immersed, turns gradually into a beautiful violet and by this violet colour W distinguishes itself clearly from Ti, Mo and Nb. The salt of phosphorus bead of Nb dissolved in acid produces with Zn an ultramarine blue colour. The reaction for W can be made still more conspicuous than in the manner described above by melting the bead already with a reducing agent, such as $SnCl_2$, Sn or Zn. The bead then turns into an intense green and in $^5/_1\,N$ muriatic acid on the white dropping-plate the beautiful violet colour presents itself in this case very soon.

The method was checked with chemically pure WO_3, with the minerals Wolframite (from Cornwall, Billiton and Oruro), Hubnerite (Bolivia), Stolzite (Zinnwald) and a mixed ore from Bolivia, containing mainly Cassiterite and Wolframite. Further with a commercial product WO_3, called Tungstite.

Thus the salt of phosphorus bead may be used in order to prepare the colourless HCl-solution in which can be reacted Ti, W, Mo and Nb, by means of zinc. The colours, arising during the reactions, are as indicated below. Moreover under each reaction the method is given to check the result in a solution obtained after the mineral has been broken down with carbonate of sodium or of sodium and potassium.

Titanium. Colourless-pale-violet.

Check: add H_2O_2; orange yellow colour, which disappears with NH_4F.

Tungsten. Colourless-dark-violet.

Check: $HCl + Zn$, a blue discoloration.

Molybdenum. Colourless-brownish-yellow. (After being either blue or not).

Check: with potassium ferrocyanide and some solid $SnCl_2$ a reddish-brown discoloration, which becomes colourless with NH_4OH. (With Cu blue and with U yellow). If Fe is present a tartrate should be added.

Niobium. Colourless-grey-ultramarine blue.

Check: With HCl and Zn the same greyish-blue colour.

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June 1933.

Astronomy. — *Distribution of the nearer stars and the masses of the visual binaries.* By A. VAN MAANEN.

(Communicated at the meeting of September 30, 1933.)

A new determination[1]) has recently been made of the corrections required to bring the longer series of modern trigonometric parallaxes into

1) *Contributions from the Mount Wilson Observatory, Carnegie Institution of Washington*, N^o^. 474, 1933.

a consistent system among themselves and, at the same time, into agreement with the revised Mount Wilson spectroscopic parallaxes. The card catalogue of parallaxes thus corrected contains such a wealth of material that it seems worth while to investigate the conclusions that may be drawn relative to certain groups of stars.

The material was first used for a discussion of the nearer stars; 617 objects were found within a distance of 20 parsecs from the sun. Table I gives the material, subdivided according to parallax and grouped according to single stars and double and multiple systems. For each group the first figure refers to the number of systems, the second to the number of individual stars.

TABLE I.

π	$\geqq 0''.200$		$0''.100$—$0''.199$		$0''.050$—$0''.099$	
Single	21	21	62	62	281	281
Double	6	12	11	22	80	160
Multiple	2	6	5	16	11	37
Total	29	39	78	100	372	478

It is very doubtful if we know all the stars even in the central region of 5 parsecs radius. For instance if we divide this space into two equal volumes, we find 24 stars in the central part as against 15 in the outer shell. Moreover, as we shall see later, we find that the large majority of these stars are of very faint absolute magnitude. For example, 24 of the 39 are $+10$ or fainter (the sun has an absolute magnitude of $+4.85$); and of the 24, 15 are in the northern hemisphere and only 9 in the southern where the observational material is less complete. Finally, no stars have as yet been found whose absolute magnitude is fainter than $+16.6$ (the magnitudes used are on the visual scale). While of course there must be a lower limit for the luminosity of a star, it is doubtful if we have already reached this limit. All these reasons make it evident that even in our immediate neighborhood we do not know all the stars. But as there is no reason to expect a different star density in this region from that at distances of 10 and 20 parsecs, we enquire what we may expect in the other two shells discussed here, on the basis of our knowledge of the central region.

As the second and the third shells are 7 and 56 times, respectively, as large as the central sphere, we should expect at least 273 and 2184 stars instead of the 100 and 478 stars actually found. Part of these differences may be explained by the present lack of material in the southern hemisphere. In the central region we have, besides the sun, 20 northern and 18 southern stars. In the two shells these figures are, respectively, 63 and 37, and 305 and 173, which again shows the lack of material in the southern hemisphere. A much more important factor in explaining the small number of stars in the outer shells is the lack of stars of low absolute magnitude. For instance, supposing the central region to be complete, we find that of the 39 stars, 5 are brighter than $+5$, 10 are between $+5$ and $+9.9$, and 24 are $+10$ or fainter, or, respectively, 13, 26, and 61 per cent. If similar percentages hold up to a distance of 20 parsecs, the relation between the numbers of expected and observed stars in the two shells will be that given in Table II [1]).

TABLE II.

M	$\pi = 0''.100$ to $0''.199$			$\pi = 0''.050$ to $0''.099$		
	Expected	Observed	E—0	Expected	Observed	E—0
$<+5$	35	20	15	284	158	126
$+5$ to $+10$	71	59	12	568	285	283
$>+10$	167	21	146	1332	35	1297

It is evident that in the outer shells we know as yet only a small percentage especially of the fainter stars. This is not surprising if we keep in mind that in the mean the stars in these shells have apparent magnitudes 1.7 and 2.7 fainter than those in the central region, while their proper motions in the mean are only 0.47 and 0.29 of those for the central region. Both factors make the discovery of the more distant stars of low luminosity considerably more difficult. If we divide each of the regions into two concentric parts of the same volume, we find, as already noted for the central region, that we know already considerably more stars for the inner than for the outer half. Computing the densities for the 6 shells, we find the results in Table III.

TABLE III.

Zone I inner half	0.092 stars per cubic parsec
outer half	.057
Zone II inner half	.038
outer half	.016
Zone III inner half	.019
outer half	0.013

[1]) In this discussion spectroscopic double stars have been treated as two stars of equal magnitude.

It is gratifying to find that, although many of the stars used in this discussion are faint, we know the spectral types of a very large number. In the three regions, respectively, we have spectra of 36 of the 39, 85 of the 100, and 366 of the 478 stars known. (The three exceptions in the central region are the companion of Procyon, Innes's star ($\alpha = 11^h20^m$, $\delta = -57^\circ$), and D.M. $-46^\circ 11540$ ($\alpha = 17^h21^m$, $\delta = -46^\circ$). Figure 1 gives for the

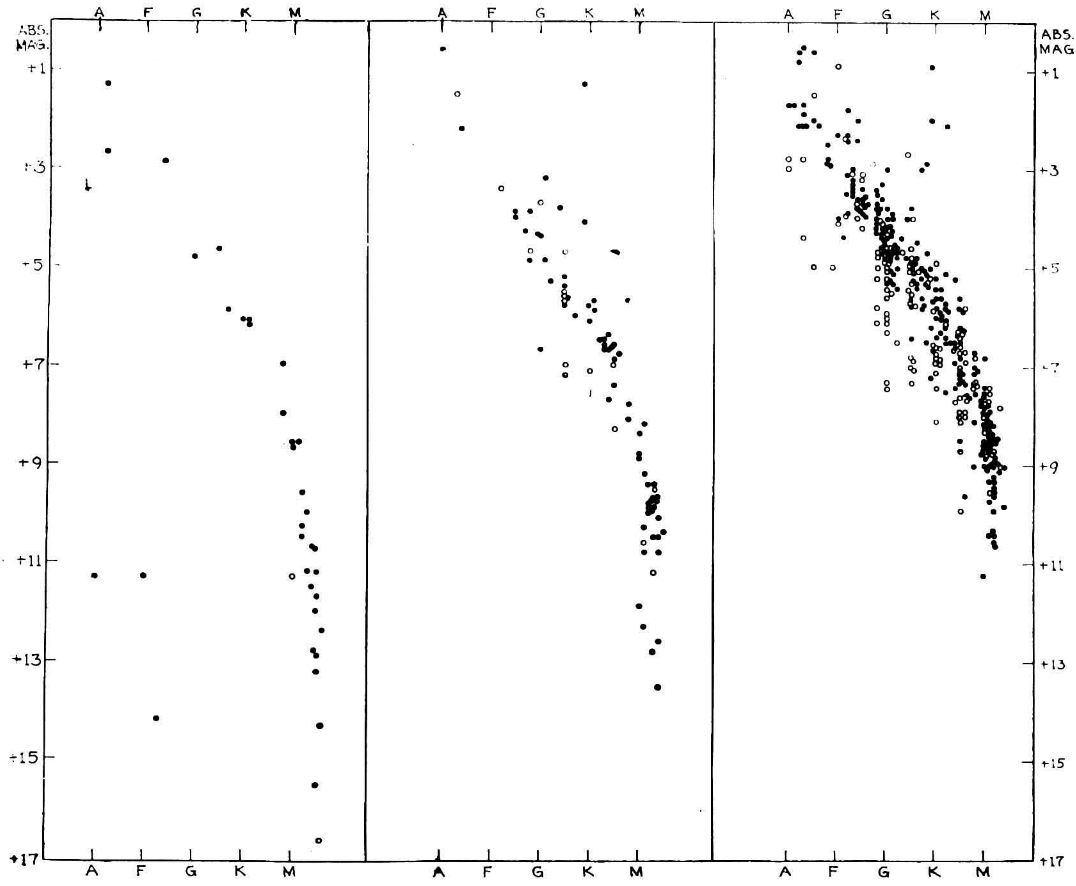

Fig. 1.

three regions the stars of known spectral type (abscissae) plotted according to their absolute magnitudes (ordinates). The stars for which only one modern parallax is known are indicated in the diagram by circles instead of dots.

It is interesting to see that not a single one of these stars has an absolute magnitude brighter than 0. In the first region the faintest star is $+16.6$; in the others, $+13.5$ and $+11.2$, respectively. Only in the central region do we find any stars that do not fall fairly well on the RUSSELL-HERTZSPRUNG diagram. These exceptions are the three well-known white dwarfs, viz. the companion of Sirius, the companion of 0^2 Eridani, and VAN MAANEN's F type star ($\alpha = 0^h 44^m$, $\delta = +5°$), having the absolute magnitudes $+11.3$, $+11.3$, and $+14.2$, respectively. The chance of finding stars of this kind, which are among the most interesting in the sky, is not large. In the central region we know 17 stars of absolute magnitude $+11.3$ or fainter, and only 3 of these are known to be white dwarfs; of the three, two are companions of double stars, and in the outer regions their discovery would have been much more difficult. In the next region we know only 8 stars equal to or fainter than $+11.3$, and of these spectra are known for only 5. In the third region we know 12 stars, but for none of these is the spectrum determined as yet. It is also interesting to note, particularly in the third region, that the apparent broadening of the diagram is caused principally by stars for which only one modern observation of the parallax is available. This circumstance may be partly due either to erroneous parallaxes or to the uncertainty in the apparent magnitudes and the spectral types, as we are here dealing with stars of rather faint apparent magnitude.

In the second place the material was used for a discussion of the visual double stars for which a good or reasonably good orbit is known. Aitken's new catalogue contains fairly reliable orbits for 102 systems. For 94 of these modern parallaxes are available, a fact which enables us to derive the absolute magnitudes and the masses of the systems [1]). These results are plotted in figure 2 with the bolometric absolute magnitudes as abscissae and

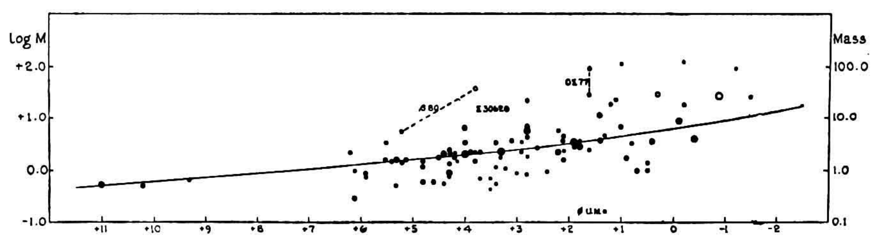

Fig. 2.

the logarithms of the masses as ordinates. On the basis of weight 1 for a modern trigonometric parallax, the weights of the individual stars range from 1 to 12, the differences being indicated in the plot by a heavier dot for a larger weight.

Four of the stars need special comment: For Σ 3062 the mean parallax is 0.″026, with weight 7. Nevertheless the star falls far from the mean curve. For 0 Σ 77 two orbits are given, both of which have been used in the diagram, the two points being connected by a broken line. For φ Ursae Majoris the mean parallax of weight 3 is 0.″026. The agreement between the spectroscopic and the trigonometric parallax is quite good, nor can there

[1]) In 1919, when I published an article on "The masses and absolute magnitudes of visual binaries" in Publications of the Astronomical Society of the Pacific, p. 231, I had only 39 systems at my disposal.

be much doubt about the orbit, but the star falls so far from the mean curve as to raise suspicion. For β 80 the mean of all the parallaxes with weight 5 is 0.″012 ; the spectroscopic value is 0.″023, which is probably nearer the truth as the trigonometric parallax of 0.″005 seems very small for a star with an annual proper motion of almost 0.″5. The two points in the diagram corresponding to $\pi = 0.''012$ and 0.″023, respectively, are connected by a broken line.

Table IV gives the arithmetical mean logarithm of the mass and the geometrical mean mass for each absolute magnitude. The values for β 80

TABLE IV

$\overline{M}$	$\overline{\text{log. Mass}}$	$\underline{\text{Mass}}$	n	Wt.	Theoretical log. Mass	△ log. Mass
− 1.40	1.58	38.0	2	3	1.03	+0.55
− 0.46	1.08	12.0	5	31	0.86	+0.22
+ 0.57	0.53	3.4	7	29	0.72	−0.19
+ 1.53	0.63	4.3	13	55	0.58	+0.05
+ 2.50	0.52	3.3	16	62	0.45	+0.07
+ 3.43	0.32	2.1	16	63	0.34	−0.02
+ 4.33	0.21	1.6	18	93	0.25	−0.04
+ 5.41	0.15	1.4	9	37	0.16	−0.01
+ 6.13	−0.15	0.7	3	11	0.10	−0.25
+10.48	−0.26	0.5^5	3	16	−0.25	−0.01
						Mean +0.01

and 0 Σ 77 have been omitted on account of their uncertainty, while the three stars fainter than + 10 are collected into a single mean. The number of stars is given in the fourth column, and the total weight of the parallaxes involved in the fifth column.

The sixth column gives the logarithm of the mass derived from EDDINGTON's mass luminosity law, revised to include the fact that we are using the masses and absolute magnitudes of binary systems instead of individual stars, while the last column shows the differences between the observed and the theoretical values. The weighted mean difference is + 0.01, or only 2½ per cent between the theoretical and the observed masses.

The large deviation for the two brightest stars (first line in Table IV) means little as the weight is extremely small.

Although the means of the masses agree very well with the theoretical values, the dispersion in the individual values is unexpectedly large. The mean difference in the logarithm of the mass is ± 0.30, which corresponds to a factor of 2 in the masses. Dividing the objects according to the weights of the parallaxes, we find that only the five stars of weight 1 have an outstandingly large mean difference in the logarithm of the mass. If we group the material according to the size of the parallax, outstandingly large mean differences in the logarithm of the mass occur only for the binaries whose parallax is 0″.012 or less. Omitting the 11 stars included in these two catagories, we still find a mean difference in the logarithm of the mass of ± 0.26, corresponding to a factor 1.82 in the masses. Another source of error which might increase the dispersion in the masses is the uncertainty in the major axes of the orbits. The material was therefore also divided according to the size of the major axes. Excluding again the 11 systems with less reliable parallaxes, we find that for $a \geqq 0.''50$ the mean difference in logarithm of the mass is ± 0.21, and for $a < 0.''50$, ± 0.37, corresponding to mean factors in the masses of 1.62 and 2.34, respectively. It is evident, therefore, that even for the systems with well determined data the dispersion in the masses is still considerable; and it seems to me that this is inherent to the masses rather than a result of uncertainties in the observational material.

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Chemistry. — *Untersuchungen über den Fettstoffwechsel.* III. Von P. E. VERKADE und J. VAN DER LEE. (Communicated by Prof. J. BÖESEKEN).

(Communicated at the meeting of October 28, 1933.)

§ 1. In der ersten Mitteilung dieser Reihe [1]) wurde nachgewiesen, dass bei zwei gesunden Versuchspersonen (V. und V. D. L.) nach Verabfolgung von Triundecylin als Bestandteil einer kohlenhydratarmen Kost erhebliche Mengen Undekandisäure im Harn ausgeschieden wurden. Bei der fortgesetzten Untersuchung dieser von uns *Diacidurie* genannten Erscheinung wurde bei einem namhaften Prozentsatz der dann von uns untersuchten Personen Ausscheidung dieser Disäure unter gleichen Umständen festgestellt. Zugleich zeigte sich dabei, dass Hinzufügung einer reichlichen Kohlenhydratmenge zur Kost bei den meisten Personen, darunter auch den beiden obengenannten Versuchspersonen, zu einer ausgesprochenen Erhöhung der Disäureausscheidung führt. Das Beweismaterial für diese beiden Behauptungen werden wir später veröffentlichen.

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[1]) VERKADE, ELZAS, VAN DER LEE c. s., diese Proceedings **35**, 251 (1932); Zeitschr. physiol. Chem. **215**, 225 (1933).