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MAN'S PLACE IN THE UNIVERSE:

As Indicated by the New Astronomy.

To the early astronomers the earth was the centre of the visible universe, sun, moon, planets, and stars all alike revolving around it in more or less eccentric and complex orbits; and all were naturally thought to exist as appendages to our globe, and for the sole use and enjoyment of man—"the sun to rule by day, the moon and the stars to rule by night." But when the Copernican system became established, and it was found that our earth was not specially distinguished from the other planets by any superiority of size or position, it was seen that our pride of place must be given up. And, later, when the discoveries of Newton and of the many brilliant astronomers who succeeded him, together with the ever-widening knowledge derived from the growing power and perfection of the telescope and of improved astronomical instruments, showed us the utter insignificance even of our sun and solar system among the countless hosts of stars and the myriads of clusters and nebulæ, we seemed to be driven to the other extreme, and to be forced to recognise the fact that this vast stupendous universe could have no special relation to ourselves, any more than to any other of the millions of suns and systems, many of which were probably far grander and more important than ours, and perhaps fitted to be the abode of more highly organised beings.

During the last half-century, and perhaps much longer, popular writers have often dealt with the problem of the habitability of the planets by intelligent beings and the probability of other suns being attended by other trains of planets similarly inhabited, and the most diverse and even opposing views have been held as to the inferences to be drawn from these supposed facts. Sir David Brewster held them to be almost essential to an adequate conception of the power and wisdom of the Deity and in some

way bound up with the doctrines of Christianity, and this has been the view of many of the teachers of religion. On the other hand, the tendency of all recent astronomical research has been to give us wider views of the vastness, the variety, and the marvellous complexity of the stellar universe, and proportionally to reduce the importance of our little speck of earth almost to the vanishing point, and this has been made use of by the more aggressive among modern sceptics to hold up religious creeds and dogmas to scorn and contempt. They point out the irrationality and absurdity of supposing that the Creator of all this unimaginable vastness of suns and systems, filling, for all we know, endless space, should have any *special* interest in so pitiful a creature as man, the degraded or imperfectly developed inhabitant of one of the smaller planets attached to a second or third-rate sun; while that He should have selected this little world for the scene of the tremendous and necessarily unique sacrifice of His Son, in order to save a portion of these "miserable sinners" from the natural consequences of their sins was, in their view, a crowning absurdity too incredible to be believed by any rational being. And it must be confessed that the theologians had no adequate reply to this rude attack; while many of them have felt their position to be untenable, and have renounced the idea of a special revelation and a supreme saviour for the exclusive benefit of so minute and insignificant a speck in the universe.

But, during the last quarter of the past century, the rapidly increasing body of facts and observations, leading to a more detailed and accurate knowledge of stars and stellar systems, have thrown a new and somewhat unexpected light on this very interesting problem of our relation to the universe of which we form a part; and although these discoveries have of course no bearing upon the special theological dogmas of the Christian, or of any other religion, they do tend to show that our position in the material universe is special and probably unique, and that it is such as to lend support to the view, held by many great thinkers and writers to-day, that the supreme end and purpose of this vast universe was the production and development of the living soul in the perishable body of man.

The Agnostics and Materialists will no doubt object that the want of all proportion between the means and the end condemns this theory from its very foundation. But is there any such want of proportion? Given infinite space and infinite time, and there can be no such thing as want of proportion, if the end to be reached were a great and a worthy one and if the particular mode of attaining that end were the best, or, perhaps, even the only possible one; and we may fairly presume that it was so by

the fact that it *has* been used, and *has* succeeded. The development of man as a spiritual being, with all his intellectual powers and moral possibilities, is certainly a great end in itself, so great and so noble that if a universe of matter and ether as large as that of which we have now obtained some definite knowledge, were required for the work, why should it not be used? Of course, I am taking the view of those who believe in some Intelligent Cause at the back of this universe, some creator or creators, designer or designers. For those who take the other view, that matter and ether, with all the laws and forces without which they could not exist for a moment, are, in their essential nature, eternal and self-existent, no such objection is tenable. For the production of life and of man then becomes merely a question of chance—of the right and exact combination of matter and its complex forces occurring after an almost infinite number of combinations that led to nothing. On this view the argument as to our unique position, derived from the discoveries of the New Astronomy, is even more forcible, though hardly so satisfactory, because it also teaches us that if man is a product of blind forces and unconscious laws acting upon non-living matter, then, as he has been produced by physical law, so he will die out by the continued operation of the same laws, against which there is no appeal. These laws of nature have been finely described in the late Grant Allen's striking philosophical poem, which he has entitled "Magdalen Towers," and which was written when he was an undergraduate at Oxford:—

> "They care not any whit for pain or pleasure,
> That seems to us the sum and end of all,
> Dumb force and barren number are their measure,
> What shall be shall be though the great earth fall.
> They take no heed of man or man's deserving,
> Reck not what happy lives they make or mar,
> Work out their fatal will unswerv'd, unswerving,
> And know not that they are!"

It is the object of the present paper to set forth the nature of the evidence bearing upon man's position in the universe, and to summarise the various lines of research that converge to render it at least a thinkable and rational hypothesis. Although most of the facts and conclusions are well known separately, and have been set forth by both scientific and popular writers, I am not aware that they have been combined, as I now attempt to combine them, or the conclusions drawn from them which seem to me to be the obvious ones.

Are the Stars Infinite in Number?

It has often been suggested that the stars are infinite in number, and that the stellar universe is therefore infinite in extent; and if the preponderance of evidence pointed in this direction, our inquiry would be useless, because as regards infinity there can be no difference of position. In whatever part of it we may be situated, that part can be no nearer the centre than any other part. Infinite space has been well defined as a circle, or rather a sphere, whose centre is everywhere and circumference nowhere.

As the telescope increased in efficiency through the labours of Dollond and Herschel, it was found that every increase of power and of light, due to increased diameter of object-glass or mirror, greatly increased the number of visible stars, and this increase went on with approximate equality of rate till the largest modern telescopes were nearly reached. But, latterly, increased size and power has revealed new stars in a smaller and smaller proportion, indicating that we are approaching the outer limits of the starry system. This conclusion is further enforced by the fact that the numerous dark patches in the heavens, where hardly any stars are visible, and those seen are projected on an intensely dark background, as in the "Coal-sacks" of the southern hemisphere and rifts and channels in the Milky Way itself, continue to present the same features in telescopes of the very highest powers as they do in those of very moderate size. This could not possibly happen if stars were infinite in number, or even if they extended in similar profusion into spaces very much greater than those to which our telescopes can reach, because, in that case, these dark backgrounds would be illuminated by the light of millions of stars so distant as to be separately invisible, as in the case of the Milky Way itself. The only other explanation would be that the star-system is penetrated in several directions by perfectly straight tunnels of enormous length, compared with their diameter, in which no stars exist, and this is considered to be so improbable as to be unworthy of consideration.

The same conclusion is reached by means of that powerful engine of research, the photographic plate. When this is exposed in the focus of a telescope for three hours, a much greater number of stars are revealed than any telescopic vision can detect, but longer exposures add less and less to the number, again indicating that the limit of stars in that direction is nearly reached.

Yet again, the method of counting the stars of the various astronomical magnitudes gives a similar result. At each lesser magnitude the number of stars is about three times greater than that of the next higher magnitude, and this rule applies with

tolerable accuracy down to those of the ninth magnitude. The total number of visible stars from the first to the ninth magnitude is about 200,000. Now if this rate of increase continued down to the seventeenth magnitude, the faintest visible in the best modern telescopes would be about 1,400 millions. But both telescopic observation and photographic charts show that there is nothing approaching this number, it being estimated that the total number thus visible does not exceed 100 millions—again proving that as our instruments reach further and further into space, they find a continuous diminution in the number of stars, thus indicating an approach to the outer limits of the stellar universe.

But perhaps the most striking proof of the limited extent of the universe of luminous stars is that dependent on the laws of light. This has been long known to physicists, and it has been very clearly and briefly stated by Professor Simon Newcomb, one of the profoundest mathematical astronomers. He tells us to imagine a series of concentric spheres, each the same distance apart from the first, which includes only the stars visible to the naked eye. The space between each pair of these spheres will be in extent proportional to the squares of the diameters of the spheres that limit it; and as the light we receive from each star is inversely proportional to its distance from us, it follows that if each region were equally strewn with stars of the same average brightness, then we should receive the same amount of light from each region, the diminution of light from each star being exactly compensated by the vastly greater numbers in each successively larger sphere. Hence it follows that if these concentric spheres were infinite we should receive an infinite amount of light from them, and even if we make an ample allowance for stoppage of light by intervening dark bodies, or by cosmic dust, or by imperfect transparency of the ether, we should at least receive quite as much light from them as the sun gives us at noonday. But the amount we actually receive is so immensely less than this as to prove that the concentric spheres of stars beyond those visible to the naked eye cannot be very numerous. For the total light of all the stars is estimated to be not more than about one-fortieth of moon-light, which is itself only about one five-hundred-thousandth of sun-light. This proof of the limited extent of the stellar universe is, therefore, a very forcible one, and taken in connection with that afforded by telescopic research, as already described, is altogether conclusive.

We have next to consider the facts known as to the distribution and arrangement of the stars, and the conclusions to be drawn therefrom.

The Distribution of the Stars in Space.

The first great fact bearing upon this subject is, that a large number of stars are not "fixed," as was universally believed down to the eighteenth century, but that many of them, and probably all, have proper motions of their own. These motions are very small, and can only be detected by observations continued for many years. The most rapid motion yet observed is that of a small star of $6\frac{1}{2}$ magnitude in the Constellation Ursa Major, which moves seven seconds of arc per annum, while others move only this amount in a century, and all but a few less than a second per annum. The proper motions of several thousand stars have now been determined. These motions are in every possible direction, but it has been recently discovered that considerable groups of stars often move in the same direction and at the same rate. The Pleiades exhibit this phenomenon, but much larger groups have the same kind of motion, and this has led to the theory that in certain parts of the heavens there is a star-drift in fixed directions. Our sun is now known to have its own "proper motion," the direction and rate of which has been determined approximately. This will, of course, produce an apparent movement in all the stars, except those situated exactly in the line of our motion, and the displacement thus caused has to be allowed for in determining the true motion of the stars in space. Should any of the stars be moving obliquely towards us, we shall only perceive that portion of the motion which is at right angles to the direction of the star from us, but the beautiful method of determining motion in the line of sight by means of the spectroscope has overcome this difficulty, and by its means we now know the real motion of many stars, both in direction and velocity, when we have been able to measure their distance from us.

This measurement of the distance of the stars is the most difficult of all the instrumental determinations of modern astronomy, both on account of the extreme remoteness of most of them, and because owing to the motions of the stars themselves, we have no fixed point from which to determine changes of position.

Most people know that by means of a measured base-line, the distances of very remote and inaccessible objects can be determined with considerable accuracy, depending upon the length of the base and its careful measurement, and equally upon the extremely accurate measurement of the angles taken at each extremity of the base. It is in this way that the position of

mountain peaks is determined, as well as the distances across narrow seas, while all civilised countries have been trigonometrically surveyed in this manner.

In the case of the stars the base line used is the diameter of the earth's orbit, more than one hundred and eighty millions of miles. Every six months we are at opposite ends of this base, and if we had any absolutely fixed point in the heavens, in the right position, from which to take our angles, we could in this way determine the distance of some of the stars. But as almost all the stars are moving at various rates and in various directions; as our sun itself is moving; and as the proper motions of the stars can only be determined in relation to other stars, there is everywhere a complication of opposing motions, and nowhere the assured fixity we require for such delicate measurements. But notwithstanding all these difficulties astronomers have by various ingenious methods now measured the distances of a number of stars with considerable precision, notwithstanding the failures of their predecessors for nearly two centuries. The nearest of all the stars are so remote that the distance between the earth and the sun as seen from the star would subtend an angle of considerably less than one second of arc; while most of those measured are so excessively distant that this angle is often one-tenth of a second or even considerably less. To understand how small a quantity this is and what a distance it implies, it may be stated that, viewed at a mile distant, the small letter o in this page would subtend an angle of about one-tenth of a second. From a star of an average distance from us, therefore, the earth and sun, if they could be seen, would appear only as far apart as the opposite sides of the letter o when a mile away from us. But stars twice as far as these have been measured, it is believed with some degree of certainty, and the distances of about sixty stars have now been satisfactorily ascertained.

It was long supposed that the brightest stars were the nearest to us, but it is now known that there is little or no relation between brightness or magnitude and distance. The nearest star yet measured is, indeed, a very bright one in the Southern Hemisphere, Alpha Centauri, but one almost as near, 61 Cygni, is of the fifth magnitude only, and another still nearer in the constellation, Piscis Australis, is of the seventh magnitude. Other stars of the first magnitude which have had their distances measured have a parallax of considerably less than one-tenth of a second, and are therefore among the remoter stars.

The true relation, as was long suspected theoretically, is between proper motion and distance, those which move fastest being nearest to us. It is as if, from a mountain-top, we observed

ships at sea from two or three miles to forty or fifty miles distant, and kept a record of their angular movements. All might be really moving at not very different speeds—from five to perhaps fifteen or twenty miles an hour, yet while some would appear to move rapidly, others would seem to be almost stationary, and this would depend almost entirely on their distance from the observer. So with the stars. All may have, and probably have, real motions which do not differ very greatly in rapidity, but only in those which are comparatively near us can we detect any motion at all. This theoretical conclusion being confirmed by all the stars, whose distances have been measured, we have a most valuable and trustworthy means of ascertaining their comparative distances from us, since those whose proper motions are either exceedingly small or cannot be detected at all, are certainly very much farther from us than those which have well-marked and large, proper motions. It is by such indications that we are enabled to arrive at some definite conclusions as to the real form and structure of the stellar universe, as we will proceed to show.

The Galaxy, or "Milky Way."

By far the most prominent feature in the starry heavens is that vast irregular nebulous ring which in all ages has attracted the attention and excited the admiration of observers. This great ring divides the whole heavens into two hemispheres, making an angle of about 63° with the equinoctial, so that portions of it pass not far from the North and South Poles. Its nebulosity is now believed to be almost wholly due to the massing together of myriads of minute stars, since each increase in the power of the telescope shows more and more of these stars, while the best photographic plates show them everywhere closely packed but still with a luminous haze between them indicating yet more stars beyond.

But beside these minute stars which give us the cloudy or milky appearance, it is found that stars of all degrees of brilliancy are more numerous in the Milky Way and in its vicinity, than elsewhere. The two poles of the Galaxy are the regions where stars are scantiest. Each 15° nearer to it, they increase in numbers, at first slowly, then more rapidly, till we reach its borders. The following series of numbers give the average number of stars in a square of 15′ at each 15° from the pole of the Galaxy, as determined by Sir John Herschel 4—5—8—13—24—53.

Later observations have fully confirmed this, while it has been shown by the late Mr. Proctor that all stars down to the tenth

magnitude, more than 324,000 in number, when carefully mapped, mark out the Milky Way in all its details by their greater density. Later still, the Italian astronomer, Schiaparelli, by using all the materials now available, arrives at the same result, and Professor S. Newcomb, of Washington, after a close examination of his maps, assures us that the Milky Way can be fairly traced out by the region of maximum agglomeration of stars.

These facts lead to the conclusion that the Galaxy is a vast annular agglomeration of stars forming a great circle round the heavens, although in places very irregular, being split in two for about one-third of its circumference, and being, besides, full of irregular dark streaks and patches where the most powerful telescopes show very few stars, so that, as Sir John Herschel says, we are irresistibly led to the conclusion that, in those regions, "we see fairly through the starry stratum"; and this is further shown by the fact that in these parts "the ground of the heavens seen between the stars is for the most part perfectly dark, which would not be the case if multitudes of stars, too minute to be individually discernible, existed beyond." This great ring is, therefore, evidently not very much extended in the direction of its own plane—that is, the ring is not flat or greatly compressed (as is Saturn's ring, for example), or we should nowhere see through it.

But what is more important is, that we must be situated not *in* any part of it as was once supposed, but at or near the very central point in the plane of the ring, that is, nearly equally distant from every part of it. This must be the case, because from any other position the ring would not appear to us so symmetrical as it does. If we were much nearer to one side of it than to the other, the nearer side would appear broader, the more remote side narrower, and these two directions would show a decided difference in the numbers of the visible stars. Sir John Herschel, indeed, thought the southern portion was nearer to us than the northern, because of its greater *brightness*, which, he says, is very striking, and conveys strongly the *idea* of greater proximity. But this may be deceptive, because the whole Milky Way shows great irregularities and variations in brightness, and it is a remarkable fact that the portions near the North and South Poles are *both* equally narrow, while the parts 90° from them are *both* very broad, rather suggesting equality of distance in all directions. Nearness would be indicated by a widening out of stars of all magnitudes not necessarily by any general increase of brilliancy. The facts, therefore, seem to show that we are about equally distant from all parts of the Milky Way.

Very important, however, is Sir John Herschel's testimony to the close correspondence of the Galaxy as a whole to a great

circle. He tells us that, following the line of its greatest brightness, it conforms, as nearly as may be, to that of a great circle inclined about 63° to the equinoctial, and cutting that circle in R.A. 6h. 47m., and 18h. 47m., while its poles are in R.A. 12h. 47m. N. Decl., 27°, and R.A. 0h. 47m., S. Decl., 27°. He therefore determines it, *by the figures he gives*, to lie in an *exact* great circle as seen from the earth, as nearly as so irregular an object can be defined. But neither he nor any other astronomer, so far as I am aware, makes any remark on the extraordinary nature of this fact, which proves that we are placed *exactly* in the plane of the medial line of the ring. The fact of the Galaxy forming a great circle as seen from the earth being so familiar, no one seems to have thought it worth while to ask why it is so. If we could look at such a fact from the outside, as it were, we should certainly impute it to some causal connection between our system and the Galaxy. But before speculating what this relation may mean we must consider another point of equal importance in our relation to the system of stars.

Our Star Cluster.

It has long been observed that the brighter stars seem scattered over the whole heavens with no special abundance in or near the Milky Way, and this was thought to be due to their being much nearer to us. It is now known, however, that brightness is no indication of nearness, so that this fact has little significance. But, as we have seen, we do possess a real test of nearness in the amount of the proper motion of stars, and this leads us to a very definite and most suggestive conclusion. For the stars which are nearest to us, judged by this test, not only have no apparent relation to the Milky Way, but are spread over *every* part of the heavens with tolerable uniformity. The most recent examination of this class of stars is by Professor S. Newcomb, who states the result in the following words:—"If we should blot out from the sky all the stars having no proper motion large enough to be detected, we should find remaining stars of all magnitudes, but they would be scattered almost uniformly over the sky, and show no tendency towards the Milky Way."

Professor Kapteyn, of Groningen, appears to have been the first to draw the obvious conclusion from these facts that these nearer stars spread around us in *every* direction, constitute a globular mass, which he termed the "solar cluster," nearly concentric with the Milky Way, and that our Sun is "deeply immersed" in this cluster.

Other astronomers have adopted this view, which seems to be

almost indisputable if the facts are as stated. For, if the cluster were *not* globular, its component stars would not appear to be so uniformly spread over the *whole* heavens; and if our sun were *not* situated at or near its centre but much nearer to one side of it than to the other, then we should inevitably find the stars of this type (those with measurable proper motions) much more numerous in one direction than in a direction exactly opposite. But although there may be some irregularities in their distribution, it has not been pointed out that there is any such regular inequality as this, and if there is not, then we must be situated very near indeed to the centre of this "solar cluster."

The results so far reached by astronomers as the direct logical conclusion from the whole mass of facts accumulated by means of those powerful instruments of research which have given us the New Astronomy, is, that our Sun is one of the central orbs of a globular star-cluster, and that this star-cluster occupies a nearly central position in the exact plane of the Milky Way. But I am not aware that any writer has taken the next step, and combining these two conclusions, has stated definitely that our Sun is thus shown to occupy a position very near to, if not actually at, the centre of the whole visible universe, and therefore, in all probability, in the *centre* of the *whole material universe*.

This conclusion is no doubt a startling one, and all kinds of objections will be made against its being accepted as a proved fact. And yet I am not acquainted with any great inductive result of modern science that has been arrived at so gradually, so legitimately, by means of so vast a mass of precise measurement and observation, and by such wholly unprejudiced workers. It may not be proved with minute accuracy as regards the actual mathematical centre. That is not of the least importance. But that it is substantially correct in the terms I have stated there seems no good reason to doubt, and I therefore hold it to be right and proper to have it so stated and provisionally accepted, until further accumulations of evidence may show to what extent it requires modification.

This completes the first part of our enquiry; but an equally important part remains to be considered—our position in the Solar System itself as regards adaptability for organic life. Here, too, I am not aware that the whole facts have been sufficiently considered, yet they are facts that indicate our position in this respect to be, in all probability, as central and unique as is that of our Sun in the stellar universe.

The Earth as Adapted for Life.

Among the many writers who have more or less seriously discussed the question of the adaptability of other planets for the development of organic life, and of the higher forms of intellectual beings, I have not met with any who have considered the problem in all its bearings. They have usually been content to show that certain planets *may possibly* be *now* in a condition to support life in forms not very dissimilar from those upon our earth; but they have never adequately considered the precedent question: Could such life have originated and have been developed upon these planets? This is the real *crux* of the problem, and I believe that a full consideration of the required conditions will satisfy us that, so far as we can judge, no other planet can fulfil them. Let us therefore consider what these conditions are.

The earlier writers on this subject could give free play to their imaginations and overcome difficulties of temperature, moisture, etc., by supposing that in other worlds there might be other elements which had different properties from any we possess, and which might render life possible under conditions very unlike those which are essential here. But the revelations of spectrum-analysis have shown us the unity of the constitution of matter throughout the whole material universe, so that not only are the planets of the solar system all composed of the same elements, but that the farthest stars and remotest nebulæ alike consist of the very same elements with which we are so familiar, while the same physical and chemical laws undoubtedly prevail. We may be confident, therefore, that wherever organised life may have developed, it must be built up out of the same fundamental elements as here on earth.

The essential features of the structure of organised beings are, continuous growth and repair of tissues, nutrition by the absorption of dead or living matter from without, and its transformation into the various unstable compounds of which their bodies are built up. For these purposes a double system of circulation, gaseous and liquid, has to be constantly in operation, and this is carried on by means of minute tubular or cellular vessels which permeate every part of the body. These wonderfully complex and exquisitely adjusted circulating systems are entirely dependent on the continuous maintenance of a very narrow range of temperatures somewhere between the extremes of the boiling and the freezing points of water, but really within much narrower limits, since if the whole of the water at any time became solidified, all the higher forms of life would be destroyed, while

a temperature very much below the boiling point, if permanently maintained, would be almost equally detrimental.

When we consider that the temperature of space is about – 273° C., while that of the outer surface of the sun is about 9,000° C., we realise what a combination of favourable conditions must exist to preserve on the surface of a planet a degree of heat which shall never for any considerable time fall below 0° C., or rise above, say, 75° C., and that these narrow limits must be *continuously maintained*, not for hundreds or thousands only, but for millions, perhaps for *hundreds of millions of years*, if life is to be developed there. It is the maintenance of this comparatively uniform surface temperature for such enormous periods—during, in fact, the whole time covered by the geological record—that most writers have overlooked as among the necessary conditions for the development of the higher forms of life on a planet; and this omission vitiates all their reasoning, since they have to show not only that the requisite conditions of temperature *may* exist now, but that there is even a probability that they have existed, or will exist, for a sufficiently extended period to allow of the development of a complex system of organic life comparable with our own. Let us then enumerate the chief favourable conditions which in their combination appear to have rendered this development possible on our earth. These are:—

(1) A distance from the sun such as to keep up the temperature of the soil to the required amount, by sun-heat alone, and to evaporate sufficient water to produce clouds, rain, and a system of river circulation.

(2) An atmosphere of sufficient extent and density to allow of the production and circulation of aqueous vapour in the form of clouds, mists, and dews, and to serve also as an equaliser of sun-heat during day and night, winter and summer, and also between the tropical and temperate zones. This amount of atmosphere is held to be largely dependent upon the mass of a planet, and this one feature alone probably renders Mars quite unsuitable, since its mass is less than one-eighth that of the earth.

(3) The very large proportion of the surface covered by deep oceans so that they surround and interpenetrate the land, and by their tides and currents keep up a continuous circulation, and are thus the chief agents in the essential equalisation of temperatures. This, again, is largely dependent on our possessing so large a satellite, capable of producing a regular, but not excessive, tidal action. The want of such a satellite may alone render Venus quite unsuitable for the development of high forms of life, even if other conditions were more favourable, which seems in the highest degree improbable.

(4) The enormous average depth of these oceans, so that the bulk of water they contain is about thirteen times that of the land which rises above their level. This indicates that they are *permanent features of the earth's surface*, thus ensuring the maintenance of continuous land-areas and of uniform temperatures during the whole period of the development of life upon the earth.[1]

It is extremely improbable that this remarkable condition obtains in any other planet.

(5) Lastly, one of the most peculiar and least generally considered features of our earth, but one which is also essential to the development and maintenance of the rich organic life it possesses, is the uninterrupted supply of atmospheric dust, which is now known to be necessary for the production of rain clouds and beneficial rains and mists, and without which the whole course of meteorological phenomena would be so changed as to endanger the very existence of a large portion of the life upon the earth. How and why this is so is fully explained in my *Wonderful Century*. Now, the chief portion of this fine dust, distributed through the upper atmosphere, from the equator to the poles, with wonderful uniformity, is derived from those great terrestrial features which are often looked upon as the least essential, and even as blots and blemishes on the fair face of nature—deserts and volcanoes. Most persons, no doubt, think they could both be very well spared, and that the earth would be greatly improved, from a human point of view, if they were altogether abolished. Yet it is almost a certainty that the consequences of doing so would be to render the earth infinitely less enjoyable, and, perhaps, altogether uninhabitable by man. We must, therefore, reckon a due proportion of deserts and active volcanoes, with sufficiently constant winds to distribute the dust from them, as among the permanent essentials of a globe fitted for the development of intelligent life. This utility of deserts and volcanoes is, I think, now stated for the first time.

Now, if we consider that these five distinct conditions, or sets of conditions, many of them dependent on a delicate balance of forces acting at the origin of our planet, appear to be absolutely essential for the existence of high types of organic life, we shall at once see how peculiar and unique is our place and condition within the Solar System, since we know, with almost complete certainty, that they do *not* all co-exist in any of the other planets. And when we consider further, that even if they do happen to

(1) The evidence which demonstrates this permanence is set forth in my *Island Life*, Chap. VI., and enforced by additional arguments in my *Studies Scientific and Social*, Vol. I., Chap. 2.

exist now, that would be nothing to the purpose unless we had reason to believe that they had also existed, as with us, *in unbroken continuity*, for scores, or, perhaps, hundreds of millions of years. All the evidence at our command goes to assure us that our earth alone in the Solar System has been from its very origin adapted to be the theatre for the development of organised and intelligent life. Our position within that system is, therefore, as central and unique as that of our Sun in the whole stellar universe.

But, it may be asked, even if it be conceded that both by position, by size, and by its combination of physical features, we really do stand alone in the Solar System in our adaptation for the development of intelligent life, in what way can the position of our Sun at or near the centre of the stellar universe, as it certainly appears to be, affect that adaptation? Why should not one of the Suns on the confines of the Milky Way, or in any other part of it, possess planets as well adapted as we are to develop high forms of organic life?

These are questions which involve the most difficult problems in mathematical physics, and only our greatest thinkers, possessing the highest mathematical and physical knowledge, could be expected to give any adequate answer to them. In the meantime I will briefly indicate what seems to me to be the probable nature of the reply. Accepting the proof astronomers have given us, that so far from the material universe of which our Sun forms a part extending infinitely into space, we can actually *see* beyond its outer boundaries, and can even approximately give a maximum limit to its magnitude, we are confronted with the problem, of how a limited universe of matter and ether, with the motions and forces which everywhere pervade it, can conserve those forces at and near its farthest limits. Is it, in fact, necessarily becoming dissipated into outer space? Do any of its constituent suns, like those comets which have hyperbolic or parabolic orbits, continually fly out beyond its range, and become lost to it for ever? Comparing the stars of the Milky Way to the molecules of a gas, must not a certain proportion of these stars continually escape from the attractive powers of their neighbours, as a result of collisions, or in other ways, and wandering into outer space, soon become dead and cold and lost for ever to the universe? Will not the whole of the outer margins of the stellar universe be therefore unstable? always being liable to pass into regions where they would be dissipated, as we see comets dissipated before our eyes? If such results are certain, it will follow that the outer portions of the universe, at all events, and for an unknown extent inward, will be entirely unfitted to ensure

that *continuity of uniform conditions* which is the first essential for the development of life.

But this is only a small portion of the problem. A still more difficult question is, how will the ether behave near the outer borders of the universe? Can gravitation maintain its influence on the confines of a finite universe in the same degree as near its centre? If, as now generally believed, gravitation is really produced by pressure of some kind, which must be equal in all directions, then it is almost certain that at any considerable distance beyond the central portion of the universe, gravitation would vary in intensity in different directions. Whether this variation could possibly be detected by means of the motions of remote binary stars, or in any other way, it must be left for mathematicians and astronomers to determine.

But leaving this question of variation of the force of gravity as beyond our powers at present, we may give a little consideration to those wonderful radiant forces, other than light and heat, the very existence of some of which we have only recently discovered. Such are electricity, magnetism, the Röntgen rays, the Hertzian, the Goldstein, the Becquerel rays, and some others. That electrical forces bear an important part in the development of living organisms there can be little doubt, while the other forms of radiation here referred to, some of which produce curious physiological effects, can hardly be supposed to have been wholly without influence in the formation of the marvellous living machine, the substance of which, in its complexity, both of structure and constituent elements, is a true microcosm—an epitome of matter and its forces. But if all these radiant forces, or several of them, have combined in the development of life, we may feel sure that they can only have done so under conditions which limit their energy to that gentle and imperceptible action which has caused them to remain so long hidden even from the most inquisitive seekers of the past century. And it is at least a possible, and I think not improbable supposition, that this imperceptibility and continuity may exist only in the more central portions of the universe, while in its outer regions less regularity may prevail, and while some of these necessary radiant forces may be wanting, others may be too abundant, or be manifested in so irregular or excessive a manner as to be antagonistic to the delicate and nicely-balanced forces which are essential to the orderly development of life.

Returning now for a moment to the consideration of our position in the stellar universe, it will assume a somewhat different aspect in view of the possibilities or probabilities just set forth.

We can hardly suppose any longer that *three* such remarkable

coincidences of position and consequent physical conditions should occur in the case of the one planet, on which organic life *has* been developed, without any causal connection with that development. The three startling facts—that we *are* in the centre of a cluster of suns, and that that cluster *is* situated not only precisely in the *plane* of the Galaxy, but also *centrally* in that plane, can hardly now be looked upon as chance coincidences without any significance in relation to the culminating fact that the planet so situated *has* developed humanity.

Of course the relation here pointed out *may* be a true relation of cause and effect, and yet have arisen as the result of one in a thousand million chances occurring during almost infinite time. But, on the other hand, those thinkers may be right who, holding that the universe is a manifestation of Mind, and that the orderly development of Living Souls supplies an adequate reason why such an universe should have been called into existence, believe that we ourselves are its sole and sufficient result, and that nowhere else than near the central position in the universe which we occupy, could that result have been attained.

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