THE INFINITY OF THE STARRY UNIVERSE

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JOHN LOWRY ADAMS.

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INTRODUCTION.

THE subject of the Infinity of the Starry Universe is closely connected with the question, What is the Milky Way? My book on the Milky Way published in June, 1905, has so far elicited no public comment in astronomical circles so far as I am aware, and this silence is capable of two different interpretations; either the evidence I adduced is unanswerable or else it is thought unworthy of serious notice. I am not justified in concluding that astronomers are averse to making the honest admission that the views they held about the Milky Way are erroneous, and I am thus obliged to conclude that my explanation of it is not regarded seriously. I have therefore in the present book added some further evidence in support of my contention, and as the view generally held by astronomers about the Milky Way is that it represents a special zone or region of the heavens, I have endeavoured to make it clear that this special zone is of such an extraordinary character that it has the enormous width of considerably over a thousand light years in the far distance, while converging on all sides towards the earth, till it becomes narrowed into a space immediately round the earth which is comparatively insignificant. The earth is in fact the central spot from which this special region or zone radiates, in effect, in all directions, growing gradually wider and

wider as it extends away into the far distance, its width being proportionate to the distance from the earth; being represented by a couple of light years, at most, at the distance of the nearest star, α Centauri, and gradually widening till it represents considerably over a thousand light years at the distance of the Milky Way luminous stream. If this idea of the character of the Milky Way zone be realized for the fact it is, a fact easily verified, there ought to be little or no difficulty in arriving at the conclusion as to the local origin of the influence which produces it, viz., the denser portion of the earth's shadow.

THE AUTHOR.

March, 1906.

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CHAPTER I.

The View generally held by Astronomers of the Finiteness of our Stellar System.

It appears to be generally accepted by astronomers that the stars which we see around us in the heavens do not belong to one stellar system extending throughout infinite space; but, while it is contended that the stars which surround us are finite in number, it is conceded by some that there may be other stellar systems, beyond our ken, and lying outside the boundaries of that to which our sun belongs. This is a safe and prudent reservation to make, seeing that we can know nothing of what is beyond all possibility of observation, but it appears antagonistic to the argument on which the conclusion that our stellar system is of finite dimensions is based. This conclusion is not arrived at merely because of the seeming decrease in the numbers of stars in the far distance, but is a deduction based mainly on a theory, the theory of the non-extinction of light in traversing space. The argument leading to this deduction is set forth in various astronomical works, among the latest being The Concise Knowledge Library's "Astronomy," published in 1898, and Professor S. Newcomb's work "The Stars: A Study of the Universe," published in 1901, and the latest (10th) edition of the Encyclopedia Britannica in the article on Astronomy. As this article is over the initials S. N. it may be presumed it is by Professor Newcomb.

In The Concise Knowledge Library's "Astronomy" the subject is dealt with by Mr. J. E. Gore, F.R.A.S., in the chapter on the "Construction of the Heavens" (page 543), and the argument is set forth thus:—

"But in addition to the conclusive evidence as to the limited number of the visible stars derived from actual observation and the results of photography we have indisputable evidence from mathematical considerations that the number of the visible stars must necessarily be limited. For were the stars infinite in number and scattered through infinite space with any approach to uniformity, it may be proved that the whole heavens would shine with the brightness of the sun. As the surface of a sphere varies as the square of its radius, and light inversely as the square of the distance (or radius of the star sphere at any point) we have the diminished light of the stars exactly counterbalanced by the increased number at any given distance. For a distance of, say, ten times the distance of the nearest fixed star, the light of each star would be diminished by the square of 10 or 100 times, but the total number of stars would be 100 times greater so that the total star light would be the same. *This would be true for all distances.* The total light would therefore, by addition, be proportioned to the distance and hence for an infinite distance we should have an infinite amount of light. For an infinite number of stars, therefore, we should have a continuous blaze of light over the whole surface of the visible heavens. Far from this being the case, the amount of light afforded by the stars on the clearest nights, is on the contrary, comparatively small, and the blackness of the background, 'the darkness behind the stars' is very obvious. According to Miss Clerke (System of the Stars, p. 7) the total light of all the stars to magnitude 9½, is about one-eightieth of full moonlight. M. G. l'Hermite found for the total amount of starlight one-tenth of moonlight, but this estimate is evidently too high. Assuming the sun's brightness as 28 magnitudes brighter than a star of the first magnitude, and Zollner's estimate that sunlight is 618,000 times that of moonlight, I find that the total light of the stars to magnitude 9½ as stated by Miss Clerke would be equivalent to the combined light of about 320,000 stars of the sixth magnitude, or 3,200 stars of the first magnitude. Even taking M. l'Hermite's high estimate of one-tenth of moonlight, the total starlight would be represented by 25,600 stars of the first magnitude."

In Mr. Gore's argument it will be observed it is assumed that the calculation applies "to all distances." The authority for this assumption is not stated and is, perhaps, taken to be well known, and I therefore presume it to be the theory which Professor Newcomb speaks of as the theory of the non-extinction of light in traversing space.

It will be noticed also that Mr. Gore speaks of indisputable evidence from "mathematical considerations" that the number of the "visible" stars must necessarily be limited. It seems strange to have to rely on mathematical considerations to determine what is the number of "visible" stars. Visible stars are, of course, those we can see, and they might, therefore, with some trouble, be

counted, or the numbers estimated. Perhaps Mr. Gore is relying on the theory as evidence that if the stars exist at all they must be "visible" no matter how distant they may be, and in that case it is the theory to which he looks for support to his "mathematical considerations."

In the article in the Encyclopedia Britannica, which I take to be Professor Newcomb's, there is also the same assumption that we should continue to receive light from stars, no matter how distant they might be; and the authority for this assumption is likewise omitted, but as the argument is more fully given in Professor Newcomb's book in the chapter on the "Structure of the Heavens," I quote here what he has to say on the subject:—

"The first question we have to attack is that of the extent of the universe. In its immediate and practical form, it is whether the smallest stars that we see are at the boundary of a system, or whether more and more lie beyond to an infinite extent. This question we are not yet ready to answer with any approach to certainty. Indeed, from the very nature of the case, the answer must remain somewhat indefinite. If the collection of stars which forms the Milky Way be really finite, we may not yet be able to see its limit. If we do see its limit, there may yet be, for aught we know, other systems and other galaxies, scattered through infinite space, which must for ever elude our powers of vision. Quite likely the boundary of the system may be somewhat indefinite, the stars gradually thinning out as we go farther and farther, so that no definite limit can be assigned. If all stars are of the same average brightness as those we see, all that lie beyond a certain distance must evade observation, at least as individual stars, for the simple reason that they are too far off to be visible in our telescopes.

"There is a law of optics which throws some light on the question. Suppose the stars to be scattered through infinite space in such a way that every great portion of space is, in the general average, about equally rich in stars. Then imagine that, at some great distance, say that of the average stars of the sixth magnitude, we describe a sphere having its centre in our system. Outside this sphere, describe another one, having a radius greater by a certain quantity, which we may call S. Outside that let there be another of a radius yet greater by S, and so on indefinitely. Thus we shall have an endless succession of concentric spherical shells, each of the same thickness, S. The volume of each of these regions will be nearly proportional to the square of the diameters of the spheres which bound it. Hence, supposing an equal distribution of the stars, each of the regions will contain a number of stars increasing as the square of the radius of the region. Since the amount of light which we receive from each individual star is as the inverse square of its distance, it follows that the sum-total of the light received from each of these spherical shells will be equal. Thus, as we include sphere after sphere, we add equal amounts of light without limit. The result of the successive addition of these equal quantities, increasing without limit, would be that if the system of stars extended out indefinitely the whole heavens would be filled with a blaze of light as bright as the sun.

"Now, as a matter of fact, such is very far from being the case. It follows that infinite space is not occupied by the stars. At best there can only be collections of stars at great distances apart.

"The nearest approximation to such an appearance as that described is the faint, diffused light of the Milky Way. But so large a fraction of this illumination comes from the stars which we actually see in the telescope that it is impossible to say whether any visible illumination results from masses of stars too faint to be individually seen. Whether the cloud-like impressions which Barnard has found on long-exposed photographs of the Milky Way are produced by countless distant stars, too faint to impress themselves individually even upon the most sensitive photographic plate, is a question which cannot yet be answered. But even if we should answer it in the affirmative, the extreme faintness of the light shows that the stars which produce it are not scattered through infinite space; but that, although they may extend much beyond the limits of the visible stars, they thin out very rapidly. The evidence, therefore, seems to be against the hypothesis that the stars we see form part of an infinitely extended universe.

"But there are two limitations to this conclusion. It rests upon the hypothesis that light is never lost in its passage to any distance, however great. This hypothesis is in accordance with our modern theories of physics, yet it cannot be regarded as an established fact for all space, even if true for the distances of the visible stars. About half a century ago Struve propounded the contrary hypothesis that the light of the more distant stars suffers an extinction in its passage to us. But this had no other basis than the hypothesis that the stars were equally thick out to the farthest limits at which we could see them. It might be said that he assumed an infinite universe, and, from the fact that he did not see the evidence of infinity, concluded that light was lost. The hypothesis of a limited universe and no extinction of light, while not absolutely proved, must be regarded as the one to be accepted until further investigation shall prove its unsoundness.

"The second limitation arises from the possible structure of an infinite universe. The mathematical reader will easily see that the conclusion that an infinite universe of stars would fill the heavens with a blaze of light, rests upon the hypothesis that every region of space of some great but finite extent is, on the average, occupied by at least one star. In other words, the hypothesis is that, if we divide the total number of the stars by the number of cubic miles of space, we shall have a finite quotient. But an infinite universe can be imagined which does not fill this condition. Such will be the case with one constructed on the celebrated hypothesis of Lambert, propounded in the latter part of the eighteenth century. This author was an eminent mathematician who seems to have been nearly unique in combining the mathematical and the speculative sides of astronomy. He assumed a universe constructed on an extension of the plan of the solar system. The smallest system of bodies is composed of a planet with its satellites. We see a number of such systems, designated as the Terrestrial, the Martian (Mars and its satellites), the Jovian (Jupiter and its satellites), etc., all revolving round the sun, and thus forming one greater system, the solar system. Lambert extended the idea by supposing that a number of solar systems, each formed of a star with its revolving planets and satellites, were grouped into a yet greater system. A number of such groups form the great system which we call the galaxy, and which comprises all the stars we can see with the telescope. The more distant clusters may be other galaxies. All these systems again may revolve around some distant centre, and so on to an indefinite extent. Such a universe, how far so ever it might extend, would not fill the heavens with a blaze of light, and the more distant galaxies might remain for ever invisible to us. But modern developments show that there is no scientific basis for this conception, attractive though it be by its grandeur.