The Motion of the Solar System relatively to the Interstellar Absorbing Medium. By W. H. Pickering, Assoc. R.A.S.

While the interstellar absorbing medium may be simply the ether, yet the character of its selective absorption, as indicated by Kapteyn, is characteristic of a gas, and free gaseous molecules are certainly there, since they are probably constantly being expelled by the Sun and stars, and certainly in a smaller way by the planets and comets. This is further indicated by the fact that the younger stars seem to be more massive than the older ones.

If, however, the ether is capable of offering any resistance whatever to the passage of matter, then gaseous molecules would, in the countless ages of their existence as free independent bodies, certainly be moving with it. Therefore in such a case also the present investigation would relate to the motion of the solar system relatively to the ether.

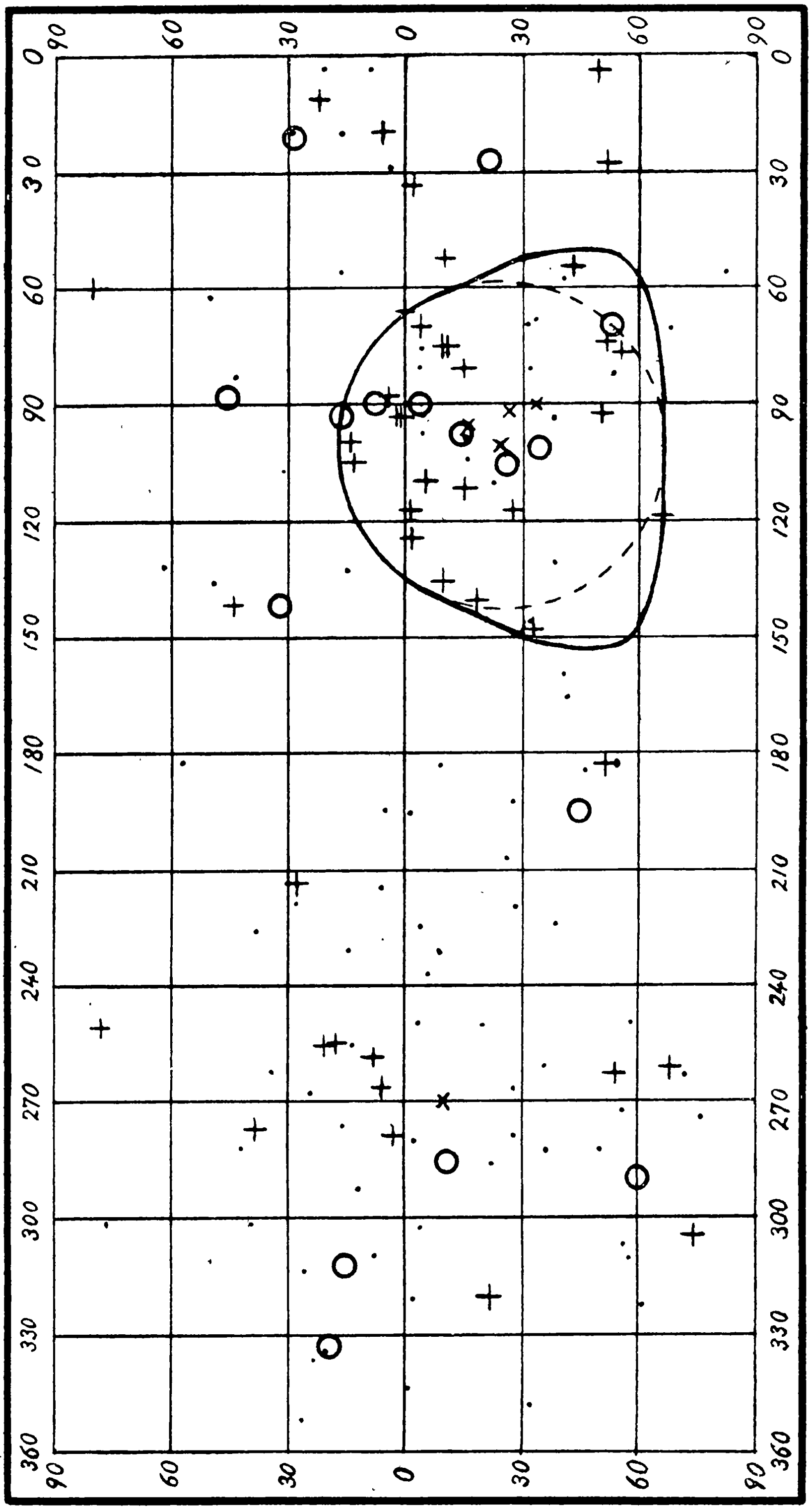
The most promising bodies in the solar system with which to investigate this question would seem to be the comets. Although 47 per cent. of those whose orbits are accurately known, and which recede far beyond the orbit of Neptune, are classed as parabolic, yet none of them are so in fact, since a parabolic orbit, like a perfect circle, is merely a mathematical conception. If these orbits were sufficiently well known they would all be divided between ellipses and hyperbolas. It is probable that a decided majority move in ellipses, and follow the Sun through space.

If now there were an absorbing and resisting medium in space, since the mass of a comet is much less in proportion to its surface than that of the Sun, it is clear that, given sufficient time, the aphelia of all the comets of long period would tend to fall behind the Sun in its path, and should be concentrated towards what we may call the Sun's "anti-apex with regard to the medium."

While this process was going on, however, this shifting of the aphelia would take place with different velocities in different areas of the sphere, most slowly near the apex and anti-apex of the Sun's motion, and most rapidly at 90° from these directions. We should accordingly expect to find comparatively few cometary aphelia in this latter belt.

If the comet had no gaseous envelopes about its component meteors, the effect upon it would be less marked than if these envelopes were extensive. Most comets are visible only by the electric illumination of these envelopes or atmospheres, as is shown by their spectra. The comet 1889 I. was traced to a distance of 8·2 units from the Sun. Whether the cometary atmospheres remain gaseous at still greater distances, or whether at aphelion they ultimately solidify, we have no means of knowing. At any rate, the more extensive the gaseous envelope, that is, the more brilliant the comet, the more marked should be the coincidence with the anti-apex of the Sun as here defined.

In the writer's recent volume on Cometary Statistics, *Harvard*



Cometary Aphelia.—W. H. Pickering.

Annals, **61**, Part III., the cometary orbits are divided into various classes according to their aphelion distances or their parabolic or hyperbolic character. In the figure are shown the longitudes and latitudes of the aphelia of all the parabolic orbits, and of all the orbits of very great aphelion distance, which are well determined, and which therefore belong to Classes D, E, and F. The telescopic comets are indicated by dots, the moderately bright naked-eye comets by crosses, and the brilliant comets by circles. There are 87 dots, 44 crosses, and 16 circles.

The dots are distributed with reasonable uniformity, one-half of them being included in a circular area covering about one-third of the total surface of the sphere. The crosses and circles, on the other hand, are much more unevenly spaced, 30 out of the 60 being concentrated within a circular area 42° in radius, which therefore contains about 13 per cent., or one-eighth the total area of the sky. The dotted line shows a circle of this radius, but when represented upon this projection it assumes a bell-shaped form, as shown by the full line. The chance that this concentration should be due to accident is only one in many thousands, and is too small to be considered.

The centre of the circle of maximum concentration of the faint comets lies in $\lambda = 270°$, $\beta = -9°$, the centre of the circle of concentration of the bright ones in $\lambda = 101°.2$, $\beta = -24°.4$. The centre of gravity of the aphelia of these bright comets is located in $\lambda = 97°.2$, $\beta = -16°.3$. It is shown in the volume above mentioned that the aphelia of most of the very eccentric orbits lie near two great circles of the sphere, and an explanation is offered for the southerly tendency of the aphelia. The circles themselves intersect near the centre of the circular area above shown, but that does not account for the difference between the distribution of the faint and bright comets, and only in part for their marked concentration at opposite portions of the sphere.

The Sun's anti-apex with regard to the stars, including both streams, lies, according to Boss, in $\lambda = 90°.5$, $\beta = -34°.3$. According to Campbell, from his spectroscopic measurements, it lies in $\lambda = 92°.0$, $\beta = -27°.5$. Each of these points is indicated on the map by a ×. Of 26 hyperbolic orbits, 9 of the corresponding comets were bright enough to be visible to the naked eye, but 3 of these probably moved originally in parabolic orbits. Of the remaining 6, only 1 aphelion lies within the circular area.

It would therefore seem that the aphelia of the brighter elliptical comets do tend to concentrate in a particular area of the sky, and that this anti-apex with regard to the resisting medium coincides pretty closely with the anti-apex with regard to the stars.

That the deviation between them is not due to accidental error, however, a glance at the map makes evident, since a circle drawn from either of the other ×'s as a centre would be manifestly erroneously located. The aphelia of 58 bright comets whose orbits are not well known, having appeared in most cases prior to the year 1700, and which are grouped therefore in Class I., give a centre still farther to the east, near longitude 110°. Their concentration is not so marked as for the better-known orbits, 19 out of 58 falling within a circle of the same size as that here shown, while 15 of them fall within the present circle.

Two explanations naturally suggest themselves, one or both of which may be correct, for the deviation between the results deduced from the stars and those deduced from the comets. One explanation is that the absorbing medium is not stationary with regard to the stars as a whole, and the other that the Sun is moving in a curve rather than a straight line, the comets indicating a region from which the Sun has formerly been moving. The result, based on the orbits of the earlier comets, can hardly be looked upon as confirmatory of this latter suggestion, since the change indicated by it is too rapid to be plausible, and, moreover, is due largely to three bright comets which appeared prior to the year 800 A.D., and whose aphelia are therefore rather uncertain.

On the other hand, the line of bright comets beginning with the great comet of 1882, $\lambda = 101^{\circ}{\cdot}6$, $\beta = -35^{\circ}{\cdot}2$, and extending along the ninetieth meridian to $\lambda = 89^{\circ}{\cdot}4$, $\beta = +46^{\circ}{\cdot}3$, with fainter comets on either side, radiating as it were from the southern end of the line, rather suggests a continuous change in the direction of the solar motion. This line, we may note, is inclined at an angle of about 20° to the direction of the Milky Way, crossing it in latitude +16°. It is true the head of the line is 10° east of the solar anti-apex with regard to the stars, but this we may perhaps assign to the other cause, the drift of the stars with regard to the absorbing medium. However, with two possible explanations of the deviation, we must clearly wait for further light before deciding upon their relative importance, and can merely conclude, therefore, that the solar motion relatively to the resisting medium differs somewhat in direction, but not very greatly, from its motion relatively to the stars.

On the Derivation of the Constants for the two Star-Streams. By J. C. Kapteyn, Assoc. R.A.S., with the co-operation of Dr. H. A. Weersma.

In two lectures, the one before the Congress at St. Louis in 1904, the other before the British Association in South Africa in 1905, I have communicated some of the elements of the two great star-streams without publishing at the same time the solution which led to these elements. I certainly intended to do so later, but as the method leads to very laborious calculations as soon as we wish to make a *detailed* comparison with the observations, I hoped at some future time to be able either to simplify it or replace the method by another which would be more commodious. Before I found leisure, however, to take up this task, Eddington published his solution. The elegance and convenience of his method leaving nothing to be desired, I provisionally gave up the plan of publishing my method at all. Afterwards Dyson published another method of exquisite simplicity, and Schwarzschild gave his well-known