83		993	008	12.34	0.79	0.07
84		989	010	13.78	0.65	0.07
85		990	018	15.77	0.92	----
87	1309	982	023	9.46	0.61	0.02
88		985	020	16.10	0.35	----
89		987	019	14.32	1.30	0.66
90		983	018	15.62	0.73	0.90

Star No.	H II	X	Y	V	B - V	U - B
91		985	017	15.51	0.96	0.07
92		978	018	15.99	0.83	----
93		976	011	15.69	0.66	----
97		964	011	12.88	1.03	0.70
99		962	015	14.89	0.91	0.31
100		954	012	14.71	0.83	0.28
101		950	014	16.53	0.24	----
103		950	018	15.45	0.70	0.13
104		950	020	13.31	0.92	0.26
105		950	022	13.20	0.96	-0.15
106		952	022	15.79	0.76	0.25
107		945	030	13.79	1.03	0.28
108	1100	953	026	12.11	1.27	0.93
109		954	028	13.32	0.83	0.50
110		959	028	12.38	0.89	0.37
111		960	022	10.42	0.76	0.07
112		964	021	14.84	1.56	----
113		966	023	16.42	-0.09	----
114		972	023	15.38	0.71	0.28
115		972	024	16.24	0.54	----
116		971	027	16.21	0.47	----
117		978	027	15.58	0.82	0.32
118		974	030	16.28	0.70	----
119		970	030	11.27	1.52	0.98
120		968	039	13.53	1.15	0.93
121		966	040	10.84	0.67	0.33
122		958	046	15.77	0.95	-0.08
123		952	036	15.72	1.01	----
124		949	042	15.91	0.84	----
125		946	051	15.53	1.22	----
126		946	055	15.62	0.95	0.13
127		953	058	15.05	0.93	0.47
128		956	060	14.20	0.94	0.52
129		957	060	15.11	1.02	0.36
130		958	059	14.97	0.89	0.48
131		012	042	14.72	0.86	0.31
132		958	053	15.35	0.97	----
133		964	050	15.53	0.95	-0.18
134		970	052	15.46	1.01	0.12
135		970	054	13.58	0.92	0.26

Star No.	H II	X	Y	V	B - V	U - B
136		961	071	12.56	1.58	1.33
137		956	084	14.22	1.23	0.74
138		950	078	15.57	0.90	----
140		950	068	14.34	1.36	0.54
141		949	068	14.87	0.59	0.99
142		947	066	15.32	0.81	0.21
143		943	061	15.51	0.95	----
144		940	060	13.26	1.43	1.28
145		933	058	15.09	1.50	0.16
146		934	056	15.53	0.94	----
147		938	053	15.90	0.84	----
148		944	048	14.06	1.20	0.74
149		934	046	15.40	1.03	0.14
151		932	040	15.99	0.42	----
152	1032	939	041	11.23	0.94	0.32
153		942	034	15.54	1.36	----
154		936	034	15.72	0.93	----
155		936	033	15.62	1.11	----
156		938	032	15.31	0.93	----
157		935	031	15.01	0.45	0.77
158		932	030	15.26	0.79	0.11
159		932	029	14.00	0.43	1.06
160		942	026	12.59	1.10	0.98
161		940	018	13.60	0.82	0.98
162		943	016	14.87	1.08	----
164		940	009	16.24	0.42	----
165		934	011	14.29	0.62	0.41
167		920	030	13.81	0.05	0.66
169		911	037	15.00	1.32	----
170		920	042	14.89	0.63	0.41
173		912	059	13.07	1.16	1.42
174		912	060	12.81	0.97	0.21
176	996	924	065	10.46	0.78	0.14
177		920	070	14.78	0.82	0.53
178		917	070	16.48	0.91	----
179		913	067	15.44	0.76	0.29
180		910	070	15.16	1.03	0.23
181		908	068	15.56	1.60	----
183		903	067	15.79	0.92	----
184		898	062	14.09	1.10	0.74

Star No.	H II	X	Y	V	B - V	U - B
185		897	061	15.76	1.10	----
188		899	050	14.88	1.51	----
189		893	053	14.85	1.13	0.59
190		887	053	15.33	1.18	----
191		887	050	15.00	0.98	0.46
192		889	051	13.75	1.31	1.09
195		899	043	14.90	1.41	----
196		895	038	12.27	0.53	0.16
197		892	037	15.50	0.54	0.23
198		892	036	15.49	0.89	----
199		906	036	15.92	0.75	----
200		902	031	13.18	0.35	0.70
201	697	897	030	8.66	0.09	0.36
202		888	036	14.91	0.72	0.50
203		887	039	13.86	0.89	0.49
204		886	042	15.17	1.14	----
205		885	042	15.43	0.87	----
206		881	046	15.17	1.18	0.23
207		875	046	15.75	1.25	----
208		872	035	14.95	1.15	0.13
209		876	032	15.10	0.42	0.59
211		892	022	15.22	0.82	0.21
212		892	017	15.47	0.90	----
213		878	011	14.92	0.25	0.63
214	489	872	012	10.41	0.66	0.14
215		868	008	14.15	0.83	0.58
216		877	005	15.62	0.96	-1.66
217		874	004	14.46	0.97	----
218		869	003	15.87	0.77	----
219		867	997	15.62	1.06	----
221		877	998	15.02	0.88	0.35
222		878	996	15.19	1.05	0.03
223		880	992	15.32	1.21	----
226		885	000	15.78	0.48	----
227		885	999	15.40	0.67	----
228		889	996	14.96	1.10	----
229		892	005	15.68	0.45	----
230		898	004	14.00	0.65	0.86
231		896	001	15.18	0.61	0.36
232		898	998	15.54	0.94	----

Star No.	H II	X	Y	V	B - V	U - B
233		898	994	15.17	0.67	0.22
234		900	992	14.90	0.49	0.75
235		911	994	13.93	0.63	1.40
235a	745	916	999	9.32	0.14	0.57
236		915	992	14.35	0.61	1.72
237	761	924	986	10.52	0.59	0.43
238		929	995	11.64	1.89	2.35
239		934	000	15.21	0.80	----
241		944	008	14.35	1.16	0.58
242	1028	953	006	12.11	1.27	0.92
243		942	994	14.41	1.27	0.62
244		942	992	15.53	1.12	----
245		939	989	15.60	1.04	----
246		948	995	15.94	0.61	----
247	956	950	990	8.02	0.33	0.11
248		948	990	7.62	0.93	1.92
249		946	986	15.35	0.82	0.31
250		947	978	14.71	0.71	0.49
251		936	977	15.32	1.11	----
252		936	974	15.83	0.79	-0.11
253		930	972	15.53	0.82	-0.02
254		922	980	15.38	1.14	----
256		920	972	15.35	0.84	0.38
257		915	976	15.47	0.93	----
258		913	976	15.65	0.67	0.10
259		909	977	15.77	0.68	-0.08
261		911	986	12.31	1.54	2.17
262		905	985	14.65	0.54	0.42
263		897	990	15.51	1.15	----
265		896	984	14.08	0.73	0.72
266	531	892	982	8.56	0.28	0.41
267		898	980	15.99	0.51	----
269		884	980	15.44	0.98	----
270		882	987	15.70	0.90	----
271		878	988	14.65	0.66	0.71
272		878	986	15.92	0.21	----
274		873	984	15.12	0.46	----
275		871	984	15.48	1.12	----
275a	344	852	996	8.20	0.52	0.01
276		867	983	15.21	1.16	----

Star No.	H II	X	Y	V	B - V	U - B
277		873	980	13.13	0.21	0.43
278		870	975	15.49	1.13	----
279		872	974	15.78	1.08	----
280		876	972	15.01	0.61	0.70
282		870	969	14.95	0.83	0.39
283		871	963	14.64	0.93	0.35
284		873	962	13.62	1.30	1.12
284a	357	871	954	13.64	0.29	1.95
284b	338	871	945	9.20	-0.36	0.96
284c	303	867	936	10.51	1.04	0.19
285		877	957	15.72	0.50	0.07
286		880	958	15.23	0.96	----
287		884	959	15.34	0.67	0.49
289		888	958	11.24	1.07	3.02
291		899	972	14.48	1.09	0.79
292		902	967	15.18	1.03	0.24
293		901	966	15.05	1.30	-0.05
294		901	964	15.41	0.61	0.20
295		904	962	15.74	0.71	----
296		905	964	15.74	1.07	----
297		907	966	15.38	1.06	0.19
298		906	970	15.73	0.97	----
299		909	970	10.77	0.49	0.32
300		911	973	15.16	0.98	0.10
301		912	969	15.33	1.06	----
302		911	965	13.17	0.70	0.15
303		908	958	11.68	1.15	1.10
304		911	959	15.68	1.00	----
306		918	959	13.59	1.36	1.34
307	708	928	956	10.15	0.47	0.41
308		931	956	15.60	1.10	-0.18
309		934	957	14.56	1.07	0.61
310		936	958	14.22	1.24	0.77
312		937	964	14.70	0.69	0.36
314		948	960	15.30	1.16	0.02
315		953	958	11.11	1.23	1.37
316		950	952	15.83	0.56	-0.01
317		949	950	15.40	1.29	----
318	804	944	953	7.89	0.08	0.29
319		939	950	15.53	0.96	----

Star No.	H II	X	Y	V	B - V	U - B
320		945	944	15.77	0.78	----
322		946	936	14.22	0.55	0.50
323		949	934	14.12	0.73	0.74
324		950	932	15.68	0.78	----
325		943	924	13.30	0.86	0.70
326		940	926	13.51	0.60	0.42
327		943	930	15.58	1.20	----
329		934	930	15.56	1.07	----
330		932	931	15.83	1.62	----
331		929	936	15.07	1.21	----
332		936	934	15.86	1.10	----
333		940	936	15.69	0.84	----
334		939	940	15.07	0.78	0.30
335		933	941	14.68	0.87	0.25
336	652	926	944	8.03	0.12	0.37
337		922	951	13.47	0.84	0.31
340		917	940	15.26	0.86	0.36
341		916	938	14.98	0.91	0.59
342		918	932	15.02	0.96	0.26
347		904	932	15.89	1.28	----
348		896	936	12.41	0.71	0.41
350		886	934	11.33	1.69	2.47
351		888	931	15.41	0.95	----
352		891	922	14.19	1.63	----
353		903	903	15.02	0.92	0.47
354		912	912	15.82	0.94	----
355	476	911	912	10.84	1.01	0.26
356		910	916	14.18	1.32	0.84
357		913	913	15.49	1.01	0.00
358		912	919	14.05	0.97	0.36
361		927	919	15.96	0.94	----
361a		921	921	15.94	0.84	----
364		934	916	15.82	0.90	----
365		943	914	12.90	1.06	0.39
366		946	912	15.72	0.82	0.02
367		933	906	15.28	1.22	----
368		931	904	14.06	1.18	0.70
369	522	924	900	12.00	1.08	0.60
370		918	900	15.95	1.14	----
371		922	892	15.74	1.09	----

Star No.	H II	X	Y	V	B - V	U - B
372		924	894	15.00	1.39	----
373		938	902	14.53	1.28	0.56
374		940	898	15.63	1.41	----
375		936	894	15.86	1.02	----
376	676	950	892	13.55	1.46	1.14
378	625	946	884	12.50	1.35	0.55
379		928	892	14.31	1.01	0.39
380		958	886	15.29	1.15	----
381	738	958	894	12.23	1.25	0.72
382		967	901	14.59	1.23	----
384		977	898	12.49	1.34	0.88
386		983	882	15.10	1.35	----
387		990	886	14.95	1.11	0.49
388		998	897	14.67	1.37	----
390	1117	998	918	10.13	0.82	0.43
391		995	920	13.15	0.72	0.36
392		002	929	13.60	1.40	0.79
393		001	928	13.09	0.92	0.15
394		000	928	15.24	0.97	0.31
397		993	930	13.64	1.37	1.11
398		990	929	11.98	1.57	1.24
399		988	931	10.89	0.57	0.52
401		957	916	14.11	1.38	0.75
402		956	919	13.68	1.07	0.66
403		956	920	13.43	1.14	1.44
405		954	952	15.95	0.92	0.03
406		962	956	15.36	0.77	----
407		959	956	15.54	0.72	----
409		954	962	10.57	0.72	0.14
410		954	965	10.01	1.35	0.82
411		956	963	13.98	0.58	0.72
412		958	962	14.08	1.21	1.17
414		956	970	15.51	1.11	-0.10
415		958	970	15.79	0.54	-0.02
416		960	978	14.61	1.39	----
417		967	980	14.15	1.26	0.90
418		967	985	11.66	0.83	0.25
419		960	986	15.67	0.59	----
420		959	986	15.33	1.67	----
422		966	991	15.59	0.90	----

Star No.	H II	X	Y	V	B - V	U - B
423		958	000	14.03	0.84	0.21
424		964	000	15.31	1.06	0.13
425		966	997	14.85	0.77	0.32
426		983	006	15.19	0.46	0.18
427		987	998	14.21	1.37	0.95
428		987	996	14.56	0.24	0.42
429		983	994	14.04	1.00	1.03
430		979	997	15.00	0.84	0.25
431		978	998	13.96	0.65	0.42
432		984	986	14.23	1.02	0.97
433		989	986	15.47	0.84	----
435		990	984	12.13	0.60	0.24
437		974	980	9.28	0.50	0.22
438	1122	978	972	14.92	0.64	0.21
440		984	970	14.77	0.95	0.51
441		984	966	15.09	0.39	0.48
442		982	966	14.88	1.02	0.28
443	1124	980	966	12.19	1.11	0.49
444		972	965	15.28	1.02	0.17
445		965	961	13.50	0.02	0.65
446		966	962	15.20	0.91	0.32
447		970	962	14.34	0.87	0.74
448		976	962	15.89	0.77	----
449		980	957	12.71	1.03	0.77
450		980	961	15.53	0.45	0.06
451		982	959	12.42	1.50	1.36
452		984	958	15.38	0.80	-0.08
453		986	960	15.65	1.05	----
455		992	963	14.31	0.62	0.31
456		990	959	15.47	1.22	----
457		988	956	14.74	0.79	----
458		988	952	14.17	1.15	0.93
459		995	950	15.19	0.73	0.18
460		997	949	15.76	1.00	----
461		000	948	16.18	0.45	-0.39
463		003	942	15.62	1.29	----
464		009	943	14.19	1.00	-0.08
466		016	943	16.06	0.98	-0.52
468		003	954	15.78	0.47	-0.03
469		003	957	15.81	0.80	----

Star No.	H II	X	Y	V	B - V	U - B
470		001	961	15.36	0.49	0.19
471		999	963	11.78	1.05	0.85
472	1284	001	967	8.33	0.05	0.42
473		002	976	15.19	0.71	0.07
474		002	978	14.30	0.41	0.22
475	1355	008	979	13.90	0.96	1.03
476		012	977	14.01	0.97	1.00
477		012	973	13.02	0.95	0.77
479		015	963	14.38	0.65	0.50
480		014	960	15.79	1.24	----
481		017	955	10.65	1.60	1.81
483		028	952	14.41	0.77	0.15
484		032	954	15.81	0.70	0.02
485		031	959	15.68	0.81	-0.14
486		027	956	15.54	1.07	-0.34
487		024	954	13.86	0.90	0.58
488	1397	022	958	7.28	0.33	-0.39
489		021	962	15.30	1.03	0.03
490		022	965	15.81	1.16	----
491		024	967	13.05	1.13	0.63
492		024	970	13.84	0.72	0.06
493		028	968	15.19	1.09	-0.03
494		034	966	14.67	0.85	0.41
495		038	964	15.14	1.67	----
496	1613	041	972	9.77	0.84	-0.01
497		038	970	15.69	1.30	----
498		037	970	15.14	1.15	----
499		034	970	14.75	1.26	0.50
500		029	971	15.15	0.97	0.02
501	1531	030	974	13.40	1.14	0.76
502		029	973	15.90	1.12	----
503		028	973	15.96	0.88	----
505		025	976	15.53	1.13	----
506		027	979	10.64	1.33	1.41
507		043	980	14.74	0.83	0.14
508		041	982	13.64	0.75	-0.08
509		042	984	14.99	0.69	0.26
510		037	983	14.12	0.78	-0.10
511		025	987	15.02	0.49	0.24
512		023	991	15.60	0.36	----

Star No.	H II	X	Y	V	B - V	U - B
513		028	990	15.38	0.86	----
514		033	001	15.82	0.64	----
515		033	004	9.84	0.55	0.43
516		036	002	11.83	1.45	1.84
517		038	998	15.16	0.99	-0.10
518		040	999	15.38	1.10	----
519		040	000	12.19	1.28	1.31
520		040	004	15.67	0.85	-0.10
522b	1338	999	997	8.51	-0.55	1.04
523		046	003	16.22	0.57	----
524		048	003	15.60	0.97	----
525		051	003	11.97	1.33	0.86
526		052	004	14.84	0.65	0.27
527		054	006	15.34	1.01	0.04
528	1856	057	002	10.07	0.71	-0.01
529		059	002	15.29	1.07	-0.08
530		058	007	15.34	0.80	-0.18
531		062	008	15.28	0.85	0.15
532		060	011	13.26	1.15	1.04
533		055	012	13.28	0.86	0.22
534		047	009	13.47	1.58	0.78
536		066	016	15.17	0.73	0.25
541		075	000	14.92	0.88	0.12
542		081	007	11.23	1.41	1.18
543		083	012	15.38	0.31	0.36
545		090	008	12.86	0.73	0.69
546		086	003	15.65	0.84	-0.19
547		088	001	15.83	1.20	----
548		088	004	16.33	0.55	----
549		091	003	15.57	0.98	----
550		094	005	15.02	0.75	-0.12
552		101	008	14.50	0.52	0.13
553		106	009	15.53	0.83	----
554		099	013	15.58	1.00	----
555		099	015	12.48	0.69	0.03
556		099	020	15.97	0.56	-0.48
557		107	015	15.11	1.08	0.30
558		108	021	13.04	0.86	-0.05
558a		098	025	16.09	1.03	----
558b		102	031	15.34	0.59	0.05

Star No.	H II	X	Y	V	B - V	U - B
558c		105	031	13.26	0.87	0.13
558d		108	031	14.70	0.79	-0.09
558e		104	035	14.44	0.84	0.23
558f		096	033	15.66	0.80	----
558g		100	037	16.40	0.83	----
558h		107	047	15.74	0.91	----
558i		110	049	15.38	1.10	0.01
558j		110	045	13.59	0.78	-0.14
565		123	042	14.95	0.60	0.51
566		125	043	15.55	0.71	0.11
567		126	044	14.21	0.70	0.26
568		126	047	15.86	0.60	0.18
569		126	048	11.07	1.04	0.72
570		125	050	15.63	0.69	----
571		123	048	13.69	1.42	0.98
572		122	049	15.13	0.95	0.61
573		114	049	14.43	0.72	0.31
574		122	053	15.36	1.16	----
575		125	054	13.51	0.89	0.75
576		127	053	14.52	1.42	----
577		115	059	13.53	0.75	0.00
579		112	063	15.34	0.73	----
580		108	063	9.04	0.21	0.16
581		104	067	14.86	0.54	0.51
582		107	069	14.14	0.80	0.75
583		116	066	11.32	0.80	0.06
584		118	063	15.54	1.05	-0.74
585		125	067	14.71	0.75	0.63
587		128	072	13.05	1.08	0.77
588		126	074	15.44	0.87	0.13
589		127	076	15.69	0.90	----
590		118	070	11.30	1.21	0.84
591		114	071	15.34	1.07	----
592		115	072	15.40	0.56	0.29
596		115	079	14.64	0.93	0.63
597		117	082	15.44	0.53	0.36
598		114	083	13.37	1.07	1.11
599		111	082	13.86	0.71	0.31
600		111	085	15.08	0.69	0.46
601		120	088	14.09	0.65	0.04

Star No.	H II	X	Y	V	B - V	U - B
602		118	089	15.40	0.32	0.23
605		110	094	14.74	1.13	----
607		106	088	13.57	1.12	0.91
608		104	080	15.82	0.79	----
608a		099	078	13.17	0.53	-0.14
609		100	074	15.83	0.87	----
610		098	070	15.83	0.49	----
611		097	076	14.97	0.69	0.29
612		095	078	15.92	0.59	----
613		091	078	13.93	1.67	0.84
614		088	077	15.79	0.57	----
615		086	078	14.40	0.57	0.51
617	2366	088	072	11.53	1.08	0.26
618		082	070	15.74	0.54	----
619		081	072	12.61	0.92	0.10
620		079	074	15.75	0.82	----
623		081	085	14.29	0.80	0.24
624		085	083	15.91	0.65	----
626		090	085	12.12	0.91	0.54
627		097	084	15.97	0.55	----
628		098	086	12.52	0.77	0.04
629	2488	098	088	7.58	0.04	0.13
630		101	092	12.35	0.67	-0.12
631		091	090	15.05	0.95	----
632		089	098	15.50	0.82	-0.10
633		092	098	14.55	0.96	0.70
634		094	103	15.36	0.65	0.23
635		097	110	14.91	0.85	0.23
636	2644	107	119	11.03	0.75	0.38
637	2588	095	130	13.25	1.06	1.15
638		085	108	15.42	1.27	----
639a		087	112	15.65	0.93	----
640		081	110	15.96	0.61	----
642		081	114	14.87	0.94	0.14
643		083	114	15.17	0.90	0.18
644		083	118	12.68	0.72	-0.06
645		078	118	15.21	1.11	----
646		076	120	13.72	0.89	0.24
647		074	118	15.19	1.09	----
648		072	121	15.76	0.69	----

Star No.	H II	X	Y	V	B - V	U - B
649		073	122	16.24	0.61	----
650		074	122	15.95	1.49	----
651		070	123	15.75	0.69	----
653		062	122	15.65	0.79	----
654		060	124	14.36	0.73	0.28
655		052	121	15.65	0.92	----
656		050	121	15.56	1.08	-0.83
657		050	120	14.59	0.81	----
658		051	118	14.09	1.77	----
660		056	118	16.00	0.60	-0.20
662		050	118	14.79	0.74	0.21
663		059	112	14.70	0.66	0.41
664		062	114	13.64	1.06	0.73
665		062	115	15.44	1.18	----
666		066	113	15.35	0.74	----
667		066	112	15.65	1.18	----
668		070	114	14.61	0.87	0.22
669		072	112	13.69	0.71	-0.15
670		077	113	15.50	1.07	----
671	2407	078	107	12.24	1.06	0.51
672		078	105	14.60	1.01	0.62
673		076	104	14.39	1.05	0.75
674		074	108	14.88	0.77	0.13
675		072	108	14.81	0.51	0.51
676		071	106	14.88	1.00	-0.26
677		070	106	13.84	0.92	-0.06
678		070	104	13.29	0.95	0.32
679		067	099	15.49	0.89	----
680		073	097	15.21	0.90	0.30
681		076	102	15.72	0.65	----
682		081	100	13.62	0.40	0.13
683		082	096	12.03	0.77	0.11
687		081	093	15.04	0.69	0.20
688		076	090	15.51	0.67	----
690		076	087	13.73	0.67	0.07
691	2263	070	084	6.83	-0.10	-0.17
692	2220	066	085	7.41	-0.02	0.31
693		065	089	11.76	0.65	0.03
694		065	088	15.81	1.01	----
695		059	091	15.83	0.67	----

Star No.	H II	X	Y	V	B - V	U - B
696		060	087	15.43	0.94	-0.08
698		061	085	15.41	1.78	----
700		063	082	11.96	0.73	-0.07
701		061	080	15.38	1.14	----
702		058	082	13.30	0.96	0.55
703		053	076	15.25	1.05	0.07
704		058	078	15.14	0.81	0.72
705		059	072	15.27	0.91	----
706		060	071	15.62	0.64	----
706a		062	075	15.68	0.49	0.28
707		062	077	14.39	0.58	0.07
708		066	079	15.60	0.98	----
709		070	076	14.77	1.66	----
710		069	074	14.69	1.06	0.17
714		071	064	15.09	0.84	----
715		063	066	14.94	0.88	0.37
716		057	066	15.46	1.69	----
717		057	061	14.34	1.01	0.50
718		062	060	15.39	0.67	----
719		056	057	13.28	0.82	0.36
720		061	054	15.63	0.62	----
721		063	055	13.55	1.00	0.97
723		067	048	15.06	0.65	0.52
724	2027	056	052	10.84	0.81	0.48
727		060	042	15.03	0.54	0.53
728		063	040	15.41	1.01	----
729		062	039	14.32	1.00	0.78
730		059	040	14.77	0.78	0.20
731		050	042	15.61	0.85	----
732		051	039	13.52	0.42	0.23
736		050	033	15.36	0.62	0.22
737	1912	052	031	8.91	0.49	0.17
738		042	038	15.24	0.81	----
739		042	039	15.30	0.57	----
740		042	045	14.87	1.05	0.45
741		042	048	11.25	1.17	0.96
742		042	049	15.45	1.07	----
743		033	045	15.53	0.88	----
744		030	043	15.55	0.71	----
745		030	044	14.35	0.96	0.50

Star No.	H II	X	Y	V	B - V	U - B
746		030	046	15.46	0.89	----
747		030	047	12.82	0.74	0.21
748		036	052	12.30	0.34	0.24
749		036	054	15.61	0.93	-0.14
750		043	053	15.63	0.83	----
752		040	060	15.54	0.92	----
753	1876	036	061	6.95	0.05	0.02
754		033	064	15.38	0.65	0.39
756		036	070	15.07	1.34	----
757		044	063	15.13	0.61	0.34
758		045	062	14.50	0.75	0.81
759		046	062	10.66	1.41	1.29
760		047	061	12.98	1.21	1.35
761		050	062	14.23	0.80	0.55
762		048	063	12.98	0.67	0.09
763		047	063	15.56	0.68	0.26
764		050	066	14.02	1.25	1.09
765		046	066	15.23	0.94	0.03
768		049	069	15.04	0.87	0.44
769		048	072	15.78	0.63	----
770		042	076	15.15	0.93	----
771		038	080	14.96	0.81	0.07
772		034	084	15.56	0.67	0.57
773		034	086	11.94	0.70	-0.02
774		034	088	14.70	1.06	0.51
775		034	092	13.63	0.64	0.05
776		030	098	15.56	0.79	----
777		033	096	15.72	0.94	----
778		035	096	15.89	0.72	----
780		037	094	15.18	1.06	0.35
781		041	095	15.28	0.98	-0.03
782		047	093	15.45	0.88	0.17
783		094	088	15.59	0.66	----
784		057	100	12.57	0.69	0.05
785		052	098	13.99	0.98	0.51
787		049	100	15.44	0.97	----
789		052	108	15.17	0.86	0.37
790		046	108	15.74	1.67	----
791		038	107	14.69	0.75	0.49
792		037	107	12.65	0.67	0.13

Star No.	H II	X	Y	V	B - V	U - B
793		036	104	15.01	1.12	0.19
794		034	102	15.70	0.86	0.08
795		032	105	13.79	0.80	0.41
796		036	114	15.50	0.93	----
797		041	115	15.66	0.80	----
798		046	118	14.99	0.80	----
799		043	120	15.54	0.63	----
800		039	122	14.13	0.62	0.29
801		034	119	13.98	1.21	1.21
802		034	122	15.41	0.57	0.46
804		046	124	15.88	0.78	----
805	2172	042	130	10.51	0.76	-0.01
806		045	132	15.28	1.03	----
807		047	132	16.09	1.68	----
810	2741	113	131	12.72	0.99	1.17
811	3097	122	244	10.81	0.87	0.27
812	2082	995	216	13.88	1.30	1.38
813	1766	955	225	9.10	0.70	-0.14
814	1776	969	193	10.79	0.93	0.19
815	2778	028	192	10.84	0.95	0.37
816	2244	037	160	12.90	1.03	0.77
817		039	132	14.13	0.62	0.29
820		028	133	14.35	0.97	0.78
824		018	134	15.03	1.08	0.46
825		017	134	13.70	0.54	0.41
826		016	136	13.88	1.56	----
827		016	133	15.23	0.79	0.44
830		015	129	11.80	0.81	0.13
831		024	129	14.95	0.78	0.47
834		012	122	12.96	0.69	0.08
837		021	118	14.55	1.34	----
838		022	118	14.97	1.34	----
839		026	122	10.72	0.63	0.10
840		029	122	15.55	0.94	----
842		029	106	15.71	0.90	----
843		028	106	15.71	0.63	0.47
844		030	103	14.25	0.75	0.49
845		026	102	15.77	0.98	----
846		021	100	15.13	1.12	----
847		019	099	15.65	0.78	-0.43

Star No.	H II	X	Y	V	B - V	U - B
849		012	100	15.52	1.01	----
850		012	104	15.91	0.73	----
851		020	112	15.56	1.02	----
853		016	112	14.42	0.79	0.23
854		014	113	15.57	0.78	----
855		012	114	15.68	1.14	----
857		007	120	15.60	0.76	----
858		008	113	15.05	0.88	0.25
862		005	103	15.65	0.98	----
863		006	104	15.22	0.82	----
864		006	108	15.25	1.00	0.12
866		004	113	14.50	0.77	0.51
867		002	117	15.53	0.97	----
869		001	122	13.50	0.80	0.28
870		003	122	15.42	0.63	----
871		005	126	15.63	0.75	----
874		997	125	15.88	0.71	----
875		994	136	15.88	0.71	----
876		987	128	15.57	0.76	----
879		983	130	15.51	0.85	----
880		982	126	13.56	1.11	1.34
881		981	128	13.04	0.96	0.61
882		980	128	13.34	0.87	0.31
883		987	132	12.32	1.28	1.12
884		974	132	13.53	0.83	0.42
885		973	133	16.06	0.70	----
887		962	132	15.35	0.99	----
889		972	128	16.02	0.80	----
891		974	128	15.69	1.01	----
894		972	123	15.54	1.01	----
896		976	116	16.02	1.56	----
897		980	114	13.89	0.72	0.22
899		988	117	15.44	1.28	----
901		993	119	15.47	1.04	----
902		996	115	15.95	0.69	----
903		991	112	15.40	2.12	-1.10
905		992	110	15.43	0.71	0.48
906		001	107	14.21	0.92	0.81
907		999	105	15.55	0.78	0.34
908		996	102	13.92	0.93	0.45

Star No.	H II	X	Y	V	B - V	U - B
909		993	102	15.07	0.85	0.47
910		994	100	14.38	0.72	0.19
911		992	099	15.29	1.00	0.07
912		990	102	15.44	0.73	----
913		986	104	15.76	0.71	----
914		983	103	15.67	0.75	0.14
915		985	100	15.42	1.07	0.13
916		986	092	15.02	1.24	----
917		985	090	15.99	0.66	----
918		985	086	15.32	0.76	0.07
919		988	092	15.39	1.06	----
920		990	092	13.33	0.60	0.16
921		991	092	15.36	1.18	----
922		991	094	13.92	0.81	0.49
923		998	097	15.61	0.63	----
924		002	100	15.44	1.30	----
925		003	096	14.36	0.80	0.43
927		002	090	15.75	0.56	0.20
928		996	086	13.62	1.10	0.97
929		994	080	15.46	1.13	----
930		991	074	14.73	1.04	0.54
931		996	073	15.24	0.94	----
932		994	078	15.51	0.78	----
933		996	078	15.52	0.79	----
933a		999	078	14.84	0.71	0.35
934		000	082	14.80	1.39	----
938		010	074	12.16	1.02	0.15
939		008	079	12.16	1.02	0.15
941		007	086	15.57	0.99	----
942		013	088	14.03	1.61	0.93
943		016	090	14.63	0.64	0.25
944		018	085	15.12	0.83	0.28
945		026	088	15.05	0.93	0.27
946		029	078	13.06	0.65	-0.02
947		031	074	16.03	0.53	----
948		027	072	15.31	1.16	----
949		025	075	15.23	1.22	----
950		025	076	15.92	0.67	----
951		021	070	15.44	0.46	0.26
952		015	064	15.08	0.88	0.16

Star No.	H II	X	Y	V	B - V	U - B
953		013	062	14.96	1.47	----
955		028	062	15.83	1.22	----
956		024	060	15.41	1.20	----
957		023	058	15.15	0.90	0.30
958		023	055	15.23	1.13	----
959	1762	026	051	8.16	0.22	0.32
960		022	052	14.72	0.97	0.62
961		016	054	15.83	0.91	----
963		013	048	13.56	0.63	0.45
964a		005	053	11.24	1.27	1.18
965		006	054	15.52	1.23	----
966		002	060	15.45	0.92	----
967		000	066	15.25	0.80	0.26
968		998	068	15.58	0.82	----
969		998	063	15.31	0.71	0.14
971	1514	998	050	12.51	0.70	0.11
972		994	052	14.64	0.83	0.30
973		988	054	14.86	1.06	----
974		988	055	15.59	1.67	----
975		988	058	15.99	1.13	----
976		987	059	15.87	0.70	----
979		984	059	11.66	1.35	1.86
981		974	060	11.52	1.18	0.81
982		978	060	16.06	0.62	----
983		979	062	15.90	1.46	----
984		980	065	14.49	0.70	0.42
985		982	069	15.47	0.78	----
987		979	071	14.39	0.60	0.48
988		976	073	13.06	0.55	0.34
989		975	074	15.54	0.94	----
990		969	070	14.70	1.24	----
991		968	072	15.63	1.07	----
992		969	075	14.39	0.56	0.52
994		978	076	15.82	0.86	----
996		978	075	15.86	0.78	----
997		982	074	12.29	1.27	1.52
998		980	077	15.43	0.81	0.57
999		982	078	15.49	0.81	0.29
1000		982	079	14.91	1.10	0.51
1001		980	081	10.15	1.45	2.08

Star No.	H II	X	Y	V	B - V	U - B
1003		975	084	13.91	0.85	0.66
1004		973	083	10.26	1.85	2.55
1005	1384	967	088	7.64	0.19	0.16
1007		978	090	14.24	1.06	1.01
1008		981	088	15.71	0.83	0.37
1009		980	094	15.29	0.94	0.00
1010		972	094	14.38	0.62	0.30
1012		975	094	15.74	0.72	----
1013		977	094	14.97	1.09	0.62
1014		978	095	15.43	0.76	0.46
1015		980	099	15.10	0.71	0.37
1016		976	100	15.85	0.91	-0.23
1017		974	100	14.67	1.10	0.61
1018		973	100	16.18	0.54	----
1019		976	110	14.10	0.81	0.29
1020		976	111	15.72	0.86	0.26
1021		975	112	13.05	0.84	0.09
1022		972	112	12.43	0.61	0.91
1023	1454	966	109	12.84	1.07	1.30
1024		964	112	15.09	0.97	0.40
1024a		964	114	14.93	1.02	0.28
1027		966	120	15.47	0.81	0.30
1028		954	127	15.81	1.12	-0.02
1029		953	126	15.03	0.91	0.32
1030		947	120	15.15	1.33	----
1032		956	122	14.33	0.44	0.27
1033		959	120	15.03	1.34	----
1034		960	116	14.61	0.87	0.45
1035		959	109	14.27	0.72	0.62
1039		952	107	15.85	1.51	----
1040		954	106	14.90	0.61	0.58
1041		964	102	8.47	0.32	0.06
1042		967	098	15.33	1.42	----
1044		959	096	13.52	0.60	0.36
1045		959	094	15.71	0.79	----
1045a		959	092	15.42	0.66	0.38
1046		953	094	15.44	1.14	----
1049		956	084	14.22	1.23	0.74
1050		950	078	15.57	0.90	----
1051		946	080	15.44	1.13	----

Star No.	H II	X	Y	V	B - V	U - B
1052		948	091	10.24	1.34	1.35
1053		946	092	15.31	0.91	0.30
1054		943	090	15.19	1.18	-0.01
1056		937	093	15.45	1.22	----
1057		934	094	15.08	1.06	0.04
1059		938	108	15.14	1.00	0.29
1060		940	117	15.45	1.28	----
1061		935	112	14.69	0.61	0.65
1062		927	108	15.40	1.09	----
1063		925	108	15.73	1.43	----
1064		921	108	15.79	0.92	----
1065	1095	920	104	11.88	0.76	0.83
1066		919	103	14.34	0.90	0.58
1067		918	102	16.05	0.68	----
1068		909	094	15.21	1.03	0.17
1069		911	091	15.91	1.44	----
1071		908	088	15.92	1.38	----
1072		914	090	15.50	0.92	0.10
1073		914	094	14.47	1.04	0.73
1074		920	094	15.26	1.30	----
1074a		923	086	14.98	0.93	0.92
1075		919	084	15.36	0.68	0.51
1076		939	084	13.85	0.49	0.46
1078		939	079	13.49	1.11	1.05
1079		941	079	14.66	1.62	----
1081		943	071	12.91	0.73	0.15
1084		938	065	15.68	0.74	----
1085		937	068	15.20	0.78	0.38
1086		937	072	15.78	0.84	0.04
1087		934	071	15.65	0.98	----
1090		930	072	13.57	0.75	0.58
1092		932	078	15.75	0.99	----
1093		926	076	14.86	0.71	0.34
1094		926	078	15.81	1.14	----
1095		924	080	14.95	1.11	----
1096		922	080	15.64	1.15	----
1097		921	080	14.32	1.03	----
1098		918	077	15.82	0.73	----
1099		914	074	13.61	1.17	1.59
1100		914	073	15.53	1.07	0.47

Star No.	H II	X	Y	V	B - V	U - B
1101	916	912	072	11.63	0.49	0.94
1102		908	072	14.15	1.36	----
1103		909	074	13.26	0.50	1.27
1104		908	080	15.25	1.14	0.19
1105		910	081	15.72	0.65	----
1106		906	082	14.75	1.60	----
1107		901	080	15.88	1.90	----
1108		898	076	14.73	0.99	0.25
1108a		898	075	15.34	0.73	0.26
1110		902	070	15.42	0.81	----
1111		896	070	15.21	1.01	0.46
1112		897	068	15.46	0.99	0.04
1113		898	067	15.05	0.43	0.68
1117		890	072	15.79	0.69	----
1118		890	076	15.44	1.05	----
1119		886	068	14.73	1.21	----
1120	727	888	064	9.67	0.66	0.01
1121		889	059	15.32	1.03	----
1122		883	057	15.59	0.91	0.01
1123		880	057	13.47	0.91	1.19
1125		858	102	14.70	1.67	----
1126	627	856	108	9.66	0.85	-0.07
1126a	605	851	114	8.96	0.46	0.16
1127	739	867	118	9.41	0.68	0.15
1128	885	889	118	12.02	0.75	1.19
1129a		913	103	14.03	1.41	----
1130	1207	929	119	10.41	0.68	0.22
1131	1266	934	126	8.20	0.54	0.09
1133	1440	947	154	15.57	0.85	0.18
1133a	1101	905	145	10.30	0.65	0.04
1133b	1015	881	177	10.60	0.67	0.03
1134	233	873	889	9.64	0.51	0.24
1135	129	965	859	11.55	0.86	0.44
1136	120	870	841	10.88	0.61	0.24
1137	157	879	839	8.02	-0.11	0.49
1138	164	884	829	9.66	0.41	0.14
1139	152	885	815	10.83	0.82	-0.04
1141	248	902	824	11.16	0.70	0.26
1142	296	923	795	11.43	0.92	0.38
1143	530	937	875	8.95	0.36	0.16

Star No.	H II	X	Y	V	B - V	U - B
1148		950	877	14.12	0.69	0.66
1149		963	867	12.88	0.93	0.50
1150		963	863	14.26	1.59	----
1151		966	862	15.34	1.09	----
1153		977	873	11.84	1.43	1.33
1154		976	868	13.30	0.76	0.68
1155		977	865	14.38	0.95	0.46
1156		976	863	14.02	1.44	1.14
1157	636	968	839	11.98	0.96	0.44
1158	513	957	811	13.68	1.26	1.28
1159	470	962	787	9.02	0.41	0.09
1160	801	014	781	7.02	0.20	-0.31
1161	948	033	784	8.68	0.58	0.25
1162	945	026	799	13.40	0.98	0.94
1164	923	014	825	10.19	0.59	0.27
1165	915	012	825	13.62	1.27	1.21
1166	882	004	835	12.61	1.07	0.84
1168		031	860	11.61	1.74	----
1169		024	858	15.57	0.89	----
1170	1136	024	864	11.98	0.96	0.58
1171		014	855	15.62	1.81	----
1172		009	855	15.58	0.96	0.01
1173	975	008	855	10.56	0.88	0.40
1174		005	855	14.80	1.15	0.25
1176		001	861	15.62	1.18	----
1177		002	861	15.72	0.61	----
1178		006	863	12.26	0.99	0.49
1179		015	869	15.84	1.68	----
1180		014	876	15.13	1.49	----
1181		008	875	15.02	1.34	----
1182		007	879	12.83	1.10	0.95
1183		004	875	15.09	1.25	----
1186		000	875	14.80	1.15	0.77
1187		992	879	15.45	1.00	----
1190		006	891	15.53	1.14	----
1191	1084	009	887	8.09	0.19	0.63
1195		018	888	15.79	0.90	----
1199		024	890	15.80	1.78	----
1203		029	900	15.05	1.02	0.06
1204		031	900	14.81	1.23	0.39

Star No.	H II	X	Y	V	B - V	U - B
1206		043	895	13.92	1.06	0.71
1207		044	890	14.21	0.77	0.65
1208		040	884	15.26	0.90	----
1209		037	887	14.45	0.93	0.47
1210		035	893	15.40	1.04	----
1211		032	895	15.01	1.19	----
1213		028	892	14.87	0.92	0.45
1215	1215	027	885	10.52	0.58	0.37
1217		033	883	14.84	1.26	----
1221	1275	040	870	11.54	0.87	0.48
1222		034	908	15.63	1.31	----
1222a		041	909	14.41	0.96	0.76
1223	1425	044	913	7.77	0.07	0.13
1224		043	925	15.07	0.75	-0.02
1225		038	927	13.69	1.17	0.85
1226		035	928	15.52	0.92	----
1227		032	920	6.96	0.44	0.00
1228	1332	031	916	12.50	0.93	0.97
1229		026	921	14.89	1.30	----
1231	1306	027	914	13.35	1.39	1.38
1232	1298	026	915	12.24	1.05	0.82
1233		024	915	14.63	0.93	0.11
1234		024	911	13.86	0.75	0.47
1235		018	913	15.32	0.91	0.32
1236		018	919	14.21	0.75	0.32
1237		016	921	14.97	0.80	0.40
1238		014	923	15.53	0.89	----
1239		014	915	14.10	0.92	0.76
1240		007	913	15.34	0.96	----
1241		004	912	13.77	1.17	1.10
1242		009	922	15.26	1.19	----
1243		008	924	14.36	1.21	----
1244		010	927	15.65	0.86	----
1245		010	931	13.10	0.75	0.35
1247		011	936	15.37	0.72	0.27
1248		018	930	15.78	0.72	----
1249		019	928	14.52	0.99	0.69
1250		020	929	15.62	0.73	----
1251		023	929	9.33	0.54	0.21
1253		024	937	10.87	0.61	0.68

Star No.	H II	X	Y	V	B - V	U - B
1254	1380	029	936	6.99	0.10	-0.11
1255		042	937	14.93	0.96	0.27
1258		034	953	14.34	1.10	0.59
1261		041	957	14.74	1.20	----
1262		040	958	15.55	0.72	----
1263		038	960	15.22	0.71	0.66
1264		036	960	15.34	1.06	----
1265		040	964	13.55	1.04	0.95
1266		043	964	13.99	1.18	0.92
1267		043	965	13.96	1.09	1.08
1270		047	963	15.33	1.21	----
1271		048	964	15.33	1.04	----
1272		052	965	15.04	1.05	0.03
1273		052	963	11.03	1.36	1.63
1277		056	959	14.79	0.74	----
1278		058	955	15.44	0.87	----
1279		058	962	12.35	0.76	0.12
1280		059	963	15.76	0.80	----
1281		060	963	16.06	1.85	----
1282		065	962	15.37	0.74	----
1283		067	964	14.31	0.61	0.20
1284		062	965	15.11	0.96	----
1285		064	966	14.75	0.96	0.02
1286		063	970	10.33	0.64	0.26
1287		061	971	15.17	1.15	----
1288		058	973	15.50	0.56	----
1289		056	973	15.84	0.73	----
1292		048	978	15.70	0.65	----
1293		044	985	14.30	0.95	0.40
1294		046	985	14.42	0.53	----
1295		047	988	14.69	1.39	----
1296		050	990	15.70	2.02	----
1297		051	989	11.74	1.67	2.28
1300		057	986	15.54	0.92	-0.10
1302		061	987	14.47	1.37	----
1303		060	978	15.82	0.49	----
1305		076	981	15.49	0.95	----
1306		074	982	14.77	0.91	0.04
1307		073	979	12.28	1.21	0.77
1308		072	978	14.50	0.73	0.33

Star No.	H II	X	Y	V	B - V	U - B
1309		071	979	13.53	0.57	0.16
1310		067	979	15.29	0.80	0.08
1311		064	981	14.82	0.87	0.50
1312		065	982	15.08	0.84	0.27
1313		067	983	15.51	1.08	----
1314		065	986	15.32	0.87	----
1315		068	986	13.97	0.84	0.54
1317		061	997	15.83	0.50	----
1321		069	994	15.58	1.79	----
1322		070	994	15.61	1.97	----
1323		075	001	14.71	0.75	0.60
1325		078	997	15.60	0.89	----
1326	2034	080	997	12.58	0.90	0.92
1327		081	991	14.12	0.77	0.02
1328		086	988	15.66	1.94	----
1329		089	989	15.16	1.20	----
1330		090	997	13.43	1.21	1.35
1331		094	000	13.22	0.73	0.20
1332		098	001	15.42	0.52	0.27
1334		108	003	15.57	0.98	----
1335		109	999	14.85	0.80	0.32
1336		112	003	15.53	0.95	----
1337		114	007	15.78	0.47	----
1340		110	017	14.74	1.20	----
1341		113	024	10.63	0.97	0.95
1342		115	023	15.38	0.70	0.14
1343		121	027	15.47	1.50	----
1344		123	027	12.52	0.62	0.31
1345		121	022	15.81	1.50	----
1346		117	017	14.39	0.84	0.22
1348		118	008	13.26	0.59	0.06
1349		122	007	15.36	0.78	-0.04
1354		122	995	14.15	0.92	0.14
1355		117	991	11.83	1.58	1.75
1356		113	989	14.22	1.14	0.41
1357		111	993	15.10	0.95	0.07
1358		106	995	15.06	1.11	-0.10
1359		106	996	14.18	0.68	0.20
1361	2195	104	986	8.02	0.30	0.09
1362		104	982	12.05	0.71	0.26

Star No.	H II	X	Y	V	B - V	U - B
1363		105	981	15.40	1.05	----
1364	2284	117	981	11.29	0.90	0.35
1365		124	981	15.03	0.89	0.15
1366		124	975	15.31	1.04	----
1367		121	977	15.08	0.86	----
1368		120	975	11.48	1.09	0.74
1369		121	973	11.99	2.00	1.47
1369a		119	972	15.70	1.40	----
1370		115	971	14.26	1.16	0.31
1373		117	969	15.16	1.03	0.51
1374		119	966	15.67	0.86	----
1375		122	965	15.26	0.84	----
1379		116	955	14.45	0.89	0.30
1381		112	956	15.06	1.31	----
1382		110	962	15.28	1.29	-0.04
1383		110	963	15.44	1.12	-0.16
1384	2147	108	964	10.83	1.00	0.42
1385		106	962	15.68	1.03	----
1386		105	960	15.80	0.99	----
1387		101	958	12.79	0.66	0.00
1390		098	963	14.07	1.23	0.69
1391		099	963	13.90	0.73	0.03
1392		101	962	15.48	0.93	----
1393		103	962	15.84	0.83	----
1394		102	967	15.31	0.89	0.36
1396		096	971	12.40	0.80	0.22
1396a		094	971	15.52	0.92	----
1397		092	972	14.32	0.78	0.34
1398		095	976	6.82	0.13	-0.22
1400		100	983	14.47	1.07	0.33
1401		095	988	14.03	1.01	0.37
1402		096	985	13.79	1.22	1.18
1403		095	982	11.68	1.42	1.34
1404		092	979	14.54	1.47	----
1405		090	979	15.23	0.97	----
1406		083	978	12.91	0.70	0.19
1407		081	976	15.48	1.05	----
1409		076	970	15.08	0.87	----
1410		080	971	14.18	1.25	----
1413		086	962	15.63	0.88	----

Star No.	H II	X	Y	V	B - V	U - B
1414		083	962	11.11	0.55	----
1417		084	958	15.51	0.46	0.22
1419		072	959	15.49	0.94	----
1420		073	959	15.94	1.04	----
1421		072	957	15.52	0.91	0.40
1422		068	958	14.88	0.73	0.44
1423		070	955	15.41	0.68	----
1424		069	953	15.83	0.93	----
1425		068	951	15.97	0.70	----
1426		075	953	15.36	0.74	0.10
1428		076	947	15.93	1.14	----
1430		078	949	15.86	1.09	----
1431		080	947	13.02	1.02	0.59
1432		080	943	15.61	0.65	----
1434		086	949	15.98	0.67	----
1435		090	945	15.33	0.83	0.09
1436		087	952	14.63	0.83	0.16
1437		089	955	11.89	1.36	1.53
1438		090	957	13.06	0.84	0.26
1439		088	957	15.92	1.37	----
1442		098	951	16.02	1.03	----
1443		108	949	15.79	0.97	----
1444		105	945	15.56	0.76	----
1445		101	943	15.57	1.23	----
1446		111	939	13.65	0.67	0.26
1447		114	939	15.77	1.27	----
1448		114	936	15.21	1.23	-0.16
1449		112	928	15.61	1.07	----
1450		111	931	14.44	0.64	0.21
1451		108	931	15.71	1.28	----
1452		104	931	13.46	1.13	1.08
1453		101	933	16.01	1.05	----
1454		104	935	14.80	1.92	----
1455		105	937	15.56	1.00	----
1456		102	937	15.51	0.93	----
1459		092	937	15.65	0.90	----
1460		096	937	15.88	1.04	----
1462		096	932	14.60	0.59	0.34
1463		098	929	15.44	0.78	----
1465		090	931	14.60	0.67	0.17

Star No.	H II	X	Y	V	B - V	U - B
1466		087	934	15.86	1.12	----
1467		085	937	15.88	1.02	----
1469		079	938	13.12	0.70	0.09
1470		077	930	15.09	0.84	0.24
1471		074	934	15.39	0.83	0.01
1473		069	936	14.79	1.22	----
1474		068	937	13.59	0.96	0.33
1475		073	939	15.62	1.30	----
1478		064	939	15.91	1.09	----
1479		064	949	15.58	0.91	----
1480		060	947	15.83	1.10	----
1481		059	949	15.65	1.29	----
1482		055	948	15.80	1.11	----
1483		054	948	15.91	0.88	----
1484		052	950	12.91	1.04	0.76
1485		052	949	13.97	0.72	0.24
1486		054	943	13.24	0.94	0.04
1487		048	936	14.74	0.87	----
1429	1532	049	930	13.85	1.19	1.13
1500		053	933	15.79	0.61	----
1501		055	929	14.18	1.44	1.09
1502		054	927	14.08	1.08	0.92
1504		052	925	15.51	0.89	0.05
1505		053	922	14.86	0.84	0.27
1506		048	922	15.48	0.78	----
1507		045	925	15.08	1.21	----
1508		047	918	15.37	1.19	----
1509		048	915	13.21	0.81	0.62
1510		059	918	15.18	0.89	0.24
1511		061	913	15.71	1.04	----
1512		058	910	15.34	0.88	0.15
1513		066	909	15.98	0.97	----
1514		069	911	15.81	0.71	-0.08
1516		076	913	14.72	1.11	0.84
1517		072	917	11.81	0.76	0.02
1518		073	918	14.62	1.54	----
1519		068	917	15.78	1.00	----
1520		066	920	15.25	1.02	----
1522		069	924	15.86	1.06	----
1523		064	924	12.57	1.20	0.94

Star No.	H II	X	Y	V	B - V	U - B
1524		061	921	15.78	1.02	----
1525		060	923	15.78	1.32	----
1526		064	926	12.57	1.20	0.94
1527		060	935	13.47	0.97	0.33
1528		066	937	13.72	1.46	1.05
1529		064	933	13.82	0.76	0.26
1530		071	927	14.71	0.78	0.31
1531		078	924	15.68	1.04	----
1532		080	923	15.60	1.06	----
1533		081	923	11.88	1.31	0.88
1534		082	924	13.68	0.96	0.67
1535		082	925	15.72	1.08	----
1536	1797	084	921	10.15	0.57	0.10
1537		088	922	15.35	0.80	0.26
1538		088	924	15.89	1.04	----
1539		090	923	11.76	0.69	0.22
1540		096	921	12.90	1.39	1.33
1541		103	921	15.37	1.31	----
1542		105	919	15.00	0.83	0.17
1544		107	910	12.21	0.84	0.17
1545		107	909	15.54	0.73	0.18
1546		104	908	14.38	1.28	----
1547		100	909	15.05	0.49	0.42
1548		103	913	14.47	0.85	0.27
1549		104	913	14.71	0.81	0.33
1550		096	919	15.44	0.63	0.00
1551		097	915	15.76	0.86	----
1552		096	913	15.88	1.33	----
1554		093	911	14.05	1.05	0.84
1555		092	914	13.00	0.74	-0.03
1556		089	915	15.38	1.39	----
1557		088	911	16.13	0.71	----
1558		084	914	15.31	1.02	0.00
1560		086	908	13.84	0.98	0.88
1561		086	906	15.01	0.99	0.54
1563		073	905	12.96	1.23	1.40
1564		072	906	13.15	0.80	-0.02
1568		064	906	15.36	0.85	0.05
1570		046	904	12.13	1.43	1.06
1571		054	903	15.68	1.07	----

Star No.	H II	X	Y	V	B - V	U - B
1572		056	903	7.55	1.17	1.45
1573		057	899	15.46	1.07	----
1574		062	898	16.01	0.91	----
1575		065	899	15.01	0.91	0.17
1578		074	885	14.22	1.16	1.03
1582	1512	069	876	13.44	1.37	1.08
1583		066	871	13.95	0.99	0.52
1586		066	892	8.68	1.02	1.10
1587		066	890	15.71	0.70	----
1589		063	885	15.79	1.33	----
1590		062	891	15.52	0.86	----
1591		062	893	15.71	0.95	----
1594		059	893	15.45	0.89	----
1595		055	892	14.93	1.10	0.33
1597		046	889	15.63	1.47	----
1598		051	888	10.94	0.71	0.27
1599		054	887	10.34	1.56	1.18
1600		054	884	15.29	1.00	----
1601		055	879	15.13	0.85	0.11
1603		046	881	15.81	0.83	----
1604		047	877	15.67	1.20	----
1605		054	873	15.51	0.93	----
1606		054	869	14.96	0.89	0.31
1607		045	869	13.66	0.76	0.29
1608		048	860	13.82	0.70	0.24
1609		046	859	15.17	1.02	0.45
1610	1200	052	817	9.89	0.71	0.06
1611	1305	066	820	13.38	1.14	1.29
1612	1139	055	789	9.52	0.38	0.04
1613	1593	096	831	11.20	0.69	0.37
1614		079	874	15.78	0.82	----
1615		081	874	14.43	0.90	0.29
1616		084	875	9.92	1.28	1.44
1617		086	875	12.45	0.73	0.12
1618		088	877	15.82	1.14	----
1619		082	881	11.42	0.79	0.35
1620		089	883	15.56	1.01	----
1621		094	881	13.98	0.76	0.24
1622		092	889	15.58	1.02	----
1623		090	894	13.96	1.40	0.88

Star No.	H II	X	Y	V	B - V	U - B
1625		085	897	15.39	1.06	----
1626		088	899	15.11	0.73	0.20
1629		098	902	14.39	0.68	-0.02
1630		100	889	15.41	0.70	0.55
1631		103	893	15.06	1.01	----
1632		109	893	15.47	0.58	-0.08
1633	1924	113	887	10.35	0.67	0.22
1633a		116	886	15.69	0.90	----
1633c		111	887	15.75	0.84	----
1635	2016	129	872	13.60	1.15	1.03
1636		114	899	14.11	0.75	0.31
1638		120	905	14.09	0.75	0.13
1639		114	908	9.40	1.86	1.89
1640		114	912	15.42	0.86	----
1642		120	909	15.83	0.81	----
1643	2345	161	895	9.19	0.31	-0.03
1644		156	910	14.00	1.29	0.99
1645		180	947	15.02	1.38	----
1646		125	916	15.40	1.07	0.13
1647		125	917	15.45	0.75	0.03
1648		125	920	15.04	0.89	0.09
1649		120	921	15.57	0.65	0.06
1650		118	923	14.80	0.60	0.30
1652		124	924	14.49	0.78	0.21
1653		127	926	13.66	0.68	0.28
1654		130	922	14.19	1.14	0.86
1656		132	925	15.91	0.63	----
1657		135	926	15.41	0.77	----
1658		135	927	15.14	0.70	0.23
1659		141	939	15.67	1.00	----
1660		140	937	14.97	0.89	0.39
1661		134	933	12.61	1.02	0.91
1663		128	931	15.15	1.42	----
1664		125	933	10.89	0.62	-0.13
1665		126	934	15.35	0.93	----
1666		126	937	14.56	0.68	0.14
1669		122	936	14.00	0.74	0.29
1670		118	936	14.77	1.31	----
1671		117	937	15.48	0.71	0.04
1672		118	939	12.82	1.23	0.88

Star No.	H II	X	Y	V	B - V	U - B
1673		120	945	15.51	0.79	0.17
1675		128	957	15.65	1.34	----
1676	2311	130	958	11.36	0.97	0.26
1677		134	955	15.67	1.02	----
1678		143	947	14.27	1.11	0.68
1679		147	957	14.83	1.08	----
1681		141	954	15.65	0.92	-0.06
1682		142	955	13.27	0.74	0.14
1683		136	957	13.82	0.80	0.12
1684		135	959	15.20	0.44	0.35
1686	2462	147	963	11.57	0.79	0.46
1687		146	968	14.56	0.52	0.20
1688		141	969	11.41	0.73	0.25
1690		132	969	14.38	0.93	0.13
1692		128	975	15.73	0.99	----
1693	2341	127	975	10.84	0.92	0.16
1695		138	977	11.51	0.57	-0.02
1696		150	975	15.63	0.81	----
1697		145	978	14.32	1.12	0.63
1698		138	983	15.47	0.97	0.22
1699		126	989	15.43	1.14	----
1700		131	989	14.91	0.68	0.36
1701		138	996	15.74	0.94	----
1703		137	989	15.09	0.47	0.32
1705		137	987	15.50	0.85	0.13
1706		144	989	14.75	0.68	0.23
1707		146	985	14.74	0.60	0.33
1708		150	985	15.17	0.87	----
1709		152	987	15.08	0.88	0.16
1710		154	992	13.21	0.79	-0.14
1711		149	994	14.97	0.84	0.26
1712		146	997	15.38	1.00	----
1713		148	999	15.09	0.77	0.06
1714		150	999	15.75	0.76	----
1714a		149	000	14.89	0.75	0.40
1715		147	005	15.23	0.89	----
1716		150	005	13.32	0.94	0.46
1717		151	005	13.25	0.52	0.19
1718		154	007	12.59	0.85	0.00
1719		152	011	13.59	1.09	0.24

Star No.	H II	X	Y	V	B - V	U - B
1720		151	009	15.78	1.04	----
1720a		146	015	14.55	0.89	0.12
1721		142	015	14.28	0.62	0.05
1722		144	010	15.64	1.21	----
1724		137	007	13.56	0.69	0.10
1725		137	010	14.82	1.02	0.35
1726		136	013	14.21	1.02	0.07
1727		137	017	15.25	0.81	0.54
1728		132	013	9.77	0.45	0.18
1729		132	011	14.71	0.61	0.22
1730		129	007	15.77	1.07	----
1731		128	007	15.58	1.19	----
1732b		128	015	15.61	0.97	----
1733		125	021	15.61	0.67	----
1734		132	022	14.95	0.60	0.39
1735		138	021	15.92	1.45	----
1736		140	024	15.66	0.72	----
1737		139	026	15.19	1.21	----
1738		148	020	11.74	1.30	1.14
1739		149	021	13.86	1.46	1.04
1740		149	023	15.74	0.97	----
1741		148	023	14.37	1.07	1.10
1742		141	031	15.23	1.02	----
1743		134	028	15.87	0.68	----
1744		134	029	12.34	1.05	0.94
1745		134	031	15.68	0.91	----
1746		127	032	14.71	0.70	0.53
1747		128	036	15.58	1.00	----
1748		142	036	15.82	0.86	----
1752		144	043	15.12	0.80	0.24
1752a		146	045	14.27	0.89	0.28
1753		132	041	14.84	0.56	0.36
1755		134	043	13.94	1.06	0.60
1756		135	045	15.67	0.92	----
1757		131	051	15.49	1.06	----
1758		132	052	15.92	0.80	----
1760		128	055	15.40	1.06	----
1760a		128	057	15.62	0.89	----
1763		134	063	13.92	0.94	0.58
1765		132	065	13.61	1.16	0.64

Star No.	H II	X	Y	V	B - V	U - B
1766		132	070	13.85	0.89	0.13
1767	2880	154	079	11.70	0.91	0.32
1768	3019	184	067	13.36	1.13	1.19
1770	2786	165	023	10.38	0.58	0.06
1771	2881	184	009	11.52	0.88	0.66
1772	2984	200	014	12.46	1.04	0.74
1773	3030	201	027	14.59	0.74	0.23
1774	3063	204	032	13.46	1.18	0.93
1775	3179	224	041	10.02	0.84	-0.15
1776		274	106	13.94	0.93	0.24
1777		273	112	11.58	0.37	1.59
1778		273	114	13.17	0.72	0.18
1779		270	119	15.17	1.17	-0.14
1780		273	118	14.87	1.17	0.09
1781		274	119	15.62	1.20	----
1782		278	111	14.14	0.92	0.74
1783		289	109	14.58	0.74	0.58
1784		309	119	11.77	1.50	1.68
1786		305	120	15.92	(2.0)	----
1789		315	121	9.59	0.72	-0.04
1790		316	122	15.84	1.61	----
1792		319	124	14.64	0.86	0.03
1793		317	125	15.68	1.29	----
1794		314	131	15.88	1.14	----
1795		312	130	13.61	0.96	-0.15
1796		302	127	15.67	2.03	----
1799		307	139	15.34	1.38	----
1800		308	141	15.13	1.03	0.02
1801		305	144	15.71	1.11	-0.35
1802		302	145	15.45	1.07	-0.14
1803		303	153	15.77	1.50	----
1804		300	133	15.63	0.95	-0.24
1805		301	134	14.18	0.77	0.33
1806		302	141	13.57	1.04	0.31
1807		297	142	14.87	0.97	0.13
1808		298	143	13.50	0.68	0.01
1809		302	146	15.63	0.91	-0.36
1810		297	146	15.49	1.44	----
1813		290	145	13.90	1.29	0.62
1814		283	146	16.00	(1.7)	----

Star No.	H II	X	Y	V	B - V	U - B
1815		284	145	14.93	1.01	----
1816		284	143	15.74	1.05	----
1817		282	139	15.89	----	----
1818		280	138	15.85	(1.15)	----
1820		284	134	15.50	1.10	-0.32
1821		275	122	16.04	1.73	----
1822		274	122	15.61	1.62	----
1824		276	134	15.70	(1.7)	----
1825		275	137	13.05	1.06	1.17
1828		264	137	14.87	1.08	0.88
1829		260	145	14.59	1.67	0.14
1830		255	150	15.76	1.28	----
1831		252	156	15.87	1.69	----
1832		253	156	15.68	(1.4)	----
1834		257	155	14.51	0.43	----
1835		263	153	15.48	0.96	-0.23
1837		267	153	15.64	(2.2)	----
1839		270	156	15.97	1.80	----
1842		277	151	15.59	1.10	----
1843		281	151	15.68	1.52	----
1844		285	158	13.99	1.02	0.72
1846		298	156	15.76	1.31	----
1849		301	158	14.55	0.83	-0.43
1850		302	159	15.43	1.29	----
1851		301	162	15.79	0.71	-0.28
1853		297	162	15.75	1.00	-0.23
1854		292	163	14.52	1.15	0.05
1855		291	165	16.20	1.46	----
1856		292	167	15.37	1.25	-0.08
1858		292	171	15.79	1.23	----
1859		294	176	10.92	1.08	-0.05
1860		283	187	12.35	0.73	0.48
1862		284	185	15.50	1.13	-0.30
1865		286	179	12.87	1.09	0.41
1866		286	178	15.41	1.68	----
1868		285	175	15.64	1.41	-0.78
1869		279	174	15.73	1.17	----
1870		279	169	14.24	1.03	0.00
1871		280	170	10.17	1.07	0.11
1873		284	166	12.35	1.31	0.84

Star No.	H II	X	Y	V	B - V	U - B
1874		286	163	15.44	1.10	0.05
1875		283	165	14.76	1.44	0.20
1877		280	166	12.66	0.80	0.14
1878		281	159	14.43	0.78	0.29
1879a		278	159	15.46	1.26	0.58
1880		276	163	11.20	0.71	-0.06
1881		275	166	13.59	0.65	0.19
1883		270	161	15.53	0.79	-0.08
1884		265	158	15.68	1.47	----
1885		262	160	12.79	1.29	1.02
1886		258	161	14.09	1.56	0.49
1888		257	165	13.29	0.71	0.11
1889		252	167	16.00	(2.0)	----
1891		252	171	14.31	0.67	0.36
1892		251	171	13.73	1.05	0.52
1893		252	175	15.70	1.16	0.81
1894		253	175	14.68	0.81	0.22
1897		257	173	15.49	1.93	----
1898		266	177	14.28	1.12	0.78
1899		269	178	15.37	1.04	-0.15
1900		267	175	14.37	1.21	0.49
1901		263	174	15.27	1.37	----
1902		263	171	14.01	1.25	0.71
1904		268	172	15.83	1.58	----
1905		266	167	15.26	0.38	----
1906		266	166	14.84	0.81	0.14
1907		271	169	15.55	1.27	----
1908		274	170	14.27	0.73	0.12
1909		274	172	15.99	0.56	----
1910		275	179	12.46	1.04	0.88
1912		274	181	15.50	1.20	----
1914		272	185	12.33	0.90	0.39
1915		274	189	15.61	1.34	----
1916		275	192	13.93	1.05	0.89
1917		274	202	13.50	0.92	0.74
1918		272	206	15.70	1.06	----
1919		270	205	15.78	1.31	----
1920		270	203	14.33	1.07	0.18
1921		268	199	12.66	1.16	1.18
1922		264	200	15.65	1.29	----

Star No.	H II	X	Y	V	B - V	U - B
1923		264	197	14.81	(1.9)	----
1925		266	195	15.43	1.01	----
1926		268	192	15.76	0.86	-0.33
1927		268	191	14.27	0.99	0.33
1929		265	192	15.61	(2.2)	----
1930		263	193	15.82	1.39	----
1932		261	190	15.22	1.91	----
1933		258	193	15.61	1.49	----
1935		257	189	15.92	1.86	----
1936		259	187	15.88	1.71	----
1937		260	185	15.68	1.20	0.54
1938		260	183	14.33	0.87	0.30
1941		255	186	15.49	1.09	-0.25
1943		249	180	13.97	1.00	0.28
1944		251	179	15.49	0.72	0.15
1946		244	178	15.39	1.43	----
1947		243	176	15.23	1.65	----
1949		238	177	15.78	1.04	----
1951		235	181	15.22	0.72	-0.02
1952		232	183	14.68	0.83	0.03
1953		231	183	13.94	0.64	0.33
1954		230	185	15.84	1.33	----
1957		228	190	14.04	1.22	0.85
1958		226	191	15.61	1.57	----
1959		230	192	15.59	0.89	-0.06
1960		234	192	15.14	1.43	----
1961		238	190	14.04	1.17	0.58
1962		239	189	15.51	1.21	----
1965		240	193	12.25	0.63	-0.06
1967		244	195	15.72	1.32	----
1968		246	193	14.36	0.76	0.71
1970		244	187	15.39	0.69	-0.03
1971		246	188	15.74	(2.21)	----
1972		251	193	13.96	0.64	0.78
1977		265	207	15.45	1.51	----
1978		266	208	12.26	1.20	1.26
1979		268	213	9.56	0.86	-0.23
1980		262	217	15.41	1.18	----
1982		261	211	14.95	0.73	0.02
1983		259	209	12.25	1.60	2.17

Star No.	H II	X	Y	V	B - V	U - B
1984		260	209	14.24	1.32	0.65
1985		254	206	15.01	1.28	0.12
1986		255	208	14.32	0.70	0.66
1987		254	209	15.10	1.22	----
1992		245	211	14.27	1.41	0.72
1993		243	207	15.57	1.33	----
1995		242	202	15.44	1.13	----
1998		232	197	15.68	1.31	----
1999		228	195	13.90	1.30	1.08
2000		222	195	14.70	0.93	-0.04
2004		233	203	9.40	1.77	2.27
2005		234	204	15.16	0.82	0.12
2006		234	209	15.74	1.48	----
2007		229	209	15.37	0.70	0.05
2008		229	207	15.54	1.98	----
2009		222	204	14.93	0.99	0.03
2010		216	200	14.98	0.77	0.17
2011		220	206	13.81	0.63	0.35
2015		226	211	14.90	1.05	-0.25
2019		227	218	15.10	1.50	----
2020		232	219	10.53	0.71	-0.15
2021		238	223	13.39	1.01	0.70
2022		234	215	12.88	0.78	0.17
2027		248	225	15.34	1.12	-0.02
2028		249	226	15.64	2.21	----
2036		249	235	15.89	1.46	----
2037		247	234	15.48	1.94	----
2040		240	229	15.48	0.77	0.01
2041		238	229	14.90	1.06	0.09
2042		238	231	14.11	1.53	0.45
2043		233	228	15.51	1.20	----
2044		238	233	15.71	1.51	----
2045		238	234	15.44	1.40	----
2046		239	237	15.59	0.93	-0.33
2047		240	237	16.05	0.76	----
2048		242	240	15.86	1.73	----
2049		235	246	15.48	1.12	-0.34
2050		231	248	15.12	1.13	-0.16
2051		231	247	12.68	0.78	0.26
2052		230	243	15.82	1.18	----

Star No.	H II	X	Y	V	B - V	U - B
2053		233	241	15.11	0.74	0.02
2054		233	239	13.95	0.90	0.37
2055		235	237	14.20	1.01	0.64
2056		228	232	13.24	1.36	0.70
2057		227	238	15.50	1.16	-0.39
2058		224	237	14.66	1.33	0.59
2059		222	239	15.56	1.24	----
2063		225	225	15.63	1.34	----
2065		219	223	15.69	1.55	----
2066		218	219	14.35	0.89	0.40
2067		210	214	15.33	1.94	----
2068		209	219	15.43	1.42	----
2070		212	222	15.22	2.07	----
2071		211	222	14.84	0.94	0.45
2072		213	226	15.54	1.83	----
2073		217	226	15.47	1.09	----
2074		217	227	15.78	2.00	----
2075		212	230	15.95	1.52	----
2076		208	231	15.91	1.51	----
2077		210	235	13.57	0.77	0.05
2078		213	239	15.00	0.81	----
2080		210	244	16.23	1.27	----
2081		212	244	14.75	1.24	-0.01
2082		216	244	15.39	1.43	----
2083		217	247	15.11	1.17	----
2084		214	252	12.21	1.64	1.80
2085		214	257	15.18	0.66	0.21
2086		212	258	14.09	0.96	0.26
2089		214	265	13.13	0.63	-0.07
2090		209	267	13.38	1.10	0.66
2091		208	267	15.80	1.65	----
2092		205	265	15.30	1.31	----
2093		204	265	15.04	1.05	-0.25
2094		210	263	12.52	1.10	0.69
2095		209	262	12.22	0.48	0.09
2096		209	260	13.43	1.23	0.97
2097		205	260	14.98	1.07	-0.05
2098		210	256	16.11	1.44	----
2099		210	253	15.39	1.08	0.06
2100		208	253	12.43	1.09	0.84

Star No.	H II	X	Y	V	B - V	U - B
2101		207	255	12.96	0.65	-0.01
2102		208	250	14.38	1.37	0.42
2103		203	248	15.33	0.72	-0.04
2104		203	247	15.70	1.32	----
2105		198	244	15.68	2.02	----
2106		194	242	15.96	1.09	----
2107		196	241	14.71	0.69	0.41
2108		197	241	15.52	0.94	-0.25
2109		201	239	15.59	0.71	-0.08
2110		200	238	13.59	0.56	0.09
2111		202	231	15.14	1.10	0.07
2112		202	227	13.91	0.77	0.28
2114		198	215	9.42	0.67	-0.36
2115		203	214	15.50	1.15	----
2116	3163	181	133	12.61	1.11	0.65
2117	3031	151	151	8.80	0.42	0.13
2118	3096	157	160	12.07	0.99	0.74
2119	2927	117	186	13.65	1.20	1.35
2120	3197	165	189	12.09	1.11	0.79
2121		181	229	12.30	0.90	-0.27
2122		174	235	15.20	0.96	----
2123		166	244	13.72	0.73	0.05
2124		172	242	14.92	0.72	0.09
2125		175	246	15.77	1.33	----
2127		183	238	15.22	0.83	0.04
2128		188	237	12.38	0.46	0.15
2129		188	239	14.09	0.99	0.74
2130		186	240	15.11	0.99	0.09
2132		181	243	14.01	0.87	0.50
2133		182	246	14.80	0.90	0.33
2134		185	247	14.69	1.06	0.08
2135		193	246	12.24	0.64	-0.06
2136		191	248	14.29	1.47	0.55
2137		189	251	15.64	1.12	----
2138		186	251	16.06	0.94	----
2139		186	253	14.19	1.41	----
2140		189	257	15.24	0.85	-0.07
2141		193	255	13.46	0.84	0.39
2142		194	258	15.24	1.64	----
2143		195	259	13.70	0.69	-0.11

Star No.	H II	X	Y	V	B - V	U - B
2144		200	255	13.42	1.07	1.03
2145		202	257	14.02	0.62	0.30
2146		200	257	10.16	0.68	----
2147		202	269	15.59	1.76	----
2148		199	271	13.74	1.17	0.89
2149		196	273	14.90	0.84	-0.01
2150		194	273	14.03	1.62	----
2151		191	274	15.52	0.75	0.23
2152		192	276	14.70	1.11	0.18
2153		189	277	15.45	1.05	0.34
2154		185	283	14.57	1.83	----
2155		182	283	14.18	0.69	0.11
2156		184	281	13.85	0.98	0.66
2157		182	271	13.81	0.74	0.04
2158		184	268	14.31	0.85	0.55
2159		188	270	15.47	1.46	----
2163		192	262	15.70	1.62	----
2164		184	264	15.79	1.86	----
2165		183	262	13.97	0.57	0.96
2166		184	261	15.78	1.52	----
2167		184	259	15.64	1.25	----
2169		176	257	15.59	1.60	----
2170		176	255	14.62	0.93	0.66
2171		177	251	15.23	1.00	----
2172		178	249	14.10	0.74	0.20
2174		172	253	15.71	1.59	----
2175		173	257	15.67	1.57	----
2176		170	255	15.63	1.65	----
2178		162	255	14.93	0.81	0.27
2179		160	255	15.38	0.98	-0.01
2180		158	253	14.77	1.01	0.39
2181		159	252	15.47	1.31	----
2182		156	249	15.32	1.18	----
2183		156	247	15.18	0.79	-0.09
2184		152	251	13.48	1.24	0.87
2186		151	253	15.91	0.64	----
2189		142	255	15.96	1.7:	----
2190		141	257	13.67	0.95	-0.03
2192		142	259	14.16	0.64	0.11
2193		146	260	15.31	1.46	----

Star No.	H II	X	Y	V	B - V	U - B
2194		148	263	14.19	0.61	0.20
2196		156	263	9.53	1.67	1.81
2197		159	258	15.41	1.13	----
2198		163	262	13.19	0.71	0.21
2199		163	267	15.84	1.10	----
2200		172	264	15.83	1.71	----
2203		172	265	15.53	0.80	----
2205		177	273	15.49	0.91	-0.27
2206		174	271	13.50	0.63	-0.04
2208		170	271	14.39	1.04	0.73
2209		165	273	15.77	2.01	----
2210		164	275	15.30	1.01	-0.08
2212		166	278	15.26	0.76	0.27
2213		171	282	14.88	0.95	0.27
2216		174	288	15.06	0.95	-0.10
2217		174	289	15.62	1.64	----
2219		170	292	15.65	1.44	----
2222		158	294	13.56	0.89	0.28
2225		158	292	15.54	1.23	----
2226		156	289	14.33	0.29	----
2227		157	287	15.66	1.21	----
2229		154	290	15.47	1.24	-0.06
2230		154	291	13.44	1.04	0.90
2231		151	291	14.11	0.69	0.26
2234		156	281	12.48	1.12	1.03
2235		154	279	15.53	1.90	----
2236		156	275	14.87	0.87	0.09
2237		146	273	14.92	0.92	0.24
2238		146	270	15.02	1.05	-0.13
2239		143	270	15.91	1.33	----
2241		140	267	15.60	1.82	----
2242		140	262	15.66	1.72	----
2243		134	259	15.87	1.47	----
2244		134	262	14.50	0.75	0.24
2245		132	261	15.62	1.24	----
2246		130	263	15.47	1.54	----
2247		129	262	15.33	1.31	----
2248		125	263	15.26	1.19	----
2249		122	263	12.59	1.00	1.07
2250		122	265	12.58	0.90	0.33

Star No.	H II	X	Y	V	B - V	U - B
2251		121	269	8.71	1.16	0.49
2254		132	266	15.50	1.57	----
2256		137	271	14.85	1.39	----
2257		140	273	15.58	1.17	----
2258		138	277	15.31	1.12	----
2259		134	279	15.39	1.23	----
2260		134	281	15.93	1.17	----
2262		145	281	12.06	0.61	-0.14
2263		148	281	13.11	0.85	0.82
2264		144	287	12.63	0.54	-0.16
2267		152	301	15.37	1.25	0.47
2268		151	301	14.99	1.11	----
2269		150	301	15.45	1.87	----
2270		150	302	15.42	1.20	----
2271		149	299	13.64	0.62	0.25
2274		142	294	15.37	1.54	----
2275		140	295	12.90	0.59	0.04
2276		140	297	15.63	1.17	----
2277		139	297	14.75	0.71	0.78
2278		136	297	14.57	1.19	0.80
2279		135	299	14.07	0.55	0.20
2280		140	303	15.33	1.59	----
2281		142	305	14.51	(3.1)	----
2282		141	305	14.50	0.74	0.38
2283		133	307	14.65	0.85	0.55
2284		131	306	15.09	1.30	----
2285		131	305	15.87	1.35	----
2286		128	303	15.66	1.04	----
2287		132	296	15.27	1.08	-0.08
2292		134	289	15.56	0.81	-0.24
2294		128	292	15.85	1.51	----
2298		117	283	12.20	1.12	1.15
2300		119	281	15.26	0.99	0.00
2301		116	281	13.13	0.67	0.52
2302		114	282	14.95	0.57	0.47
2303		113	282	15.23	1.29	----
2305		112	272	14.27	0.79	0.55
2306		116	266	15.50	2.13	----
2307		117	265	15.20	1.30	----
2308		116	265	15.58	1.03	-0.19

Star No.	H II	X	Y	V	B - V	U - B
2309		106	270	15.06	1.17	0.14
2310		102	271	12.63	0.49	0.00
2311		096	274	6.60	-0.19	0.01
2312		102	276	14.33	1.29	0.60
2313		104	278	15.01	0.88	-0.10
2315		107	281	15.47	1.74	----
2316		108	283	15.99	1.12	----
2317		105	287	14.99	1.77	----
2318		104	292	14.38	1.00	0.25
2319		108	293	13.95	1.14	0.55
2320	3122	109	289	11.89	0.90	-0.08
2321		117	292	14.57	1.08	0.40
2322		118	293	15.73	1.37	----
2323		118	297	14.70	0.85	0.56
2324		123	296	15.39	0.91	0.10
2326		122	302	15.70	1.61	----
2331		117	312	15.91	1.19	----
2332		115	318	14.79	1.85	----
2333		108	319	7.67	1.07	1.02
2334		106	319	13.14	1.04	1.40
2335		111	314	15.38	1.32	----
2337		110	309	14.91	1.31	----
2338		111	305	15.86	1.35	----
2340		112	304	16.07	0.84	----
2341		106	303	14.64	1.29	----
2345		097	289	15.66	1.51	----
2346		096	289	15.45	1.25	----
2347		094	287	14.75	1.39	0.04
2348		096	285	13.95	0.76	0.30
2349		092	285	15.54	0.98	----
2351		089	279	14.07	1.43	0.44
2352		089	277	15.20	1.07	0.34
2353		088	275	15.64	1.50	----
2354		086	277	13.31	1.10	0.97
2357		072	280	15.19	0.95	0.06
2358		078	285	15.31	1.48	-0.42
2359		079	285	12.83	0.98	0.95
2360		084	285	14.73	0.82	0.10
2362		088	289	13.99	0.66	0.68
2363		088	291	15.28	1.42	----

Star No.	H II	X	Y	V	B - V	U - B
2364		088	292	15.85	2.25	----
2368		092	297	13.91	0.87	0.19
2369		096	296	15.52	1.36	----
2370		091	301	15.02	1.34	----
2374		097	305	15.17	1.44	----
2375		096	307	14.68	0.73	0.33
2376		102	309	15.46	0.96	----
2377		104	310	15.51	1.2:	----
2378		102	310	15.53	1.17	-0.09
2379		101	310	12.56	1.02	0.49
2379a		100	311	14.53	0.86	0.01
2380		100	317	10.54	1.01	-0.48
2382		094	323	11.58	0.64	0.04
2383		090	321	11.82	0.78	-0.17
2384		092	317	15.36	1.45	----
2385		094	319	15.54	1.43	----
2386		095	317	15.49	1.15	----
2387		093	315	13.64	1.38	0.90
2388		093	311	15.61	1.73	----
2389		090	316	14.87	1.53	----
2390		089	316	14.93	1.06	0.38
2391		084	322	14.17	1.40	0.47
2393		078	322	14.87	1.68	----
2394		070	318	15.12	0.67	0.12
2398		064	316	9.35	0.45	0.13
2399		064	314	13.19	1.12	1.27
2402		076	318	15.47	1.29	-0.13
2403		080	317	15.11	1.53	----
2404		088	313	15.06	1.09	----
2405		086	313	12.54	0.81	-0.21
2406		084	311	12.36	1.19	1.11
2408		079	310	15.34	1.45	----
2409		078	309	15.78	1.32	----
2411		084	301	15.47	1.13	----
2412		082	299	13.52	0.65	0.43
2413		084	296	15.52	0.96	----
2414		075	291	12.48	0.83	0.35
2415		074	290	15.41	1.53	----
2416		070	292	15.41	1.26	----
2417		069	289	14.32	0.91	0.61
2418		066	281	15.67	1.53	----

Star No.	H II	X	Y	V	B - V	U - B
2419		064	281	15.68	1.26	----
2420		064	282	15.26	1.38	-0.29
2422		058	281	14.50	1.10	0.01
2423		058	286	15.71	1.49	----
2424		056	288	14.87	1.45	-0.12
2425		062	291	15.24	1.29	----
2426		059	292	15.55	1.30	----
2430		073	303	14.69	1.78	----
2431		070	303	15.11	1.68	----
2432		069	305	15.61	1.30	----
2434		060	309	15.24	1.09	0.18
2436		058	301	14.93	0.96	0.07
2437		056	299	15.35	1.62	----
2438		052	293	15.56	1.32	----
2439		052	291	14.73	0.74	0.16
2441		049	282	15.49	1.48	----
2443		048	287	15.29	0.70	-0.05
2444		047	289	13.79	0.59	0.50
2445		043	288	15.38	1.41	----
2447		047	301	15.18	1.21	----
2448		042	300	15.75	1.33	----
2449		042	301	15.60	1.67	----
2450		042	302	15.33	1.94	----
2451		041	305	14.94	2.50	----
2453		044	306	14.69	0.69	0.68
2454		047	314	15.78	1.67	----
2458		052	323	12.47	0.60	0.34
2460		058	324	12.80	1.09	1.19
2461		060	326	14.67	0.83	0.39
2462		065	329	14.34	1.40	0.09
2463		057	331	15.02	1.77	----
2464		055	329	15.66	1.31	----
2465		053	329	15.61	2.3:	----
2468		041	326	14.64	1.21	0.04
2469		038	333	15.42	1.42	----
2470		038	327	14.89	1.15	0.21
2471		043	322	14.40	1.22	0.42
2472		042	314	15.06	1.91	----
2473		042	313	15.90	1.43	----
2473a		043	311	15.03	1.67	----

Star No.	H II	X	Y	V	B - V	U - B
2474		039	309	11.94	0.86	0.68
2475		034	310	14.86	1.84	----
2476		029	310	14.18	0.66	----
2477		030	319	14.83	1.74	----
2478		034	323	15.53	1.32	----
2480		029	332	14.59	1.06	0.48
2482		008	335	15.44	1.14	----
2483		008	332	15.74	1.11	-0.22
2487		010	327	13.23	0.82	1.07
2490		022	319	14.94	1.58	----
2491		023	318	14.96	0.82	0.24
2494		021	305	14.93	1.06	0.25
2495		026	305	15.40	0.67	0.31
2496		027	299	15.17	1.38	----
2497		029	298	14.86	1.21	----
2498		034	298	13.99	1.24	0.47
2499		030	295	9.62	0.39	0.02
2500		016	293	13.20	1.38	1.01
2501		014	303	15.31	1.25	----
2502		003	299	12.73	0.79	0.60
2505		007	293	15.09	2.05	----
2505a		007	292	11.45	0.53	-0.09
2506		005	289	12.02	0.52	0.09
2507		000	287	14.38	0.88	0.00
2508		000	289	15.54	1.40	----
2509		991	286	14.50	0.98	0.38
2509a		000	293	14.16	0.65	0.81
2510		995	295	11.57	0.84	0.35
2511		991	293	13.25	0.42	0.50
2513		999	304	15.45	1.65	----
2514		998	308	15.57	1.63	----
2515		995	315	15.37	1.63	----
2516		997	313	15.26	1.09	0.13
2517		000	315	14.13	0.71	0.24
2518		002	313	14.80	1.50	----
2519		004	310	14.06	1.44	0.88
2520		006	310	13.78	0.74	1.44
2521		007	316	13.57	0.69	1.02
2522		003	328	15.47	1.63	----
2523		002	329	15.38	1.28	----

Star No.	H II	X	Y	V	B - V	U - B
2524		998	329	13.85	1.08	0.99
2525		998	330	15.37	1.29	-0.01
2527		996	334	14.38	1.61	----
2528		991	328	15.03	1.30	0.09
2529		993	325	14.19	0.86	1.07
2530		980	331	15.60	1.37	----
2531		977	323	12.11	1.29	1.74
2532		982	321	11.31	0.73	0.02
2533		982	324	11.82	0.63	0.52
2534		984	324	14.86	1.67	0.20
2536		981	311	15.34	1.49	----
2538		984	310	15.62	1.83	----
2539		986	309	13.22	0.61	0.55
2542		980	305	13.64	0.67	0.53
2543		982	301	13.60	0.63	0.92
2544		974	285	14.57	1.24	0.27
2545		973	284	12.91	0.56	0.08
2546		973	283	15.39	1.46	----
2547		963	281	15.31	1.90	----
2548		967	284	15.69	1.48	----
2549		971	287	14.92	1.17	-0.14
2550		970	293	13.96	1.22	1.23
2551		961	295	14.34	1.19	0.60
2552		964	303	13.39	0.68	0.47
2553		970	300	15.35	1.47	----
2554		974	297	15.47	2.13	----
2555		976	299	13.69	1.04	0.92
2557		970	305	14.35	1.20	0.72
2558		970	307	15.48	1.82	----
2561		973	310	14.30	1.04	0.83
2562		972	313	13.58	1.42	1.03
2563		968	319	15.41	1.66	----
2564		968	321	14.32	1.14	----
2565		969	321	15.25	1.39	----
2566		970	328	15.84	1.68	----
2567		967	330	13.98	0.71	0.63
2568		964	330	14.73	0.68	0.27
2569		958	330	14.42	1.22	0.98
2570		960	326	15.05	1.42	----
2571		958	319	15.61	1.05	----

Star No.	H II	X	Y	V	B - V	U - B
2572		960	313	10.66	1.75	(2.76)
2573		959	315	15.56	1.58	----
2575		956	322	15.19	1.45	----
2576		953	321	15.65	1.45	----
2577		943	323	15.15	1.99	----
2578		934	322	11.02	1.71	2.88
2579		947	313	15.30	1.77	----
2580		953	303	15.23	1.01	0.04
2581		950	303	13.36	1.31	1.54
2583		949	281	15.09	1.24	----
2584		940	277	15.11	1.36	-0.03
2585		937	281	14.22	0.80	0.53
2586		932	283	13.77	0.83	0.87
2587		928	283	15.39	0.80	0.31
2588		928	281	15.75	1.52	----
2589		926	280	15.34	0.99	-0.19
2590		924	281	15.86	1.21	----
2594		934	292	15.45	1.65	----
2596		936	295	15.39	1.43	----
2598		945	295	14.60	1.26	----
2599		943	300	14.46	1.14	0.55
2600		939	303	14.79	1.74	----
2604		933	306	15.91	1.69	----
2607		925	300	15.47	1.44	----
2608		926	303	15.34	1.61	----
2609		924	307	13.82	0.66	0.40
2611		927	314	15.00	0.79	----
2612		930	317	15.39	1.41	----
2613		927	317	15.16	1.26	----
2617		922	321	15.36	1.52	----
2618		918	320	15.54	1.76	----
2619		916	313	13.98	0.97	1.00
2620		919	310	15.70	1.86	----
2621		920	307	15.59	1.25	----
2622		917	303	15.57	1.77	----
2623		909	301	15.70	1.57	----
2624		909	302	15.33	0.97	----
2626		908	308	15.40	1.44	----
2627		913	308	15.76	1.18	----
2629		912	311	14.93	1.65	-0.05

Star No.	H II	X	Y	V	B - V	U - B
2632		901	313	13.13	0.91	1.17
2633		898	312	15.07	1.18	0.03
2634		898	311	15.35	1.50	----
2635		896	311	14.94	1.15	----
2636		892	311	15.09	1.49	----
2637		892	309	15.64	1.50	----
2638		894	309	14.23	0.66	0.57
2639		896	306	15.57	1.19	----
2642		900	301	13.12	0.51	0.42
2643		900	300	14.07	0.85	0.94
2644		897	295	15.48	1.46	----
2645		900	293	11.59	0.85	0.28
2646		903	292	15.48	2.7:	----
2647		904	289	15.70	1.30	----
2648		903	289	14.94	1.58	----
2649		901	285	11.41	1.20	1.08
2650		897	283	15.44	1.43	----
2651		898	283	15.65	2.07	----
2654		909	281	15.13	1.28	-0.14
2655		910	273	14.85	0.91	0.40
2657		912	275	14.28	1.04	0.80
2658		914	276	13.59	0.93	0.66
2659		916	275	15.27	1.20	----
2660		920	275	14.73	1.11	-0.12
2661		920	276	15.68	1.13	-0.41
2662		919	277	14.88	0.89	0.38
2663		917	279	15.63	2.16	----
2664		915	280	13.69	0.62	0.72
2666		911	287	15.42	1.22	----
2667		911	288	14.82	0.66	0.74
2668		911	290	15.81	1.32	----
2669		911	291	15.54	1.70	----
2669a	571	816	185	11.12	0.74	0.33
2669b	514	810	175	10.63	0.71	0.28
2669c	173	760	139	10.82	1.47	-0.17
2669d	153	766	116	7.54	0.35	-0.09
2669e	97	760	095	12.63	0.77	1.44
2669f	174	775	103	11.68	0.63	0.50
2669g	250	788	105	10.73	0.60	0.19
2669h	405	829	083	9.95	0.28	0.25

Star No.	H II	X	Y	V	B - V	U - B
2669i	314	815	072	10.62	0.68	0.12
2669j	320	818	068	11.00	0.96	0.40
2669k	293	812	067	10.72	0.76	0.12
2669l	345	836	034	11.59	0.85	0.49
2669m	232	820	020	8.15	0.15	0.15
2669n	253	827	011	10.62	0.67	0.14
2669q	158	822	979	8.27	0.15	0.12
2669r	263	846	967	11.68	0.70	0.48
2669s	193	838	957	11.39	0.51	0.64
2670		742	890	14.44	0.69	----
2671		744	885	15.77	1.07	----
2672		746	879	16.01	1.23	----
2674		739	877	16.13	1.32	----
2675		736	879	15.47	1.60	----
2676		734	881	16.17	0.93	----
2677		733	876	15.86	1.42	----
2679		722	879	14.64	1.15	0.20
2680		716	874	12.24	0.54	0.25
2681		712	873	13.02	1.40	1.75
2684		714	866	11.63	1.05	1.40
2685		708	865	15.72	1.10	----
2688		709	855	16.38	1.03	----
2689		710	850	15.93	1.28	----
2690		710	845	15.83	1.27	----
2691		712	845	15.75	2.25:	----
2692		710	843	15.58	1.21	----
2693		709	843	14.13	1.63	0.26
2694		713	842	15.10	0.84	0.17
2698		719	850	12.91	1.06	1.72
2699		719	851	16.00	1.44	----
2703		743	869	15.83	1.65	----
2704		747	869	15.78	1.39	----
2705		752	866	15.41	1.17	----
2707		746	861	16.27	1.36	----
2708		758	858	15.24	1.31	----
2710		758	849	15.82	1.18	----
2711		748	853	13.18	0.55	1.13
2712		744	853	14.96	0.76	0.03
2713		746	849	13.15	1.13	1.29
2714		740	850	15.76	1.72	----

Star No.	H II	X	Y	V	B - V	U - B
2715		740	841	16.04	1.88	----
2716		734	846	15.07	1.43	----
2721		727	823	15.33	0.99	-0.08
2722		729	822	12.68	0.92	1.16
2726		734	826	14.61	0.79	0.31
2727		743	831	12.18	0.42	-0.16
2729		756	835	15.73	1.11	----
2732		760	831	15.34	1.06	----
2734		756	827	13.46	1.12	1.20
2735		759	827	15.03	0.55	0.11
2736		767	829	15.43	1.13	----
2737		770	829	9.60	0.82	0.92
2738		772	827	15.08	0.72	0.36
2739		766	824	15.09	1.13	0.06
2743		740	822	14.92	0.24	0.30
2744		747	819	15.15	1.20	-0.17
2747		735	811	15.44	0.82	0.18
2749		733	808	15.73	0.81	----
2751		736	803	13.81	0.21	0.67
2752		740	809	13.39	0.67	0.52
2753		741	809	15.50	1.24	----
2754		748	797	14.22	1.00	0.67
2755		754	780	13.92	0.53	0.90
2757		757	777	12.75	0.95	1.03
2758		763	769	15.45	1.40	----
2759		764	770	15.52	1.05	----
2760		766	766	15.65	1.26	----
2761		771	762	14.20	0.78	0.81
2762		768	781	14.89	0.83	0.12
2763		768	785	15.43	1.05	-0.27
2766		758	793	14.96	0.69	-0.11
2767		748	804	13.32	0.54	0.36
2768		748	811	15.07	0.69	0.11
2769		752	811	12.13	0.47	0.08
2770		752	813	14.34	1.01	0.87
2771		755	811	15.24	0.68	-0.14
2772		757	815	14.20	0.76	0.74
2773		760	811	15.37	0.90	-0.08
2775		765	815	15.47	1.21	-0.26
2780		770	810	15.48	1.65	----

Star No.	H II	X	Y	V	B - V	U - B
2781		770	805	14.75	0.63	-0.03
2782		774	816	15.47	0.81	0.10
2784		780	824	14.63	1.25	0.31
2785		778	817	11.35	1.07	1.16
2787		776	809	11.29	0.76	1.14
2788		777	801	15.36	0.95	0.05
2791		778	792	13.50	0.38	0.62
2792		778	787	15.27	1.38	----
2794		784	795	14.39	0.66	1.28
2795		796	793	13.71	0.75	0.52
2796		798	793	15.16	0.79	0.20
2797		800	793	11.23	0.83	0.40
2803		799	772	14.57	0.77	0.37
2804		794	775	14.90	0.73	0.52
2805		794	783	14.99	0.87	----
2808		784	779	15.09	0.87	-0.08
2809		780	777	14.66	0.91	----
2812		776	765	14.69	1.02	0.46
2813		777	758	14.73	0.65	0.21
2816		783	752	15.39	1.31	----
2819		791	763	15.70	1.24	----
2820		790	765	9.35	0.38	-0.02
2822		788	769	15.64	1.26	----
2823		793	769	15.72	1.22	----
2825		792	767	14.49	0.60	0.66
2826		798	762	15.52	1.65	----
2827		801	755	11.81	1.11	1.11
2828		797	755	15.25	0.94	0.01
2830		793	746	15.32	1.36	----
2831		791	743	14.12	1.11	1.03
2832		794	739	12.93	0.35	0.45
2833		796	746	13.49	0.85	1.09
2834		806	749	15.07	0.81	-0.14
2835		812	761	14.32	0.92	0.00
2837		807	763	14.83	0.71	0.22
2838		810	766	14.83	1.67	----
2839		814	769	14.83	0.42	0.32
2840		815	769	13.99	1.11	0.83
2841		816	769	15.79	1.02	----
2843		818	769	13.07	0.56	0.91

Star No.	H II	X	Y	V	B - V	U - B
2846		820	763	14.87	1.07	0.14
2850		828	767	14.99	0.99	-0.01
2851		825	768	15.62	1.28	----
2852		812	781	15.82	0.89	----
2853		816	780	15.74	0.85	----
2854		818	783	15.58	1.28	----
2855		832	769	14.75	1.37	0.37
2856		832	765	15.75	1.06	----
2860		842	753	14.09	0.99	0.78
2862		824	748	15.38	1.16	0.30
2863		818	755	15.88	(2.12)	----
2864		813	751	15.88	1.29	----
2866		813	749	16.19	1.29	----
2867		815	749	14.60	0.51	0.41
2868		811	741	13.91	1.17	1.27
2869		809	739	15.35	0.58	0.16
2870		808	737	15.30	0.35	0.47
2871		810	737	14.94	0.76	0.23
2873		822	730	15.95	1.45	----
2874		826	731	16.06	1.11	----
2876		828	731	12.92	0.33	0.52
2877		828	732	15.90	1.10	----
2877a		830	733	12.66	0.42	0.57
2878		830	735	15.38	0.32	0.20
2879		825	737	15.80	1.37	----
2880		826	738	15.54	0.73	0.04
2882		833	742	14.98	0.84	0.17
2883		836	745	15.56	0.83	----
2884		837	741	15.64	0.79	-0.23
2885		838	734	15.69	0.83	----
2888		834	726	15.30	0.76	-0.02
2889		827	723	16.00	0.72	----
2890		827	719	15.98	1.27	----
2891		828	718	13.58	0.62	0.32
2892		829	720	14.46	1.80	----
2893		830	719	14.56	0.32	0.47
2894		836	713	12.72	0.60	0.83
2895		838	711	15.52	1.48	----
2896		844	709	14.59	0.67	0.21
2897		848	719	15.51	0.72	-0.13

Star No.	H II	X	Y	V	B - V	U - B
2898		842	717	12.80	1.02	1.67
2900		838	723	15.47	0.68	----
2902		841	725	15.41	1.03	----
2903		843	722	14.57	0.50	0.39
2904		846	725	15.69	1.41	----
2906		854	751	15.00	0.14	0.21
2907		858	743	11.64	1.09	1.53
2908		859	743	15.74	0.96	----
2909		862	749	14.61	0.39	0.43
2911		874	741	15.57	0.98	-0.31
2912		876	739	15.55	0.61	0.04
2913		876	738	15.52	1.78	----
2914		874	730	14.98	0.38	0.45
2915		875	729	15.79	1.54	----
2916		872	717	13.36	1.00	0.97
2917		874	716	14.72	0.52	0.12
2918		871	715	15.67	0.97	-0.27
2923		854	706	14.55	0.78	0.81
2925		860	709	15.94	1.13	----
2926		862	707	15.64	1.24	----
2927		865	705	15.81	1.80	----
2928		862	697	15.90	1.20	----
2929		862	695	15.76	0.96	----
2931		869	700	15.41	0.74	0.18
2932		872	700	15.69	1.37	----
2933		873	703	11.95	0.95	1.08
2934		880	697	15.64	1.09	----
2937		886	704	15.70	0.76	0.04
2940		878	715	16.01	1.36	----
2947		895	734	12.99	0.64	0.46
2948	102	900	751	10.61	0.62	0.32
2949	186	918	756	10.63	0.65	0.48
2950		912	728	15.55	0.77	-0.19
2952		906	722	14.03	0.97	0.89
2953		910	717	15.18	0.38	0.53
2955		900	718	15.06	0.78	0.49
2959		902	695	15.65	0.53	0.05
2961		906	685	15.55	1.59	----
2962		898	681	14.26	0.63	1.10
2963		905	680	13.48	0.60	0.86

Star No.	H II	X	Y	V	B - V	U - B
2964		908	681	11.98	0.86	0.87
2965		908	678	12.14	0.70	0.34
2966		918	679	13.93	0.66	0.61
2967		919	678	11.16	0.88	0.49
2968		915	687	14.95	1.23	----
2969		905	693	14.20	0.84	0.52
2972		917	698	15.07	0.93	0.23
2974		921	699	14.62	0.67	0.22
2975		925	706	12.50	0.61	0.73
2976		923	711	15.73	0.87	----
2977		918	712	15.41	1.16	----
2978		920	717	14.91	0.34	0.34
2979		921	722	14.75	1.00	0.74
2980		930	721	15.70	1.56	----
2981		929	717	14.55	0.98	0.75
2982		933	718	15.30	0.57	0.26
2983		934	716	12.83	0.60	0.31
2984		939	715	15.17	1.03	-0.06
2985		940	711	15.80	0.62	----
2986		940	709	14.36	0.82	0.63
2987		938	705	15.74	1.36	----
2989		934	698	14.92	0.80	0.52
2990		936	696	15.82	1.06	----
2991		929	693	14.89	0.61	0.15
2992		930	689	14.98	0.64	0.28
2993		934	687	15.82	1.35	----
2994		928	683	14.39	1.25	----
2995		926	679	15.67	1.20	----
2997		930	676	12.40	0.68	0.59
2998		943	673	15.64	(1.71)	----
2999		940	680	15.09	0.53	0.21
3000		938	693	14.06	0.88	1.29
3001		940	696	14.76	0.83	-0.08
3003		946	701	15.86	0.99	----
3004		946	696	15.32	0.72	0.05
3005		947	686	14.45	0.85	0.45
3006		951	675	15.77	1.22	----
3007		954	677	15.68	1.72	----
3009		963	668	15.31	1.01	----
3010		969	669	12.50	1.20	1.47

Star No.	H II	X	Y	V	B - V	U - B
3011		973	667	13.35	1.00	1.20
3012		978	666	14.52	1.13	0.65
3014		964	680	15.66	1.09	----
3016		970	685	13.45	0.94	1.05
3017		968	685	13.39	0.69	0.65
3018		960	691	15.80	1.77	----
3020		954	691	14.79	0.91	0.57
3021		953	695	12.44	0.60	0.31
3022		954	699	12.20	0.66	0.50
3023		957	697	15.76	1.70	----
3024		956	707	15.40	0.74	-0.04
3025		950	711	15.19	0.50	0.05
3026		958	713	15.84	0.72	----
3028		969	711	15.15	0.87	-0.08
3029		972	709	15.03	1.24	----
3030		977	707	15.58	1.24	----
3031		981	699	15.07	0.92	0.09
3032		986	692	15.24	0.74	0.16
3033		988	688	14.61	0.66	0.36
3034		985	691	15.27	2.60	----
3035		984	689	15.86	1.65	----
3036		977	699	15.47	0.58	0.13
3039		972	691	15.49	0.95	-0.32
3040		974	689	15.77	1.28	----
3041		977	685	15.30	1.07	0.17
3042		975	680	11.79	0.90	0.36
3043		974	679	15.68	1.08	----
3044		994	663	15.26	0.93	0.05
3045		999	664	13.69	0.90	0.89
3046		002	663	15.17	0.81	0.06
3047		008	662	13.84	1.28	0.60
3048		011	665	13.69	0.71	0.39
3050		016	669	14.04	0.72	0.32
3051		011	670	15.19	0.58	0.39
3052		007	673	15.67	1.34	----
3054		998	677	14.66	0.93	0.60
3056		994	676	14.16	0.60	0.35
3057		992	676	14.40	0.98	0.24
3058		991	675	13.23	0.26	0.55
3059		992	671	15.72	(1.65)	----

Star No.	H II	X	Y	V	B - V	U - B
3060		996	683	15.31	0.99	0.06
3063		997	708	15.98	1.22	----
3064		999	706	15.87	0.45	----
3065		012	701	12.66	0.84	1.04
3066		002	699	14.21	1.18	0.51
3067		000	697	15.25	1.19	0.07
3068		004	696	14.37	0.94	0.85
3069		008	696	15.81	0.27	----
3071		009	692	14.50	0.85	0.08
3072		008	689	13.00	0.68	0.40
3076		013	683	9.04	1.23	1.04
3077		014	680	15.53	1.13	----
3078		013	678	13.70	0.57	0.55
3079		018	677	14.78	1.22	-0.03
3081		021	682	14.87	1.39	----
3082		026	683	12.06	1.38	1.61
3083		027	681	15.50	1.20	----
3084		022	674	15.69	1.14	----
3085		022	669	15.39	1.38	----
3086		023	669	15.41	1.23	----
3087		025	668	14.54	0.80	0.51
3088		030	663	10.75	0.89	0.65
3090		030	671	14.98	1.65	----
3091		037	676	13.48	0.45	0.46
3092		041	681	15.11	1.27	-0.27
3093		038	681	15.68	0.95	-0.30
3094		037	684	15.81	1.02	----
3095		032	688	14.13	1.18	0.65
3096		039	689	15.06	1.08	0.35
3097		044	690	7.67	0.30,	0.23
3098		050	691	14.88	0.73	0.04
3099		041	695	15.69	0.89	-0.33
3100		042	699	15.29	0.63	0.15
3101		044	703	15.44	0.62	-0.06
3102		046	710	15.63	0.92	-0.18
3103		058	707	15.53	1.10	----
3104		061	706	14.84	1.03	0.09
3105		066	706	15.65	1.27	----
3106		072	708	16.05	1.23	----
3108		073	714	15.90	1.12	----

Star No.	H II	X	Y	V	B - V	U - B
3109		074	709	14.90	1.61	----
3110		077	699	14.91	0.76	-0.11
3112		078	688	14.45	1.17	0.57
3113		076	689	15.70	1.26	----
3114		070	700	15.82	1.03	----
3115		065	699	15.63	1.58	----
3116		066	696	13.06	0.67	0.01
3117		060	696	13.71	1.04	0.59
3118		058	695	14.43	0.85	0.19
3119		050	681	15.45	0.73	-0.20
3120		048	679	16.02	1.22	----
3121		047	677	10.76	0.82	0.24
3122		052	675	15.78	1.72	----
3125		044	667	13.45	0.92	0.31
3126		045	665	14.20	0.96	0.20
3127		055	666	15.56	1.21	----
3128		057	669	15.35	0.86	-0.20
3129		059	669	14.61	1.02	0.34
3130		063	668	14.62	0.51	0.20
3131		063	671	11.80	1.51	1.71
3132		058	673	15.42	0.70	-0.37
3134		059	679	13.82	0.84	-0.04
3138		072	670	10.51	1.32	0.91
3139		085	671	12.91	0.73	0.15
3140		098	675	13.44	1.04	1.02
3141		095	677	13.51	0.95	0.60
3142		090	677	12.79	0.99	0.93
3143		089	675	13.83	1.13	1.04
3144		083	678	14.98	0.61	-0.01
3145		084	682	15.31	0.96	----
3146		086	687	14.91	1.08	0.09
3147		089	683	15.73	1.21	----
3148		092	683	12.95	0.81	0.07
3149		093	691	13.93	0.73	0.08
3150		091	691	13.72	0.66	0.01
3151		090	694	14.62	0.71	0.13
3153		082	707	15.99	1.05	----
3154		086	709	15.62	1.30	----
3155		086	710	14.56	0.99	0.32
3156		082	712	15.20	1.33	----

Star No.	H II	X	Y	V	B - V	U - B
3157		079	715	11.95	0.91	0.66
3158		092	715	15.52	1.15	----
3160		096	709	14.82	0.95	0.38
3161		103	712	13.89	0.83	0.41
3162		105	711	15.46	0.95	----
3163		104	706	15.61	1.62	----
3164		104	703	15.86	1.41	----
3165		096	702	15.63	1.57	----
3166		100	691	13.03	0.53	0.26
3167		108	684	13.06	0.69	0.08
3168		115	685	15.44	1.06	-0.28
3169		113	687	14.47	0.64	-0.06
3170		110	689	13.75	0.95	0.67
3171		110	690	15.11	1.36	-0.02
3172		106	695	15.69	0.63	-0.10
3173		114	691	14.72	0.80	-0.15
3174		115	693	14.74	0.60	-0.17
3175		120	697	14.83	0.65	-0.33
3176		118	699	14.43	0.59	0.04
3177		112	700	15.84	0.92	(-0.20)
3178		120	713	15.69	1.51	----
3179		119	714	15.64	1.07	----
3180		122	717	13.76	0.79	0.26
3181		114	720	15.17	1.21	----
3182		110	722	15.54	0.85	----
3183		105	728	15.88	1.14	----
3184		100	719	11.87	0.79	0.41
3185		099	719	14.86	0.72	-0.36
3186	1132	069	752	9.32	0.73	0.04
3187	1182	076	753	10.48	0.76	-0.03
3188	1220	084	749	11.88	0.80	0.55
3189	1407	102	766	8.19	0.22	0.13
3190	1553	115	773	12.41	0.97	0.75
3190a	1883	119	859	12.64	0.77	0.80
3191	1993	134	857	8.28	0.48	-0.20
3192	2106	150	850	11.53	0.98	0.26
3193	2209	158	859	14.13	1.54	0.45
3194	2126	149	861	11.68	0.94	0.56
3195	2665	220	855	11.42	0.94	0.27
3196	2506	192	871	10.19	0.91	-0.27

Star No.	H II	X	Y	V	B - V	U - B
3197	2406	173	880	11.09	0.93	0.08
3198	2415	170	890	8.11	0.13	0.29
3199	2870	223	910	12.61	0.92	0.96
3200	3104	269	897	13.53	1.24	1.09
3201	3069	246	936	13.84	1.05	1.03

A P P E N D I X   II

Charts of the Pleiades Region.

Description of the Charts

The master chart on page 194 gives the plan of the sections in which the region of the Pleiades was divided for obtaining the charts of the four sub-regions of the Pleiades which were photometered. The boundaries of the four sub-regions are marked both on the master chart as well as on the sectional charts. Numbers for sectional charts appear at the bottom of each chart. Some of the sections are divided into two parts and marked A and B for that section.

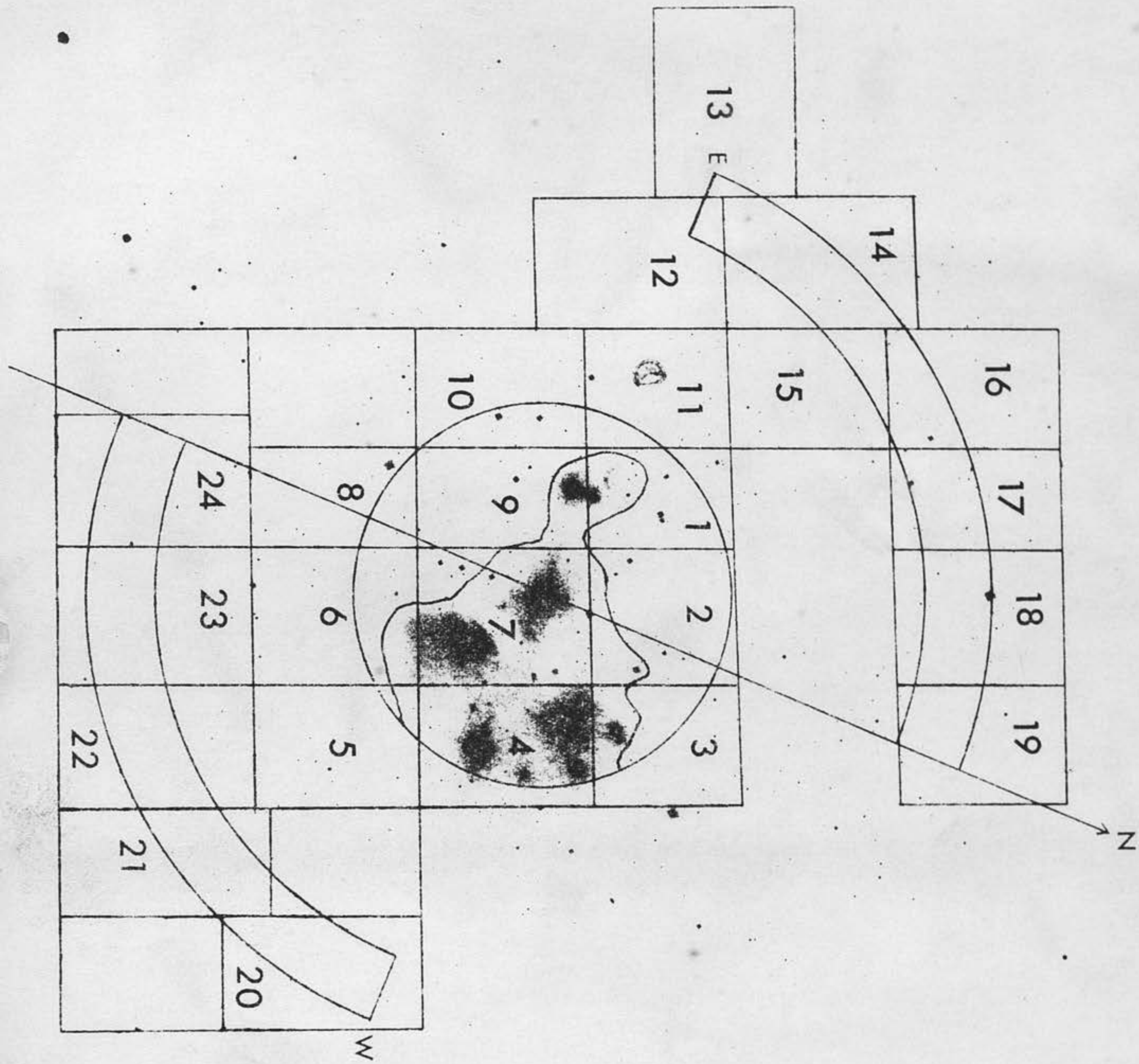
The following are the range of numbers for stars in the four sub-regions;

The Nebuous Region. From 1 to 558j ,

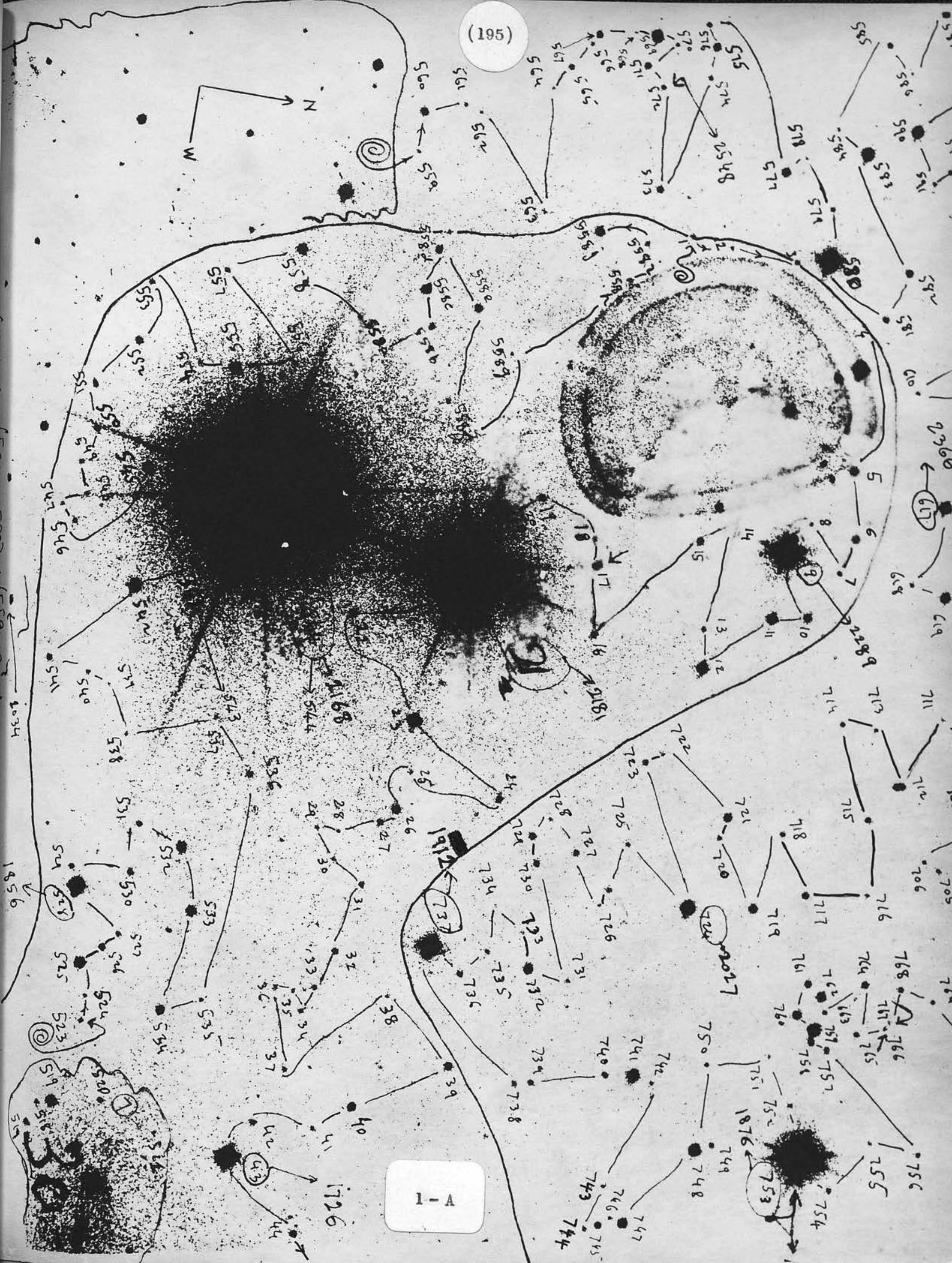
The Circular Region. From 559 to 1774 ,

The Outer North-east Sector. From 1775 to 2669 ,

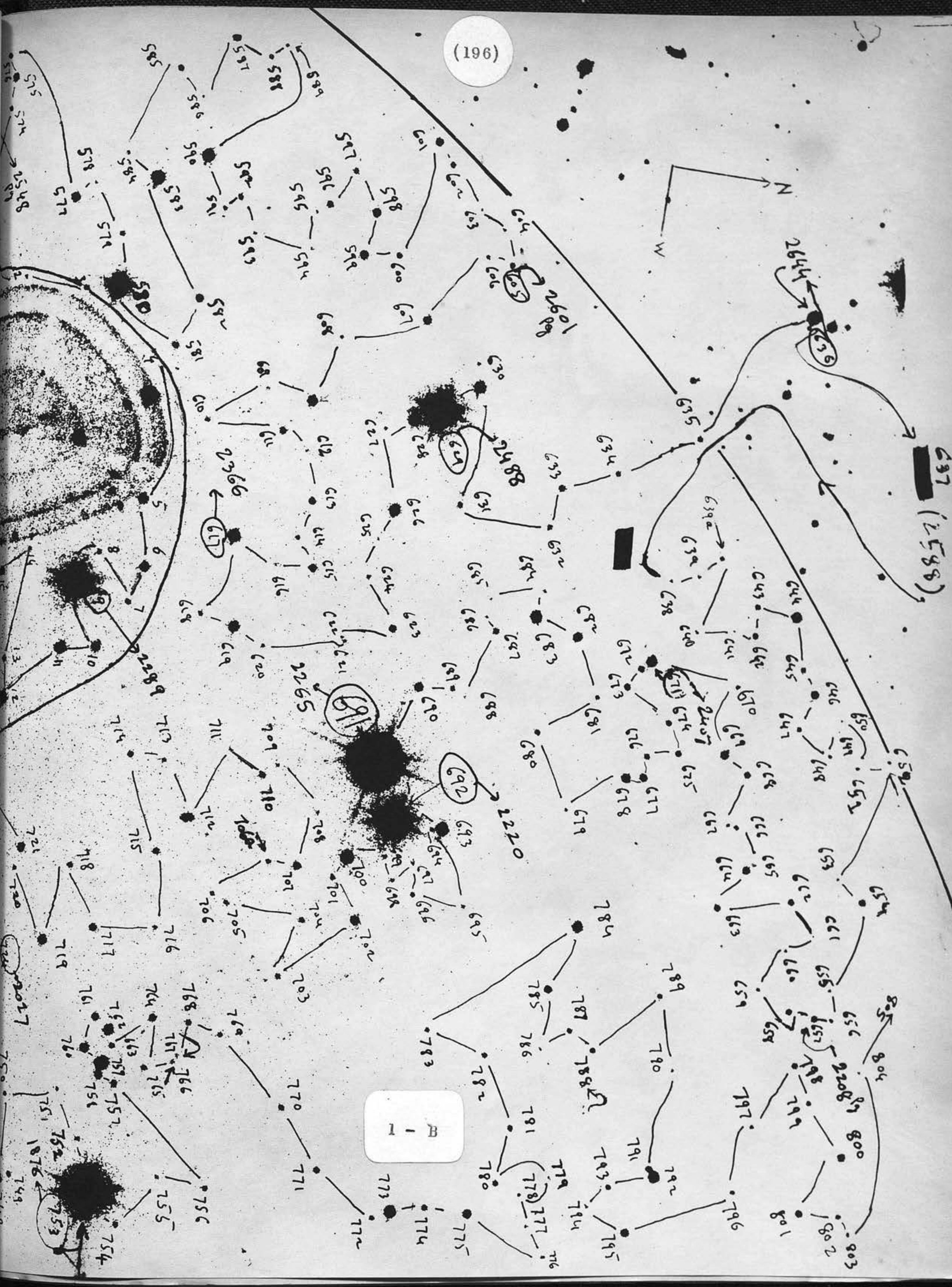
The Outer South-west Sector. From 2669a to 3201 .



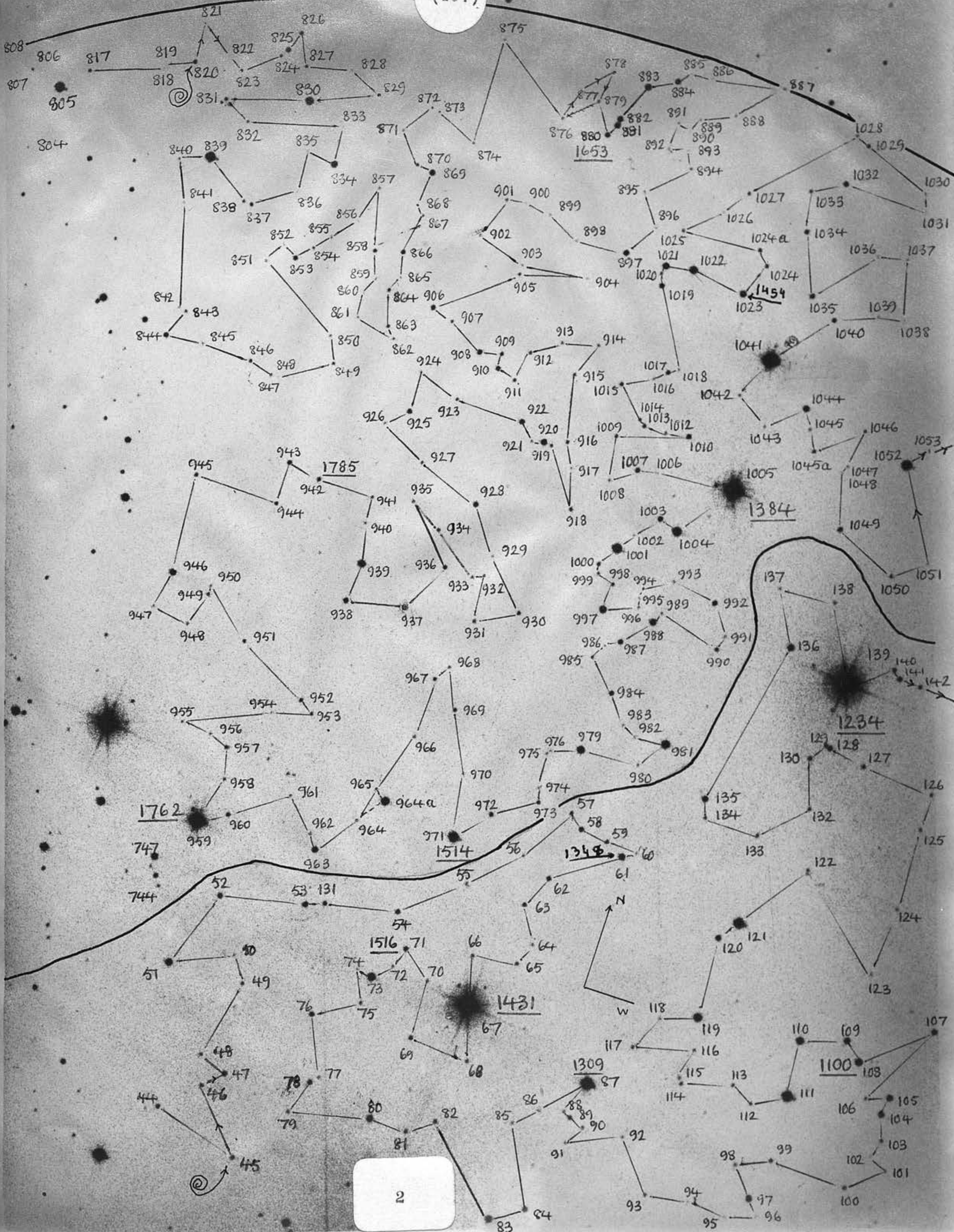
Master - Chart.



1 – A



1 - B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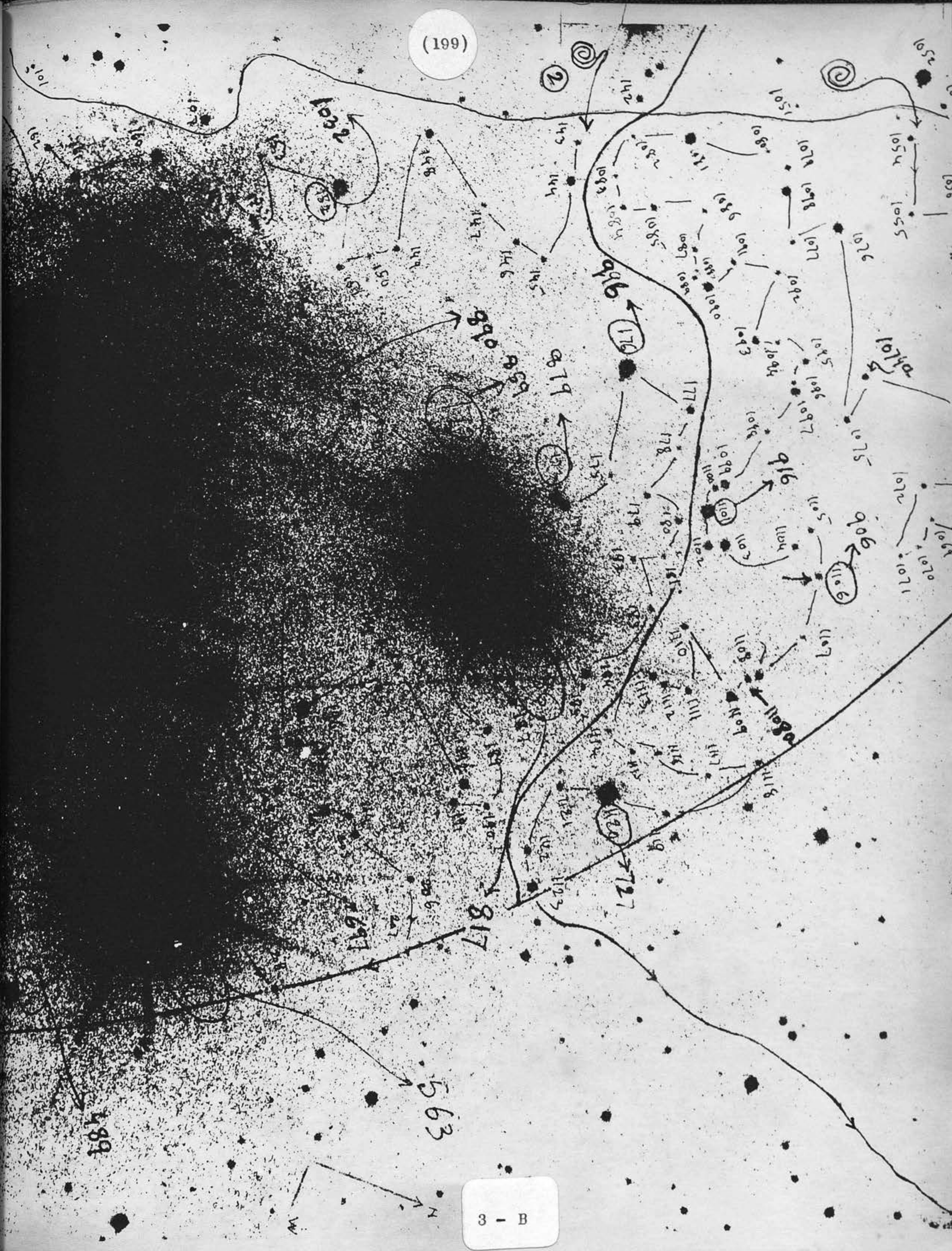

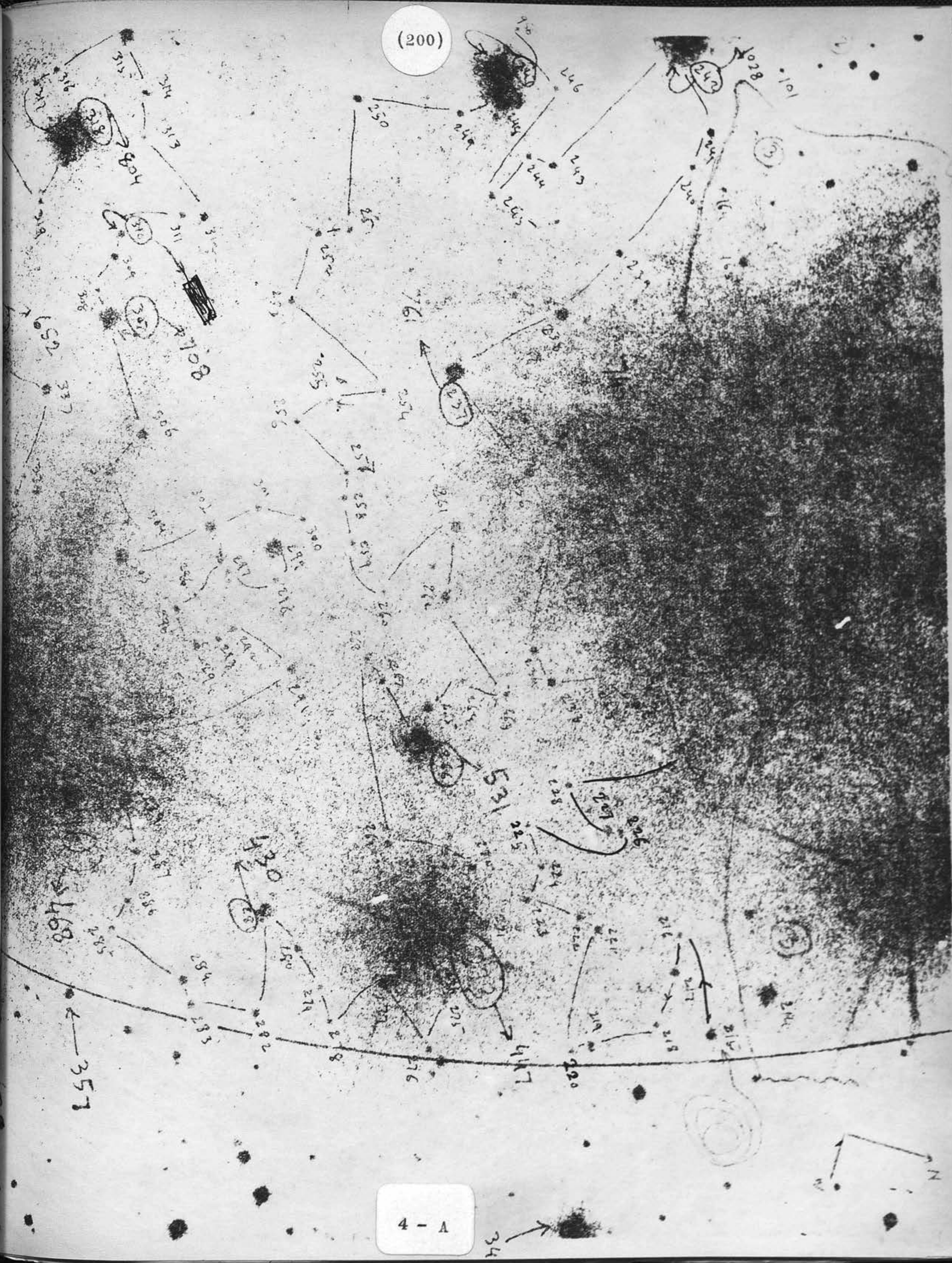

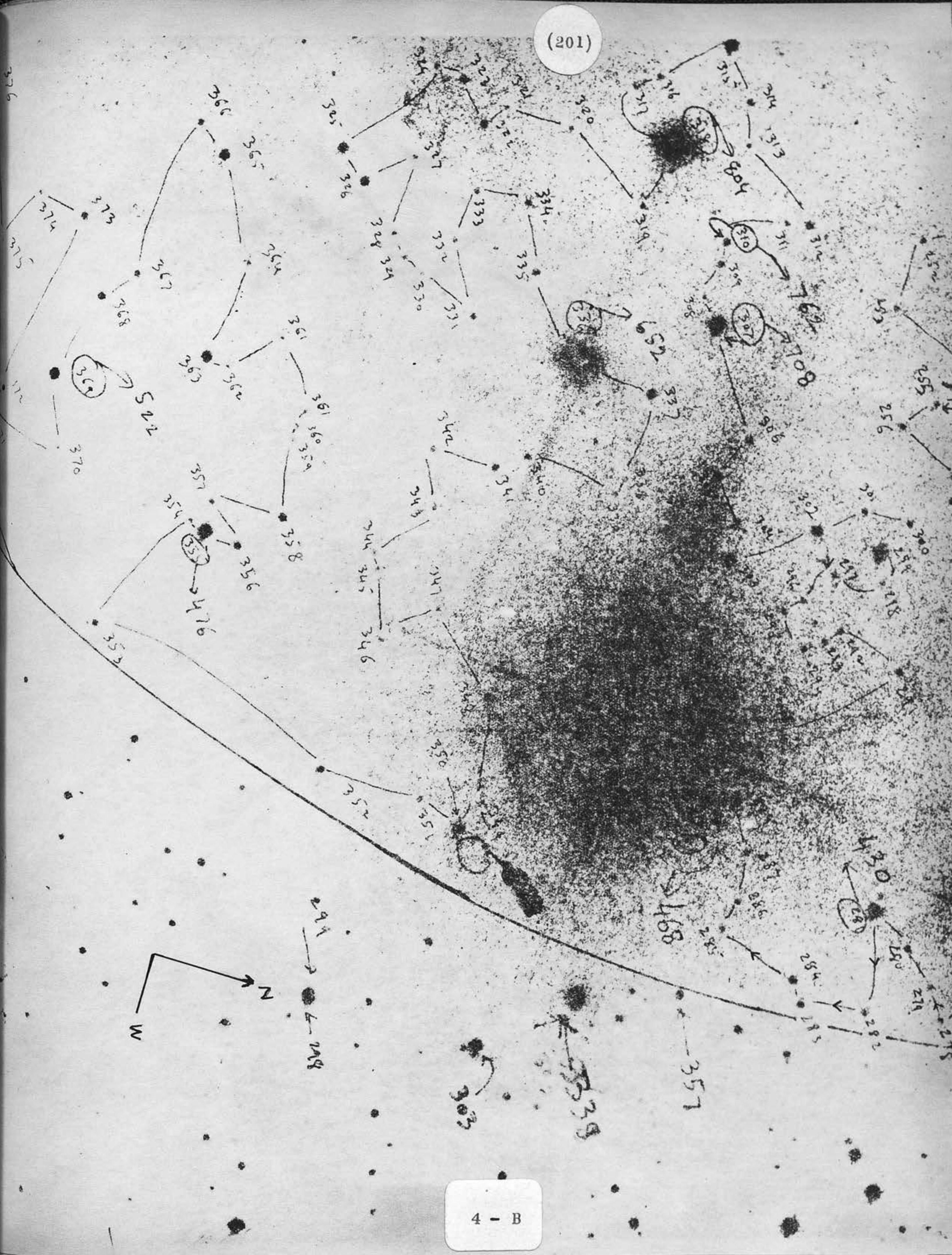

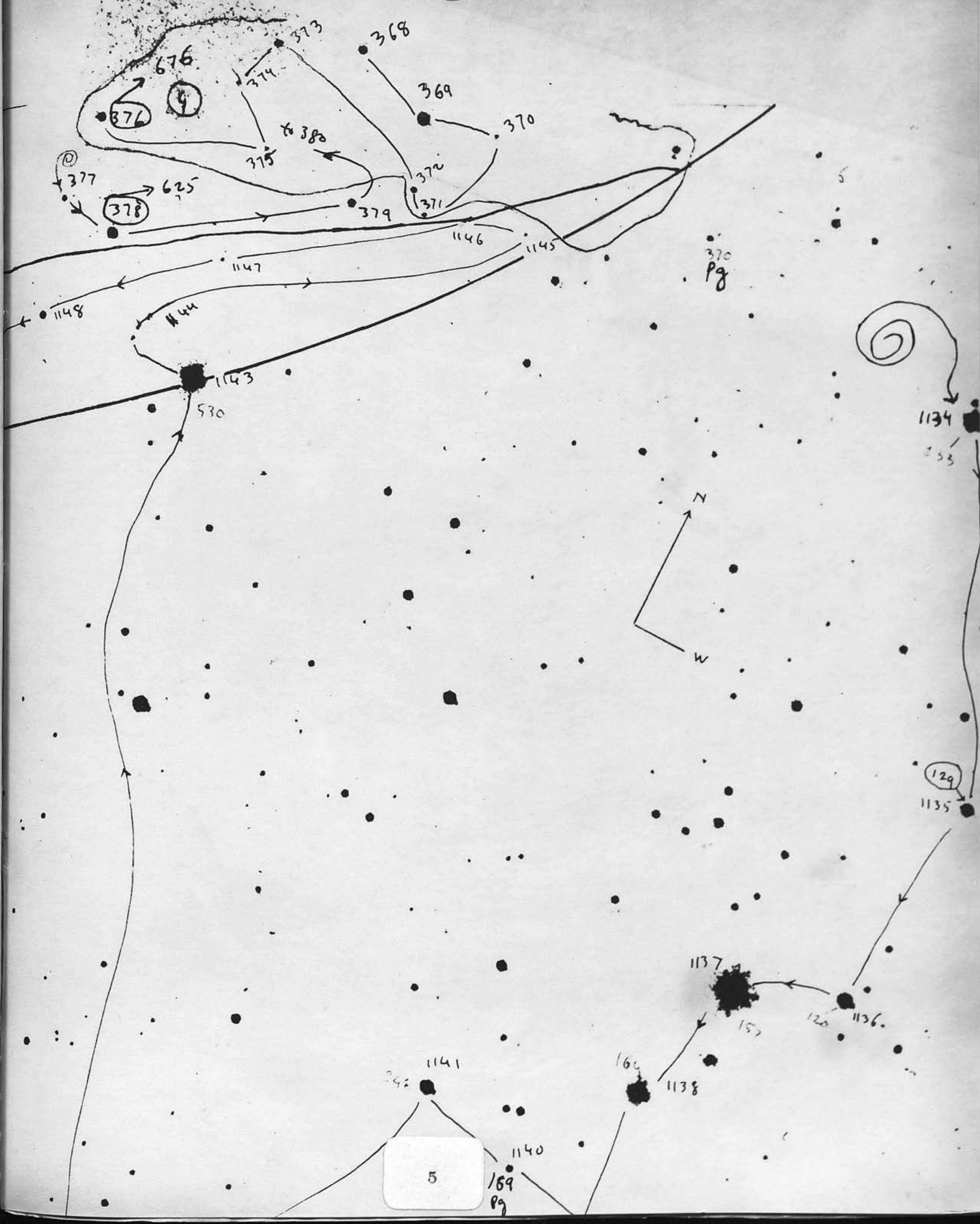
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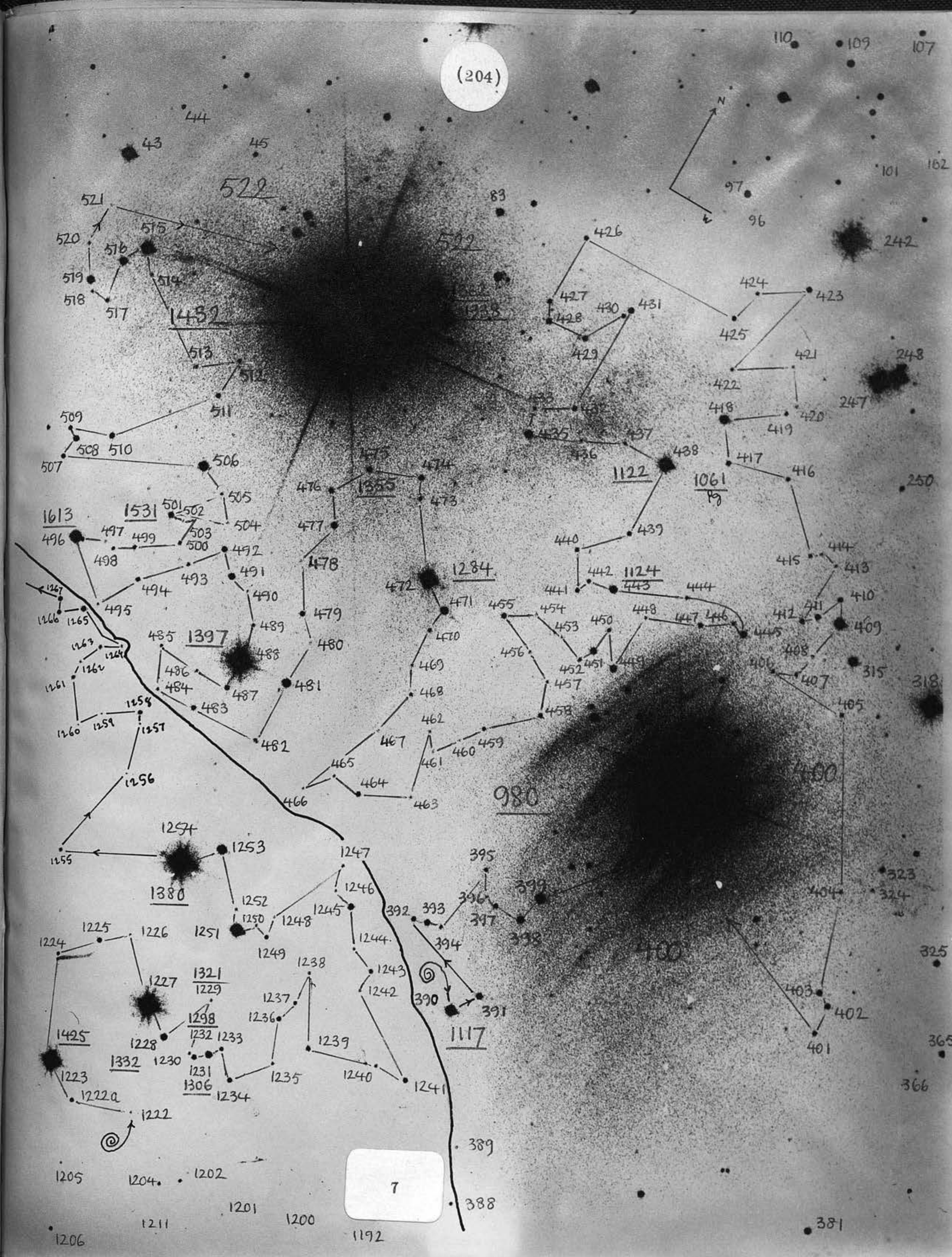
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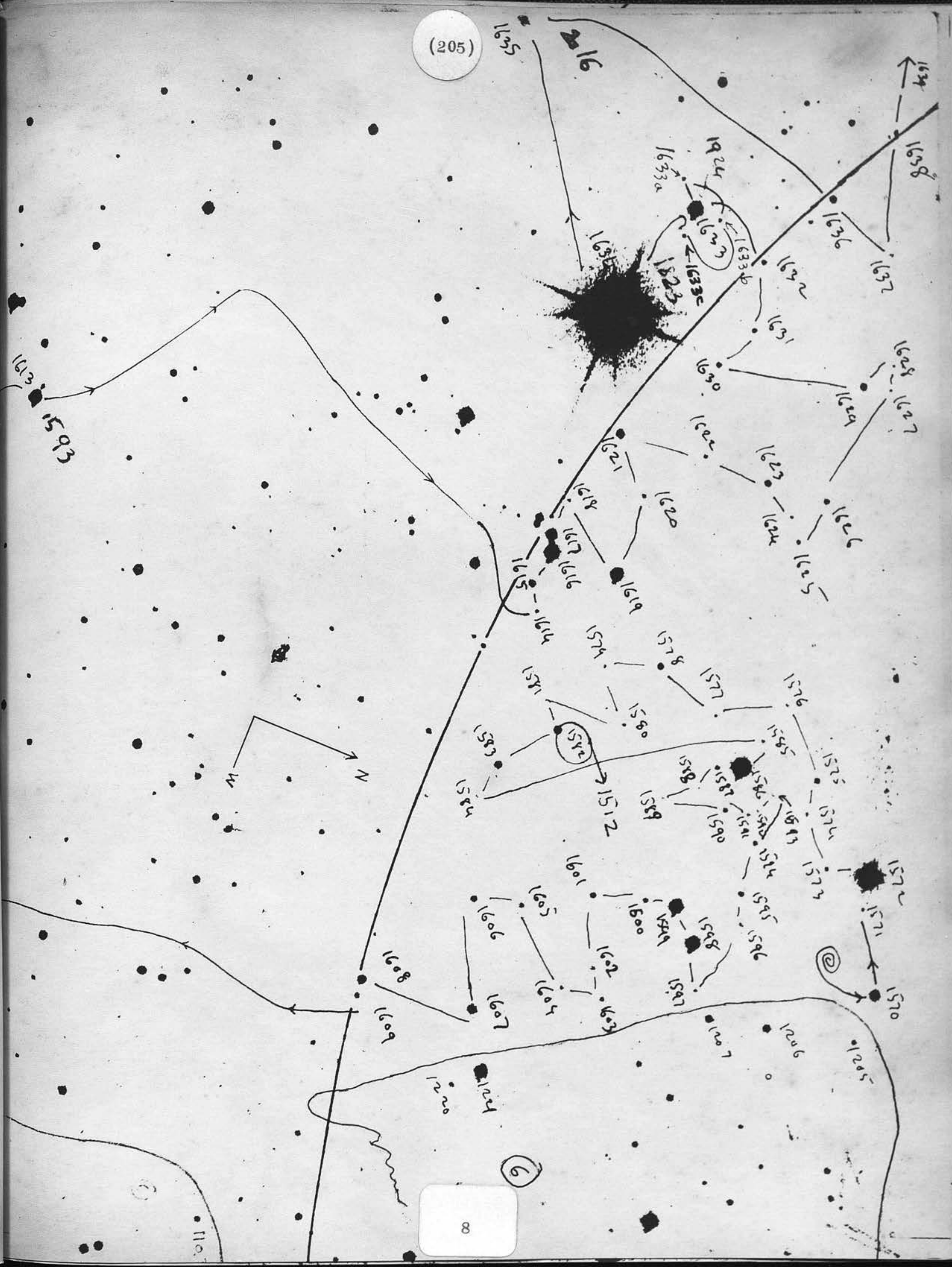
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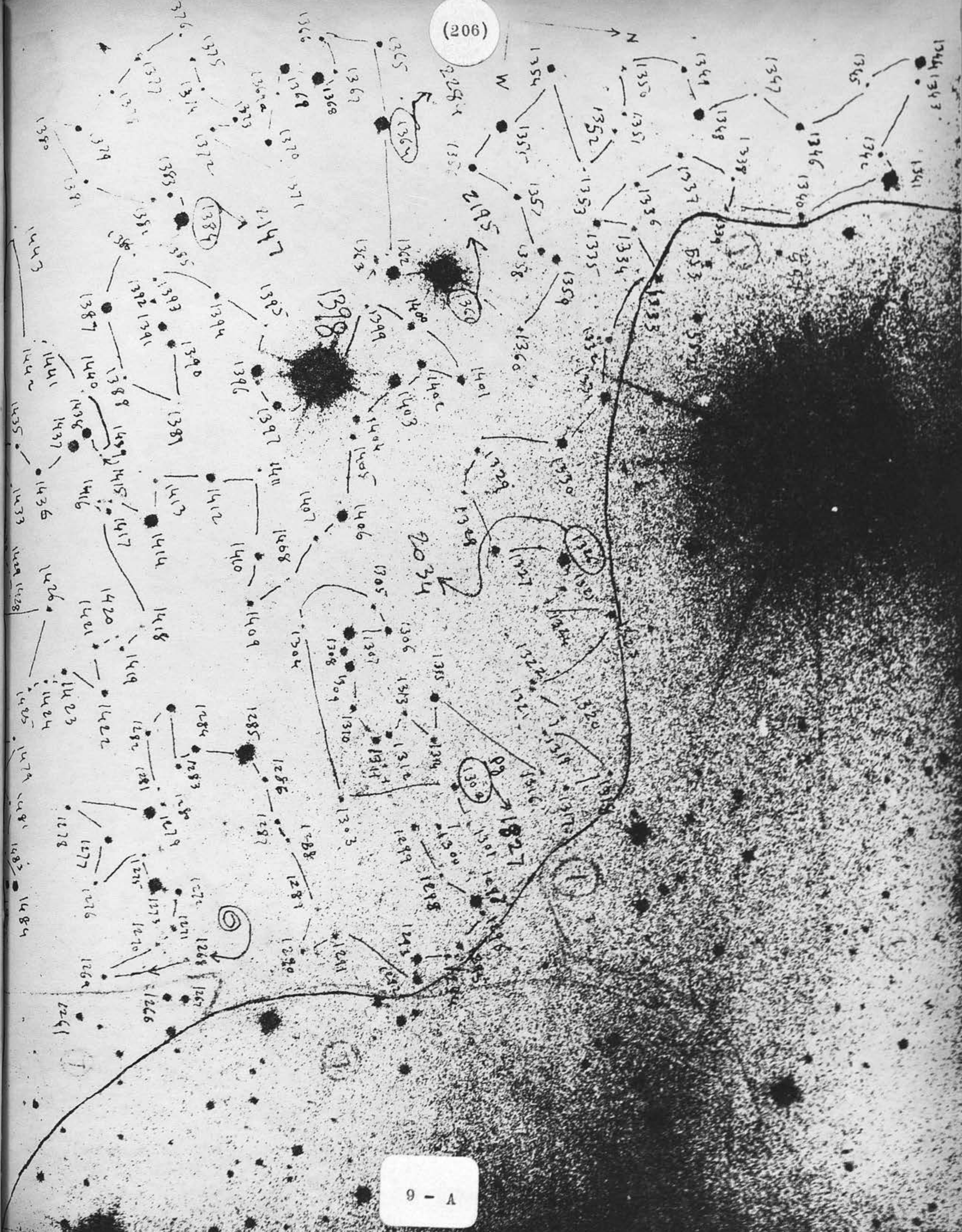
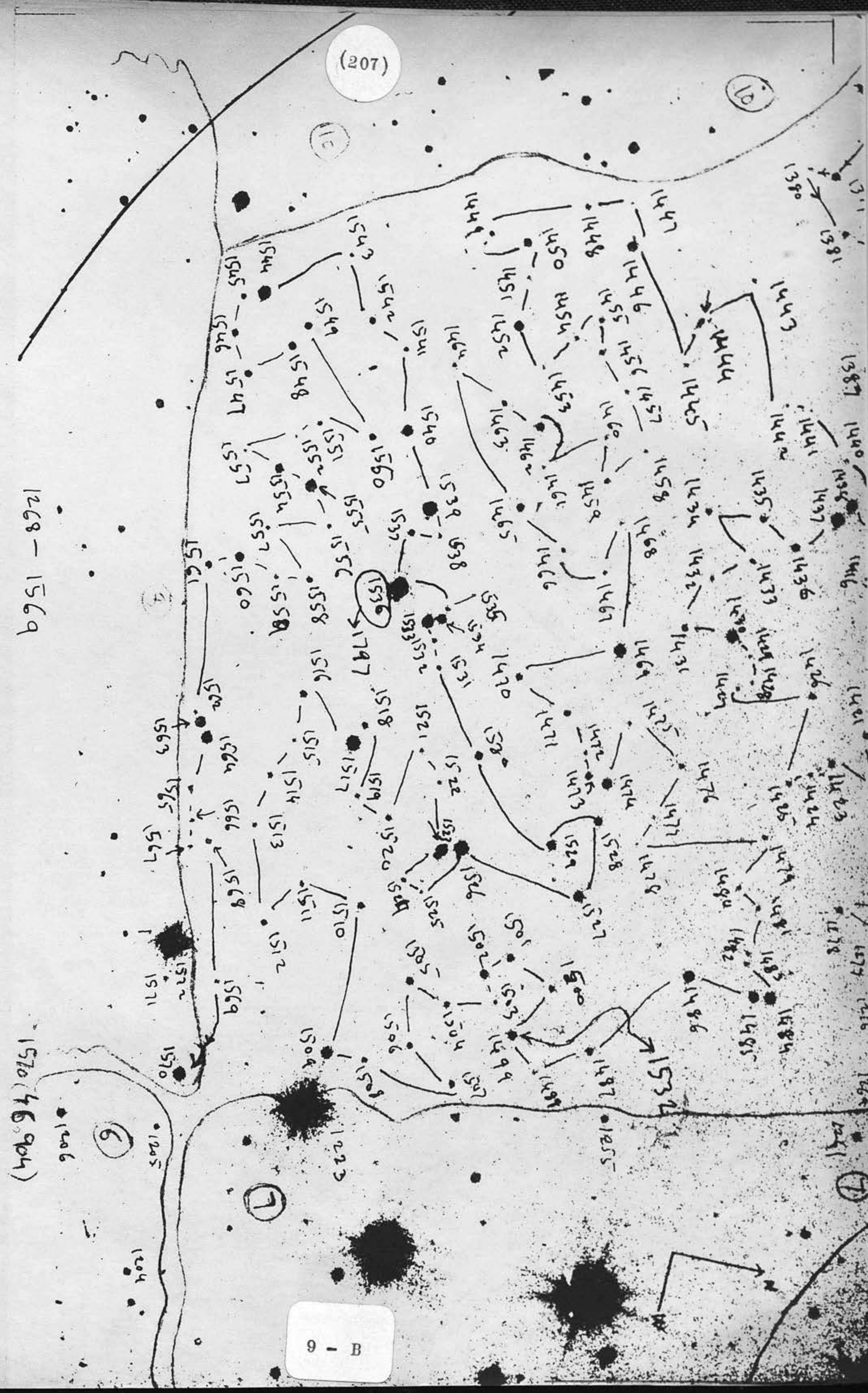
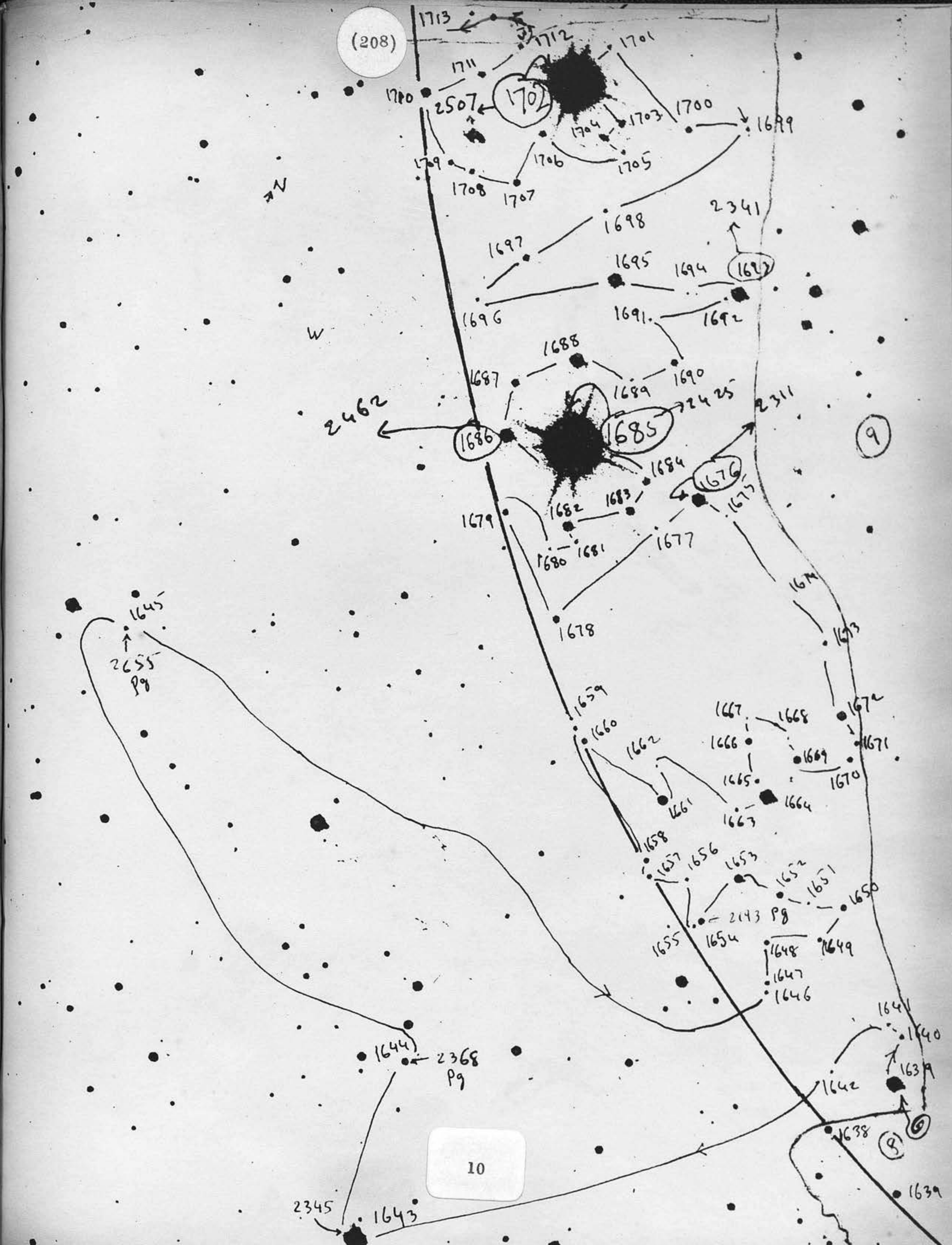


9 - A





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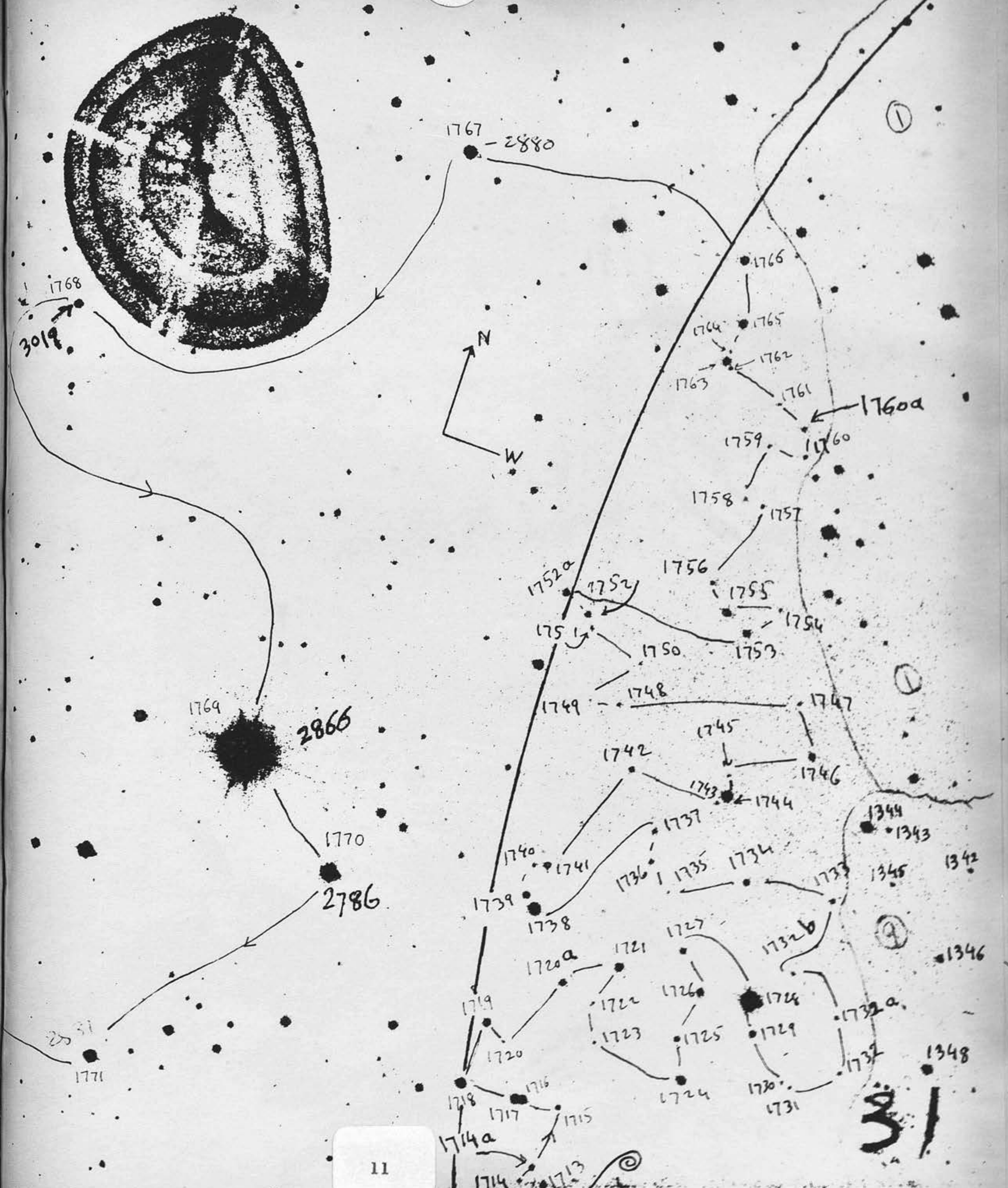
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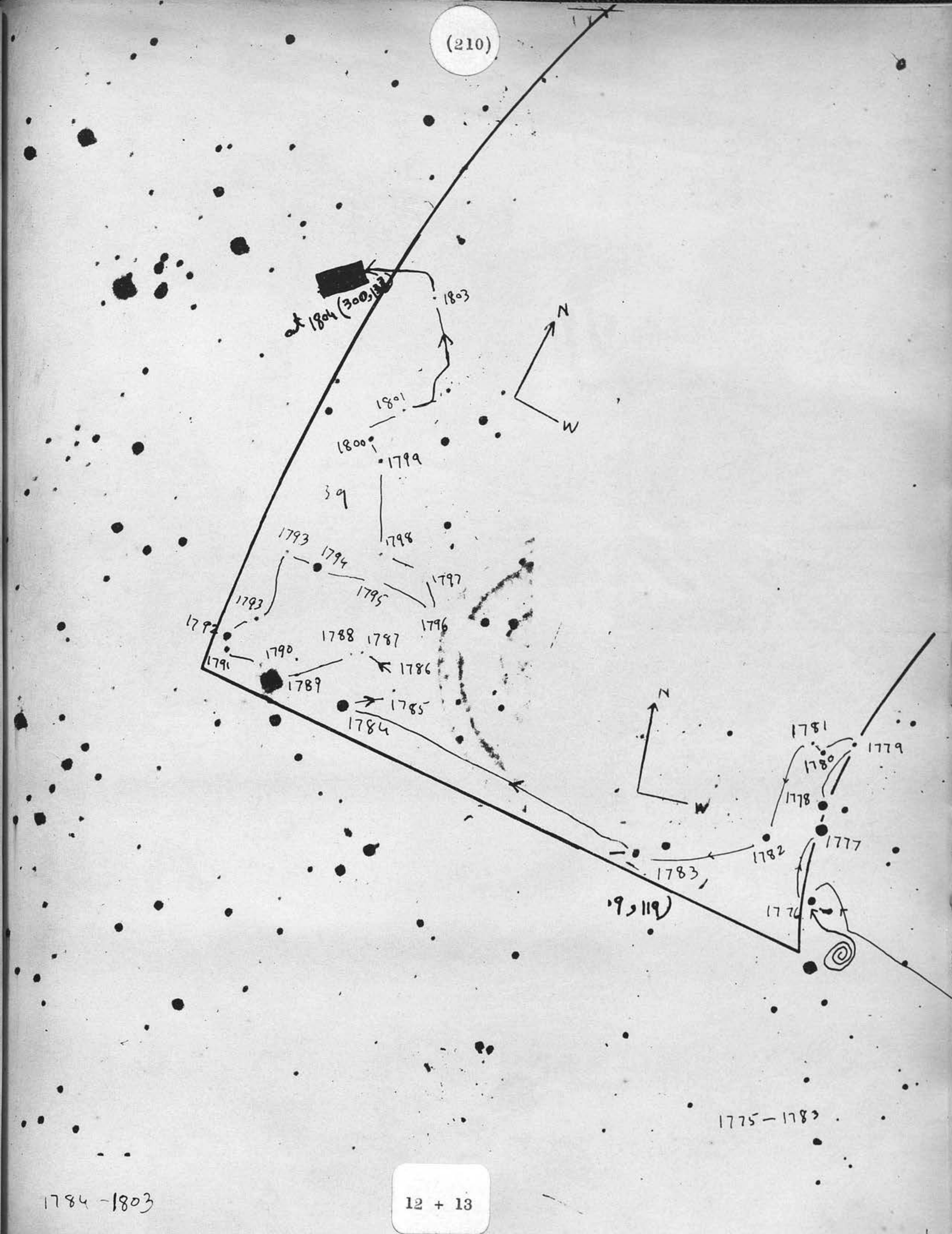
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1784 -1803


1804 — 2083
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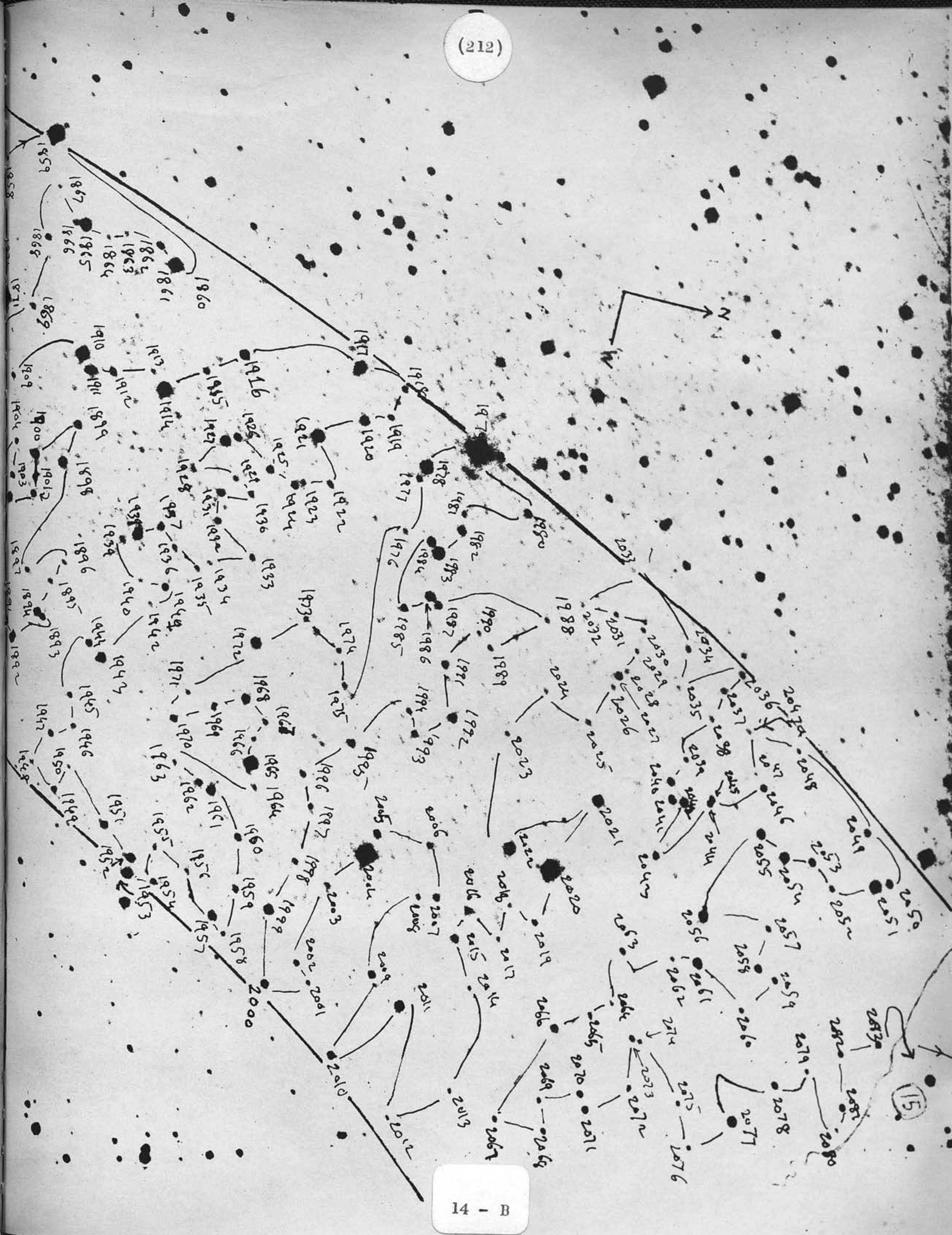
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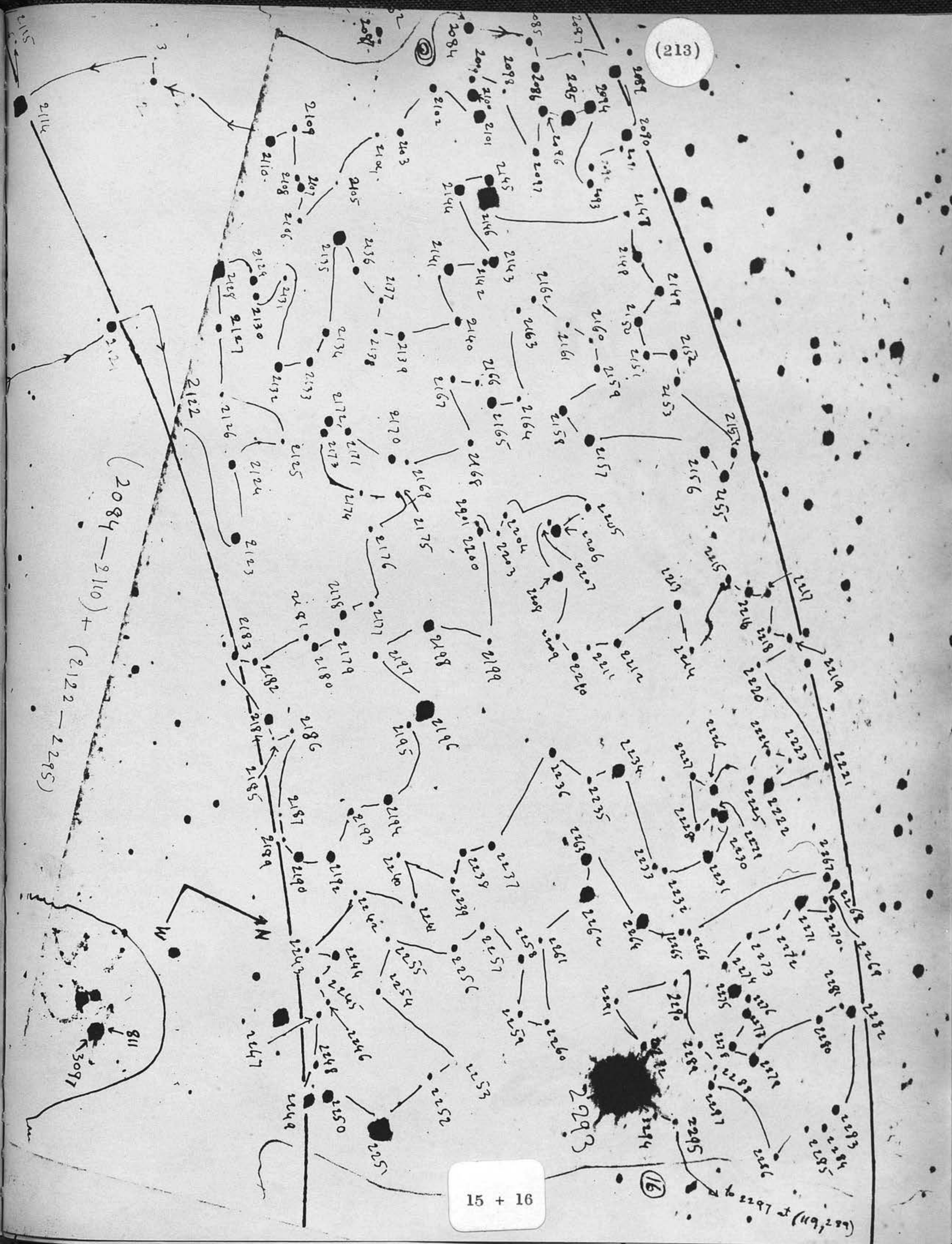

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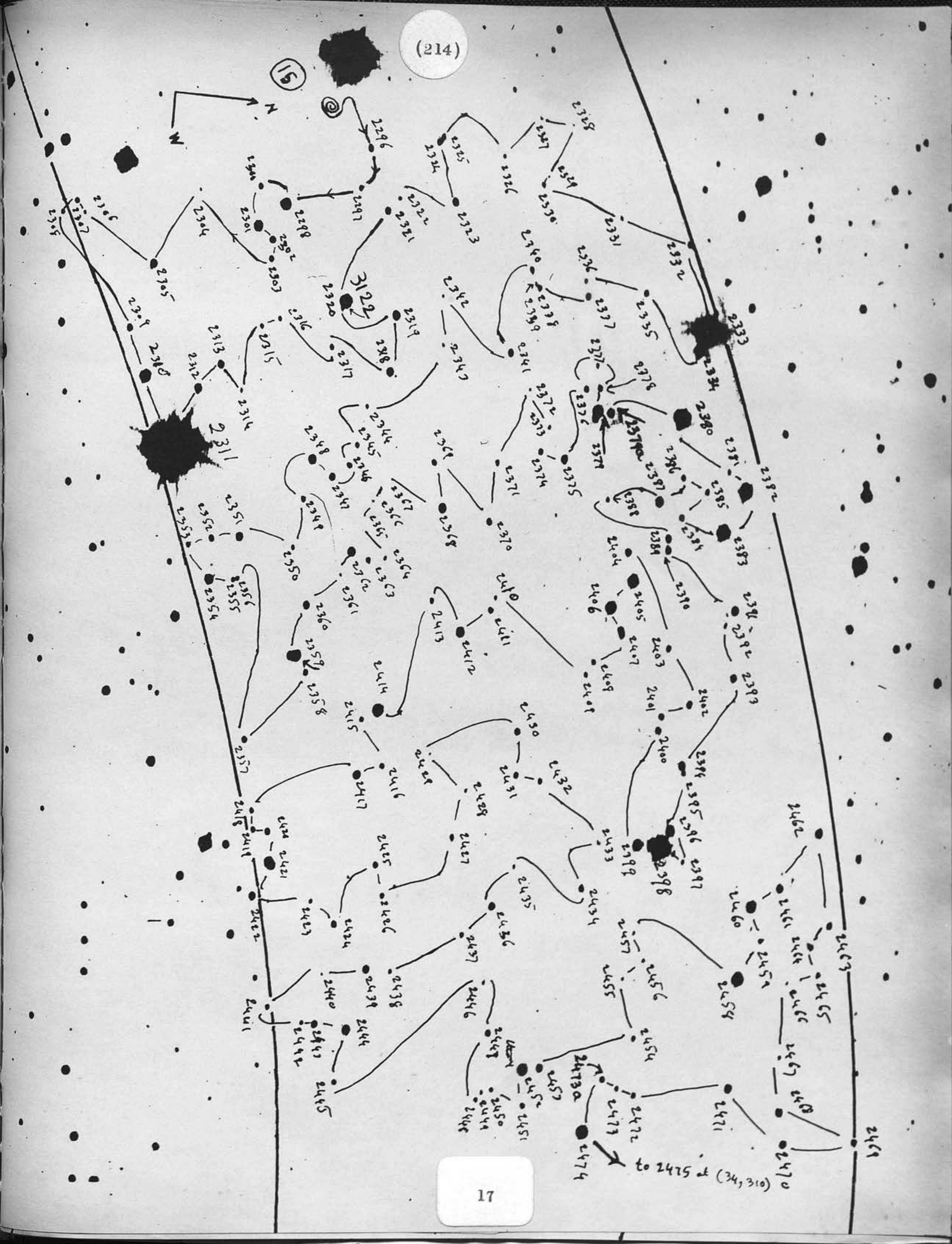
15
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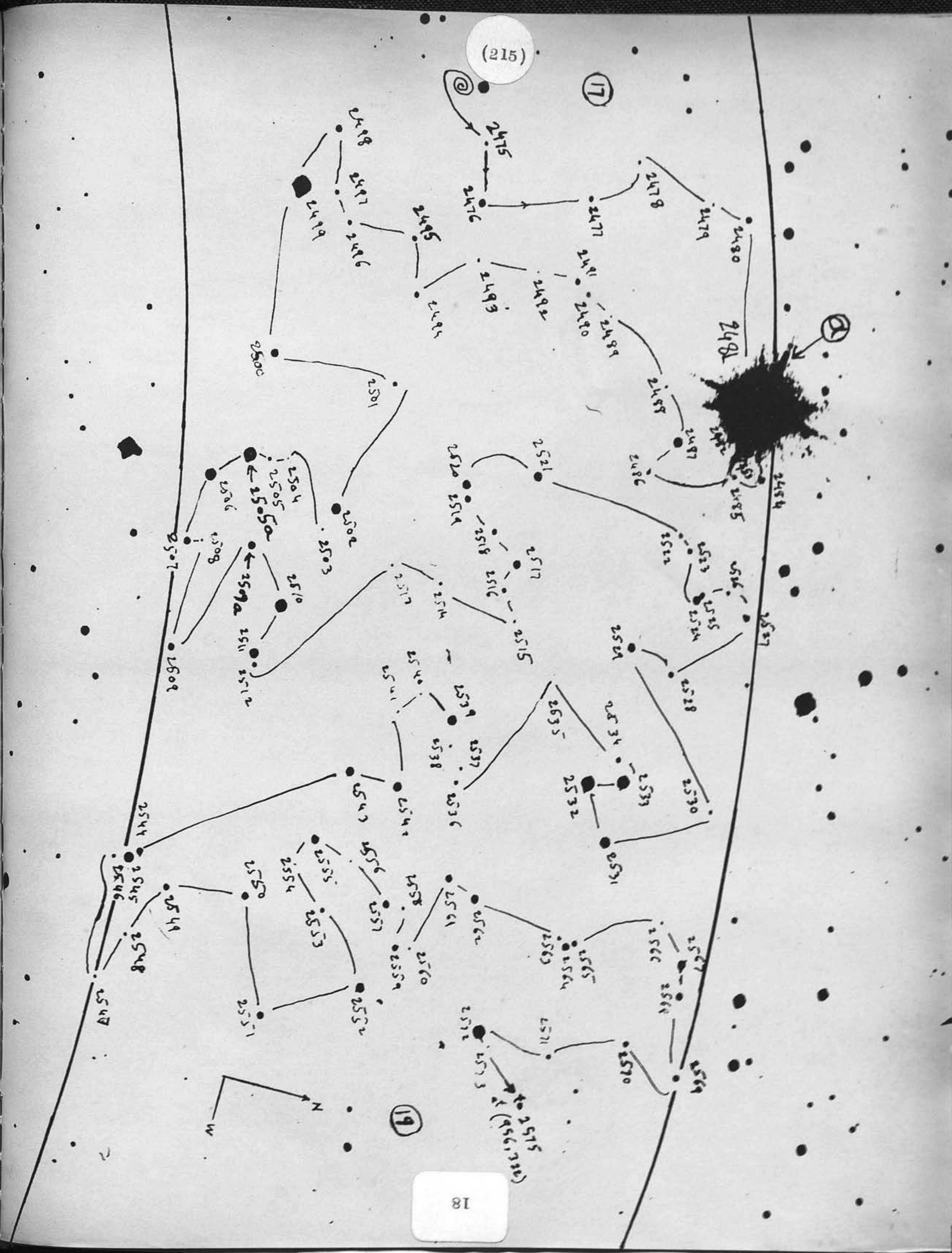
to 2475 at (34, 310)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(956,736)
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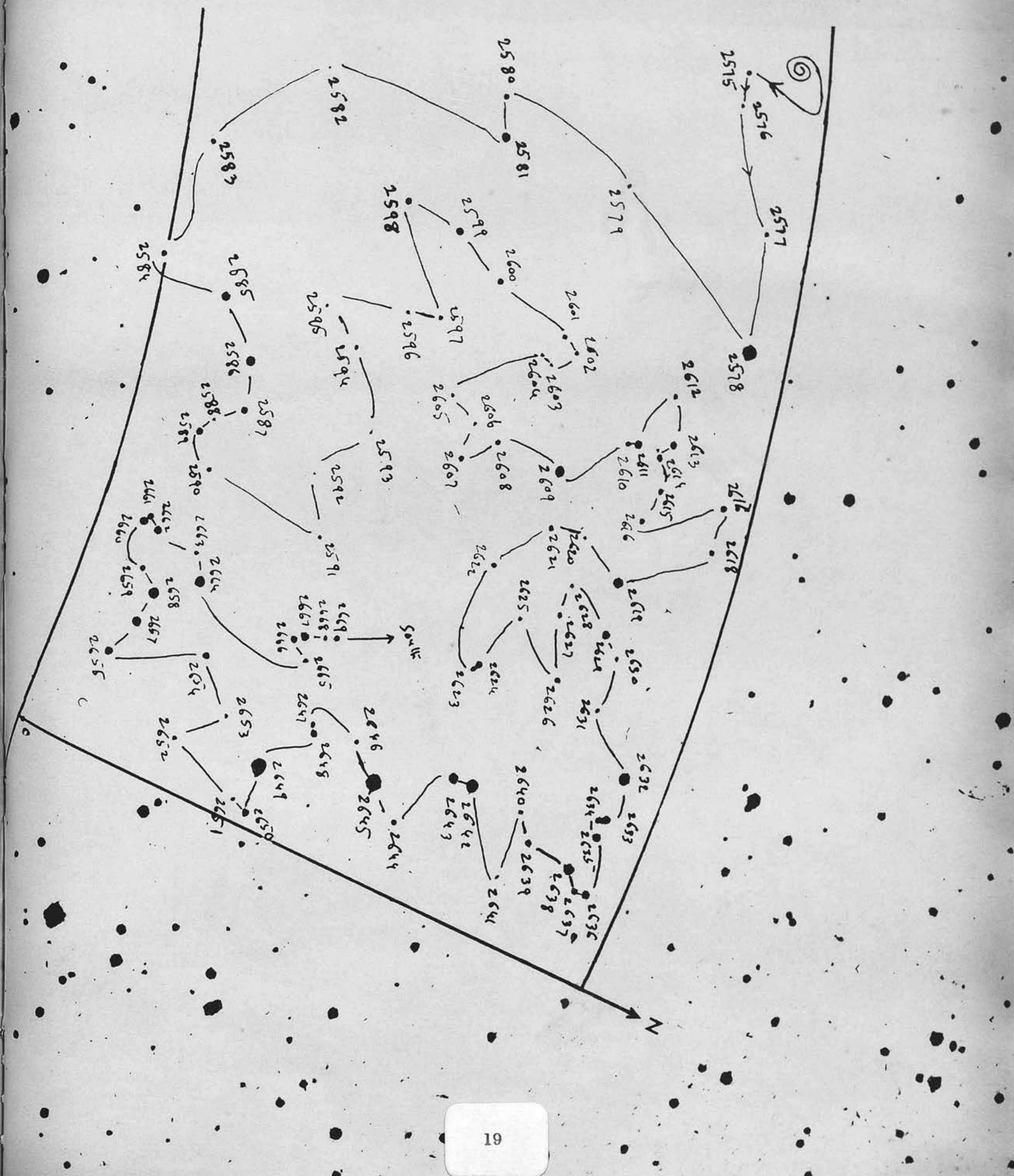
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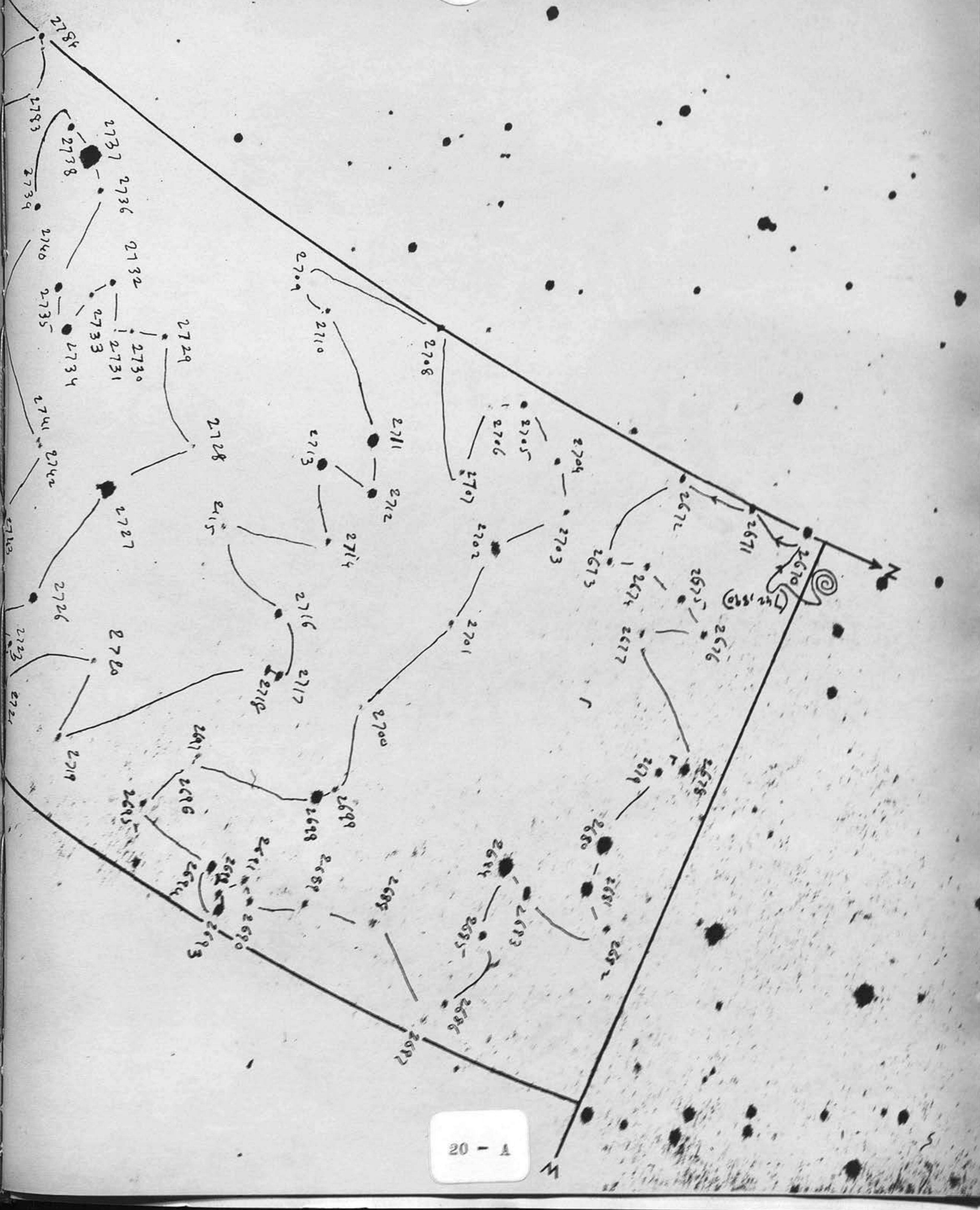
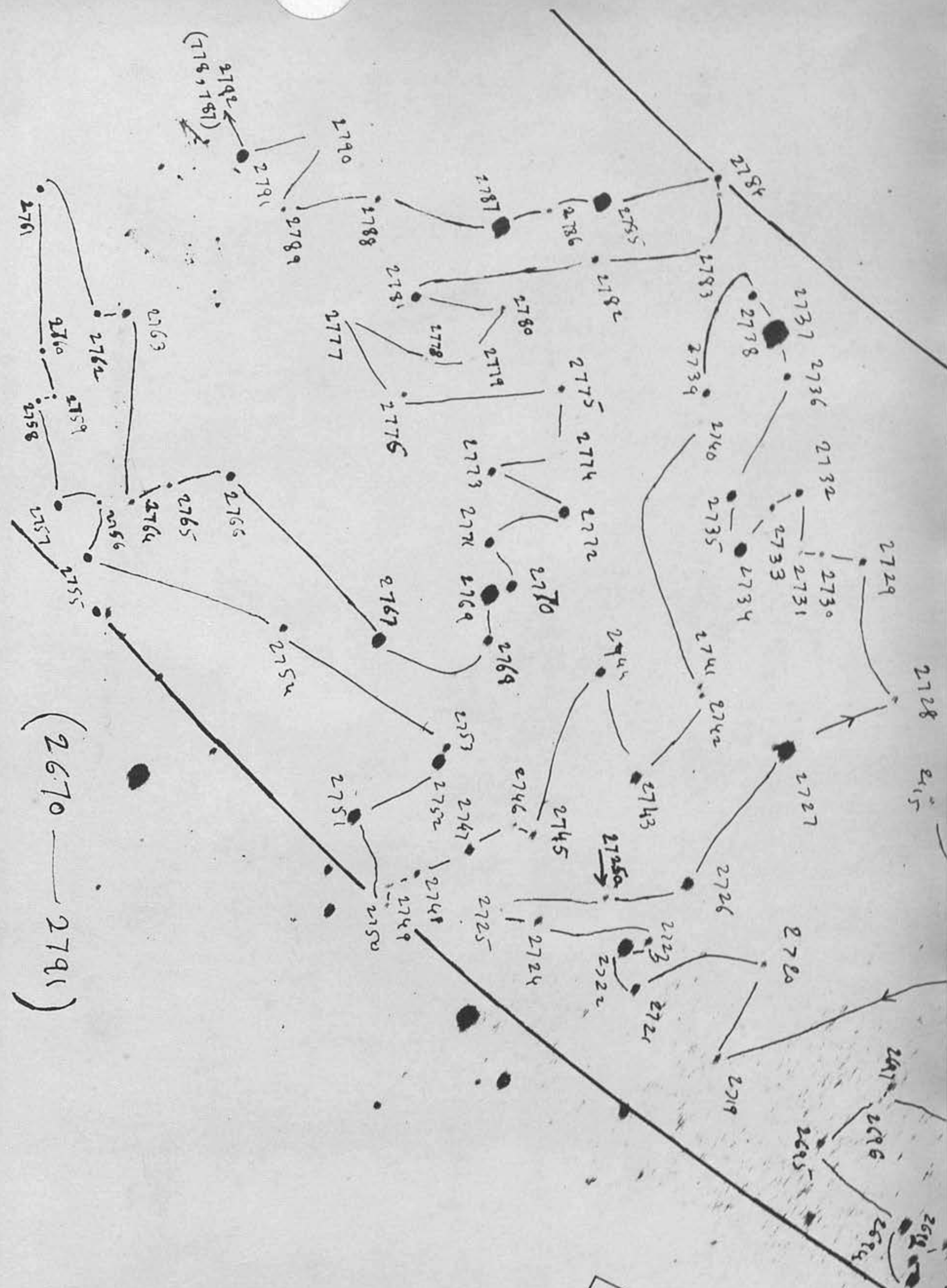
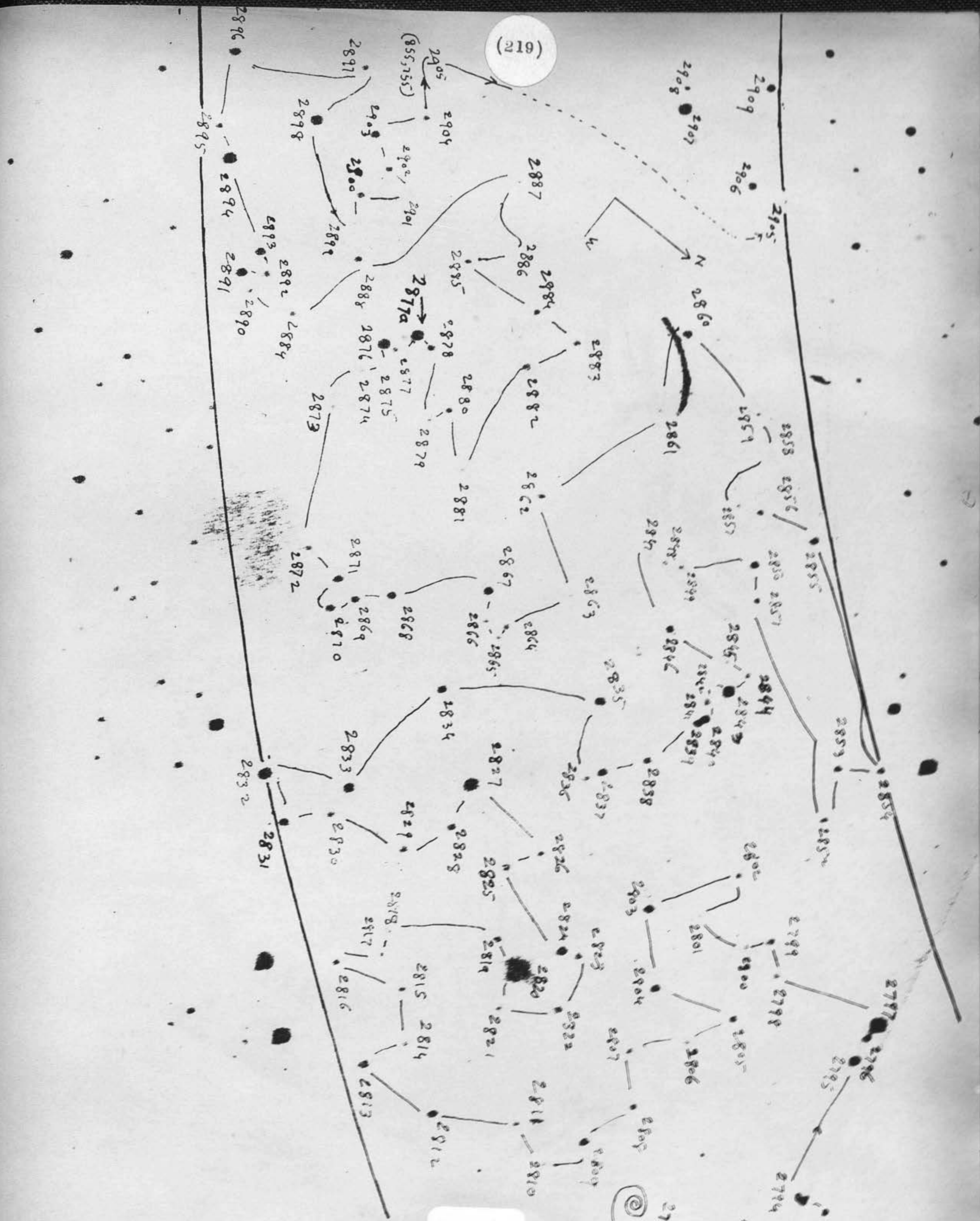
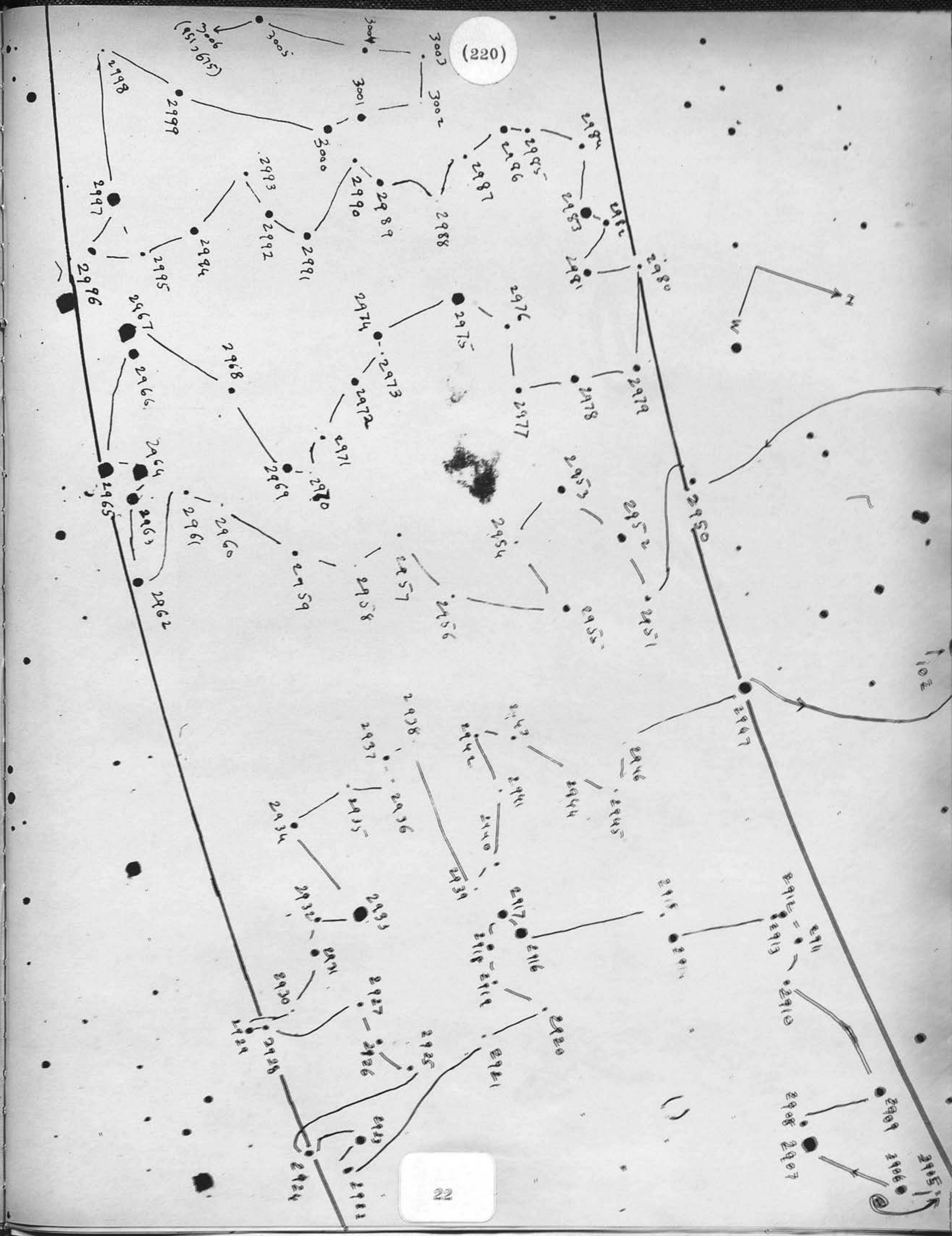
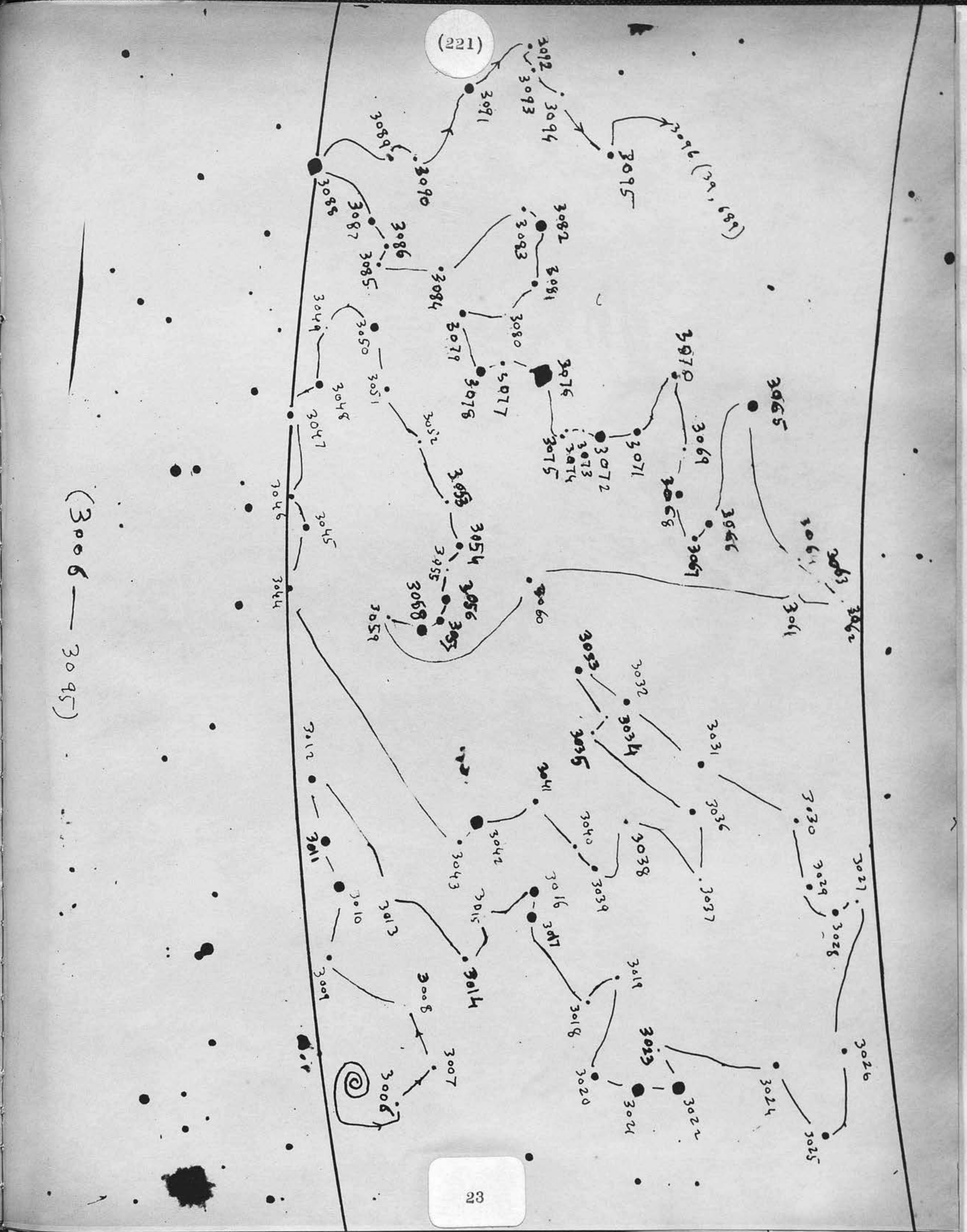


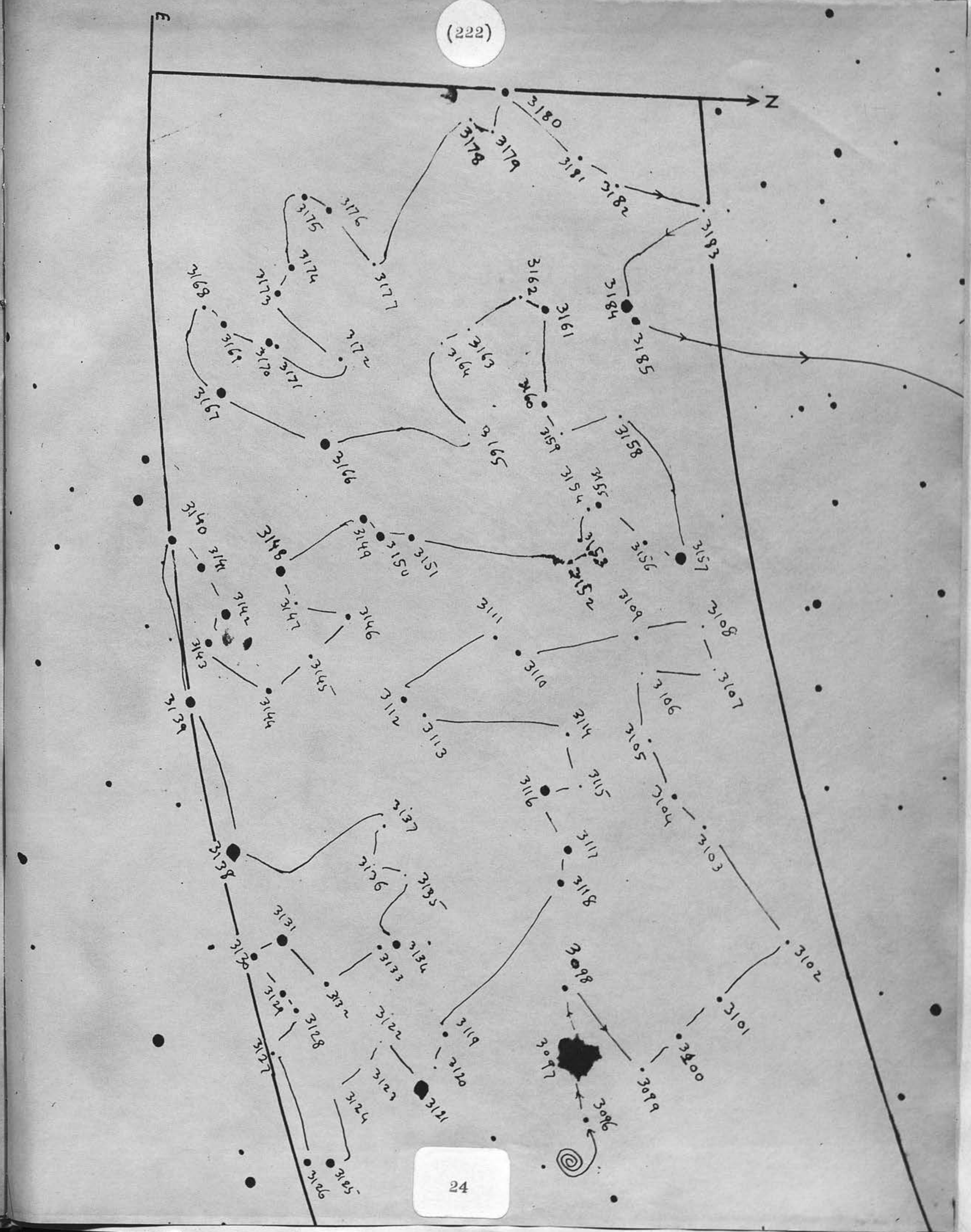
20 - A


(2670 — 2791)






(3006 — 3095)
3096 (39,689)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