S being the sun. Imagine this stratum to be uniformly filled with stars (of course in the actual universe instead of sharply defined boundaries AB and CD, we shall have a gradual thinning out of the stars) it follows that in the two directions SP and SP' the fewest stars will be seen; these then are the directions of the galactic poles. As we consider a direction such as SQ farther and farther from the pole the boundary of the universe in that direction becomes more and more remote so that more stars are seen, and finally in the directions SR and SR' in the galactic plane, the boundary is perhaps beyond the limits of our telescopes. That the universe must have a boundary in the directions SR and SR', we can hardly doubt, but nothing is known of its shape or distance except that in all directions it must be far greater than SP or SP'; in particular it is not known whether the sun is near the centre or otherwise. That the sun is nearly midway between the two boundary planes can be tested by comparing the star-densities of the northern and southern galactic hemispheres. These are zone for zone very nearly equal ; the slight excess of stars in the southern hemisphere perhaps implies that the sun is a little north of the central position. This is confirmed by the fact that the Milky Way is not quite a great circle of the celestial sphere, but has a mean south galactic latitude of about 1∙7°.

If, instead of considering the whole mass of stars, attention is directed to those of large proper motion, which are therefore in the mean relatively near us, the crowding to the galactic plane is much less noticeable, if not indeed entirely absent Thus Kapteyn found that the Bradley stars having proper motions greater than 5\* per century were evenly distributed over the sky. Dyson and Thackeray’s tables show the same result for the Groombridge stars down to magnitude 6·5; but the fainter stars (with centennial proper motions greater than 5*''*) show a marked tendency to draw towards the galactic circle. The result is precisely what should be expected from the theory of the shape of the universe which has been set forth. If in the fig. we describe a sphere about S with radius SP so as just to touch the boundaries of the stratum of stars, then, provided a class of stars is considered wholly or mainly included within this sphere, no concentration of stars in the galactic plane is to be expected, for the shape of the universe does not enter into the question. It is only when some of the stars considered are more remote and lie outside this sphere (but of course between the two planes) that there is a galactic crowding. We infer that nearly all the stars down to magnitude 6∙5, whose proper motions exceed 5", are at a distance from the sun less than SP, whilst of the fainter stars with equally great proper motions a large proportion are at a distance greater than SP. This result enables us to form some sort of idea of the distance SP.

On considering the distribution of the stars according to their spectra, it appears that the Type II. (solar stars show no tendency to congregate in the galactic plane. The result of course only applies to the brighter stars, for we have very little knowledge of the spectra of stars fainter than about magnitude. 7∙5. The explanation indicated in the last paragraph applies to this case also Type II. stars are in general much less intrinsically luminous than Type I., so that the stars known to be of this type must be comparatively near us, for otherwise they would appear too faint to have their spectra determined. They are accordingly within the sphere of radius SP (fig.), and consequently are equally numerous in every direction. The Type I. stars, being intrinsically brighter, are not so limited. According to F. McClean, of the stars brighter than magnitude 3∙5, only the helium and not the hydrogen stars of Type I. show a condensation towards the galactic plane. Thus we see that the effect of limiting the magnitude to 3∙5 is that the hydrogen stars are now practically all within the sphere SP, and it is only the helium stars, whose absolute luminosity is still greater, that are more widely distributed. Of the rarer types of spectra., stars of Type III. agree with those of Type II. in being evenly distributed over the sky; Types IV. and V. however, congregate towards the galactic plane. The most remarkable are the Type V. (Wolf- Rayet) stars; in their case the condensation into the galactic regions is complete, for of the 91 known stars of this type, 70 are actually in the Milky Way and the remaining 21 are in the Magellanic Clouds (two large clusters in the southern hemisphere, which re­semble the Milky Way in several respects). Excluding the latter, the 70 Wolf-Rayet stars have a mean distance from the central galactic circle of only 2∙6°. There can be little doubt that these stars belong to the Milky Way cluster, so that their presence is a property of the cluster rather than of the galactic plane in general. Spiral nebulae have the remarkable characteristic of avoiding the galactic plane, and it has been suggested that the space outside the limits of the *stellar* universe is filled with them. It does not, however, seem probable that their apparent anti-galactic tendency has such a significance; in the Magellanic Clouds spiral nebulae are very abundant, a fact which shows that there is no essential antipathy between the stars and the spiral nebulae. ,

As might be expected, the relative motion of the two great star-drifts is parallel to the galactic plane.

A glance at the Milky Way, with its sharply defined irregular boundaries, its clefts and diverging spur, is almost sufficient to assure us that it is a real cluster of stars, and does not merely indicate the directions in which the universe extends farthest. Barnard’s photographs of its structure leave little doubt on the matter; the numerous rifts and dark openings show that its thickness cannot be very great. To complete our representation of the universe, it is therefore necessary to add to the fairly uniform distribution of stars between two planes a gigantic cluster of an annular or spiral form, also lying between the planes and completely surrounding the sun. The Milky Way is not of uniform brightness, so that we are perhaps nearer to some parts of it than to others, but it is everywhere very distant from the sun. Estimates of this distance vary, but it may probably be put at more than three thousand light years (parallax less than 0∙001*''*). Nevertheless the Milky Way contains a fair proportion of lucid stars, for these are considerably more numerous in the bright patches of the Milky Way than in the rifts and dark spaces.

It has been seen that the parallaxes afford little information as to the distribution of the main bulk of the stars and that the chief evidence on this point must be obtained indirectly from their proper motions. Our principal knowledge of this subject is due to Kapteyn *(Gröningen Publications,* Nos. 8 and 11), and though much of his work is pro­visional, and perhaps liable to considerable revision when more extensive data are obtainable, it probably gives an idea of the construction of the universe sufficiently accurate in all essential respects. As has been explained the mean distance of a. group of stars can be readily determined from the parallactic motion, which, when not foreshortened, is approximately four times the parallax; but to obtain a complete knowledge of the distribution of stars it is necessary to know, not merely the mean parallax of the group, but also the frequency law, *i.e,* what proportion of stars have a quarter, half, twice or three times, &c., the mean parallax. One result of Kapteyn’s investigations may be given here. Taking a sphere whose radius is 560 light years (a distance about equal to that of the average ninth magnitude star), it will contain:—

1 star giving from 100,000 to 10,000 times the light of the sun 26 stars ,, 10,000 ,, 1,000 ,, ,,

1,300 ,, ,, 1,000 ,, 100 ,, ,,

22,000 ,, ,, 100 ,, 10 ,, ,, ,,

140,000 ,, ,, 10

430,000 ,, ,, 1 ,, 0·1 ,,

650,000 ,, ,, 0·1 ,, 0·01 ,, ,, ,,

Whether there is an increasing number of still less luminous stars is a disputed question.

The comparative nearness of the stars of the solar type, which we have had occasion to allude to, is confirmed by the fact that their proper motions are on the average much larger than those of the Sirian stars. Kapteyn finds that magnitude for magnitude, the absolute brightness of the solar stars is only one-fifth of that of the Sirian stars, so that in the mean they must be at less than half the distance. As the numbers of known stars of the two types are nearly equal, it is clear that, at all events in our immediate neigh­bourhood, the solar stars must greatly outnumber the Sirian.

References.—Of modern semi-popular works entirely devoted to and covering the subjects treated of in this article the principal is Simon Newcomb's *The Stars, a Study of the Universe;* mention must also be made of Miss A. Μ. Clerke’s *The System of the Stars* (2nd ed., 1905), which contains full references to original papers; *Problems in Astrophysics,* by the same author, may also be consulted. The following works of reference and catalogues deal with special branches of the subject; for variable stars, Chandler’s “Third Catalogue,” *Astronomical Journ.* (1896), vol. xvi., is now very incomplete; *Harvard Annals,* vol. lv., pt. 1, and vol. lx., No.. 4, together constitute a catalogue of 3734 variable stars; ephemerides of over 800 variables are given in the *Vierteljahrsschrift* of the *Astronomische Gesellschaft.* For double stars see Burnham’s *General Catalogue* (1907), and Lewis, *Memoirs of the R.A.S.,* vol. lvi. ; the orbits of the principal binaries are discussed in T. J. J. See, *Evolution of Stellar Systems,* and another list will be found in *Lick Observatory Bulletin,* No. 84. A list of spectroscopic binaries dis­covered up to 1905 is given in *Lick Observatory Bulletin,* No. 79. For the spectrum analysis of stars, Scheiner’s *Astronomical Spectro­scopy* (trans. by Frost) may be consulted. The “ Draper Catalogue,” *Harvard Annals,* vol. xxvii., gives the classification according to spectrum of over 10,000 stars; for the brighter stars *Harvard Annals,* vol. 1. forms a more complete catalogue. Of the numerous memoirs discussing stellar spectra in relation to evolution, A. Schuster, “The Evolution of Solar Stars,”. *Astrophysical Journ.* (1903), vol. xvii., may be mentioned as giving a concise survey of the subject. (A. S. E.)

**STARAYA RUSSA,** a town of Russia, in the government of Novgorod, 58 m. S. of the city of Novgorod, on the river Polista, by means of which and Lake Ilmen it is brought into steamer communication with St Petersburg. Pop., 15,234. Brine springs on the east of the town were used as a source for the supply of salt as late as 1865; at present they are used only as mineral waters (temperature 51-54° F.), having a great