CHAPTER X

ARE THERE PLANETS AMONG THE STARS?

"... And if there should be
Worlds greater than thine own, inhabited
By greater things, and they themselves far more
In number than the dust of thy dull earth,
What wouldst thou think?"--BYRON'S CAIN.

This always interesting question has lately been revived in a startling manner by discoveries that have seemed to reach almost deep enough to touch its solution. The following sentences, from the pen of Dr. T. J. J. See, of the Lowell Observatory, are very significant from this point of view:

"Our observations during 1896-'97 have certainly disclosed stars more difficult than any which astronomers had seen before. Among these obscure objects about half a dozen are truly wonderful, in that they seem to be dark, almost black in color, and apparently are shining by a dull reflected light. It is unlikely that they will prove to be self-luminous. If they should turn out dark bodies in fact, shining only by the reflected light of the stars around which they revolve, we should have the first case of planets--dark bodies--noticed among the fixed stars."

Of course, Dr. See has no reference in this statement to the immense dark bodies which, in recent years, have been discovered by spectroscopic methods revolving around some of the visible stars, although invisible themselves. The obscure objects that he describes belong to a different class, and might be likened, except perhaps in magnitude, to the companion of Sirius, which, though a light-giving body, exhibits nevertheless a singular defect of luminosity in relation to its mass. Sirius has only twice the mass, but ten thousand times the luminosity, of its strange companion! Yet the latter is evidently rather a faint, or partially extinguished, sun than an opaque body shining only with light borrowed from its dazzling neighbor. The objects seen by Dr. See, on the contrary, are "apparently shining by a dull reflected light."

If, however (as he evidently thinks is probable), these objects should prove to be really non-luminous, it would not follow that they are to be regarded as more like the planets of the solar system than like the dark companions of certain other stars. A planet, in the sense which we attach to the word, can not be comparable in mass and size with the sun around which it revolves. The sun is a thousand times larger than the greatest of its attendant planets, Jupiter, and more than a million times larger than the earth. It is extremely doubtful whether the relation of sun and planet could exist between two bodies of anything like equal size, or even if one exceeded the other many times in magnitude. It is only when the difference is so great that the smaller

of the two bodies is insignificant in comparison with the larger, that the former could become a cool, life-bearing globe, nourished by the beneficent rays of its organic comrade and master.

Judged by our terrestrial experience, which is all we have to go by, the magnitude of a planet, if it is to bear life resembling that of the earth, is limited by other considerations. Even Jupiter, which, as far as our knowledge extends, represents the extreme limit of great planetary size, may be too large ever to become the abode of living beings of a high organization. The force of gravitation on the surface of Jupiter exceeds that on the earth's surface as 2.64 to 1. Considering the effects of this on the weight and motion of bodies, the density of the atmosphere, etc., it is evident that Jupiter would, to say the very least, be an exceedingly uncomfortable place of abode for beings resembling ourselves. But Jupiter, if it is ever to become a solid, rocky globe like ours, must shrink enormously in volume, since its density is only 0.24 as compared with the earth. Now, the surface gravity of a planet depends on its mass and its radius, being directly as the former and inversely as the square of the latter. But in shrinking Jupiter will lose none of its mass, although its radius will become much smaller. The force of gravity will consequently increase on its surface as the planet gets smaller and more dense.

The present mean diameter of Jupiter is 86,500 miles, while its mass exceeds that of the earth in the ratio of 316 to 1. Suppose Jupiter shrunk to three quarters of its present diameter, or 64,800 miles, then

its surface gravity would exceed the earth's nearly five times. With one half its present diameter the surface gravity would become more than ten times that of the earth. On such a planet a man's bones would snap beneath his weight, even granting that he could remain upright at all! It would seem, then, that, unless we are to abandon terrestrial analogies altogether and "go it blind," we must set an upper limit to the magnitude of a habitable planet, and that Jupiter represents such upper limit, if, indeed, he does not transcend it.

The question then becomes, Can the faint objects seen by Dr. See and his fellow-observers, in the near neighborhood of certain stars, be planets in the sense just described, or are they necessarily far greater in magnitude than the largest planet, in the accepted sense of that word, which can be admitted into the category--viz., the planet Jupiter? This resolves itself into another question: At what distance would Jupiter be visible with a powerful telescope, supposing it to receive from a neighboring star an amount of illumination not less than that which it gets from the sun? To be sure, we do not know how far away the faint objects described by Dr. See are; but, at any rate, we can safely assume that they are at the distance of the nearest stars, say somewhere about three hundred thousand times the earth's distance from the sun. The sun itself removed to that distance would appear to our eyes only as a star of the first magnitude. But Zöllner has shown that the sun exceeds Jupiter in brilliancy 5,472,000,000 times. Seen from equal distances, however, the ratio would be about 218,000,000 to 1. This would be the ratio of their light if both sun and Jupiter could be removed to about

the distance of the nearest stars. Since the sun would then be only as bright as one of the stars of the first magnitude, and since Jupiter would be 218,000,000 times less brilliant, it is evident that the latter would not be visible at all. The faintest stars that the most powerful telescopes are able to show probably do not fall below the sixteenth or, at the most, the seventeenth magnitude. But a seventeenth-magnitude star is only between two and three million times fainter than the sun would appear at the distance above supposed, while, as we have seen, Jupiter would be more than two hundred million times fainter than the sun.

To put it in another way: Jupiter, at the distance of the nearest stars, would be not far from one hundred times less bright than the faintest star which the largest telescope is just able, under the most exquisite conditions, to glimpse. To see a star so faint as that would require an object-glass of a diameter half as great as the length of the tube of the Lick telescope, or say thirty feet!

Of course, Jupiter might be more brilliantly illuminated by a brighter star than the sun; but, granting that, it still would not be visible at such a distance, even if we neglect the well-known concealing or blinding effect of the rays of a bright star when the observer is trying to view a faint one close to it. Clearly, then, the obscure objects seen by Dr. See near some of the stars, if they really are bodies visible only by light reflected from their surfaces, must be enormously larger than the planet Jupiter, and can not, accordingly, be admitted into the category of planets proper, whatever else they may be.

Perhaps they are extreme cases of what we see in the system of Sirius--i.e., a brilliant star with a companion which has ceased to shine as a star while retaining its bulk. Such bodies may be called planets in that they only shine by reflected light, and that they are attached to a brilliant sun; but the part that they play in their systems is not strictly planetary. Owing to their great mass they bear such sway over their shining companions as none of our planets, nor all of them combined, can exercise; and for the same reason they can not, except in a dream, be imagined to possess that which, in our eyes, must always be the capital feature of a planet, rendering it in the highest degree interesting wherever it may be found--sentient life.

It does not follow, however, that there are no real planetary bodies revolving around the stars. As Dr. See himself remarks, such insignificant bodies as our planets could not be seen at the distance of the fixed stars, "even if the power of our telescopes were increased a hundredfold, and consequently no such systems are known."

This brings me to another branch of the subject. In the same article from which I have already quoted (Recent Discoveries respecting the Origin of the Universe, Atlantic Monthly, vol. lxxx, pages 484-492), Dr. See sets forth the main results of his well-known studies on the origin of the double and multiple star systems. He finds that the stellar systems differ from the solar system markedly in two respects, which he thus describes:

"1. The orbits are highly eccentric; on the average twelve times more elongated than those of the planets and satellites.

"2. The components of the stellar systems are frequently equal and always comparable in mass, whereas our satellites are insignificant compared to their planets, and the planets are equally small compared to the sun."

These peculiarities of the star systems Dr. See ascribes to the effect of "tidal friction," the double stars having had their birth through fission of original fluid masses (just as the moon, according to George Darwin's theory, was born from the earth), and the reaction of tidal friction having not only driven them gradually farther apart but rendered their orbits more and more eccentric. This manner of evolution of a stellar system Dr. See contrasts with Laplace's hypothesis of the origin of the planetary system through the successive separation of rings from the periphery of the contracting solar nebula, and the gradual breaking up of those rings and their aggregation into spherical masses or planets. While not denying that the process imagined by Laplace may have taken place in our system, he discovers no evidence of its occurrence among the double stars, and this leads him to the following statement, in which believers in the old theological doctrine that the earth is the sole center of mortal life and of divine care would have found much comfort:

"It is very singular that no visible system yet discerned has any resemblance to the orderly and beautiful system in which we live; and one is thus led to think that probably our system is unique in its character. At least it is unique among all known systems."

If we grant that the solar system is the only one in which small planets exist revolving around their sun in nearly circular orbits, then indeed we seem to have closed all the outer universe against such beings as the inhabitants of the earth. Beyond the sun's domain only whirling stars, coupled in eccentric orbits, dark stars, some of them, but no planets--in short a wilderness, full of all energies except those of sentient life! This is not a pleasing picture, and I do not think we are driven to contemplate it. Beyond doubt, Dr. See is right in concluding that double and multiple star systems, with their components all of magnitudes comparable among themselves, revolving in exceedingly eccentric orbits under the stress of mutual gravitation, bear no resemblance to the orderly system of our sun with its attendant worlds. And it is not easy to imagine that the respective members of such systems could themselves be the centers of minor systems of planets, on account of the perturbing influences to which the orbits of such minor systems would be subjected.

But the double and multiple stars, numerous though they be, are outnumbered a hundred to one by the single stars which shine alone as our sun does. What reason can we have, then, for excluding these single stars, constituting as they do the vast majority of the celestial host,

from a similarity to the sun in respect to the manner of their evolution from the original nebulous condition? These stars exhibit no companions, such planetary attendants as they may have lying, on account of their minuteness, far beyond the reach of our most powerful instruments. But since they vastly outnumber the binary and multiple systems, and since they resemble the sun in having no large attendants, should we be justified, after all, in regarding our system as "unique"? It is true we do not know, by visual evidence, that the single stars have planets, but we find planets attending the only representative of that class of stars that we are able to approach closely--the sun--and we know that the existence of those planets is no mere accident, but the result of the operation of physical laws which must hold good in every instance of nebular condensation.

Two different methods are presented in which a rotating and contracting nebula may shape itself into a stellar or planetary system. The first is that described by Laplace, and generally accepted as the probable manner of origin of the solar system--viz., the separation of rings from the condensing mass, and the subsequent transformation of the rings into planets. The planet Saturn is frequently referred to as an instance of the operation of this law, in which the evolution has been arrested after the separation of the rings, the latter having retained the ring form instead of breaking and collecting into globes, forming in this case rings of meteorites, and reminding us of the comparatively scattered rings of asteroids surrounding the sun between the orbits of Mars and Jupiter. This Laplacean process Dr. See regards as

theoretically possible, but apparently he thinks that if it took place it was confined to our system.

The other method is that of the separation of the original rotating mass into two nearly equal parts. The mechanical possibility of such a process has been proved, mathematically, by Poincaré and Darwin. This, Dr. See thinks, is the method which has prevailed among the stars, and prevailed to such a degree as to make the solar system, formed by the ring method, probably a unique phenomenon in the universe.

Is it not more probable that both methods have been in operation, and that, in fact, the ring method has operated more frequently than the other? If not, why do the single stars so enormously outnumber the double ones? It is of the essence of the fission process that the resulting masses should be comparable in size. If, then, that process has prevailed in the stellar universe to the practical exclusion of the other, there should be very few single stars; whereas, as a matter of fact, the immense majority of the stars are single. And, remembering that the sun viewed from stellar distances would appear unattended by subsidiary bodies, are we not justified in concluding that its origin is a type of the origin of the other single stars?

While it is, as I have remarked, of the essence of the fission process that the resulting parts of the divided mass should be comparable in magnitude, it is equally of the essence of the ring, or Laplacean process, that the bodies separated from the original mass should be

comparatively insignificant in magnitude.

As to the coexistence of the two processes, we have, perhaps, an example in the solar system itself. Darwin's demonstration of the possible birth of the moon from the earth, through fission and tidal friction, does not apply to the satellites attending the other planets. The moon is relatively a large body, comparable in that respect with the earth, while the satellites of Jupiter and Saturn, for instance, are relatively small. But in the case of Saturn there is visible evidence that the ring process of satellite formation has prevailed. The existing rings have not broken up, but their very existence is a testimony of the origin of the satellites exterior to them from other rings which did break up. Thus we need not go as far away as the stars in order to find instances illustrating both the methods of nebular evolution that we have been dealing with.

The conclusion, then, seems to be that we are not justified in assuming that the solar system is unique simply because it differs widely from the double and multiple star systems; and that we should rather regard it as probable that the vast multitude of stars which do not appear, when viewed with the telescope, or studied by spectroscopic methods, to have any attendants comparable with themselves in magnitude, have originated in a manner resembling that of the sun's origin, and may be the centers of true planetary systems like ours. The argument, I think, goes further than to show the mere possibility of the existence of such planetary systems surrounding the single stars. If those stars did not

originate in a manner quite unlike the origin of the sun, then the existence of planets in their neighborhood is almost a foregone conclusion, for the sun could hardly have passed through the process of formation out of a rotating nebula without evolving planets during its contraction. And so, notwithstanding the eccentricities of the double stars, we may still cherish the belief that there are eyes to see and minds to think out in celestial space.

THE END