Astronomical Predictions

By Prof. K. N. Chakrabutty, m. sc.

Although the relation of man to the universe is like a dust particle too minute to be seen even by most powerful microscopes, yet invented man has never been content to limit his investigations into the mysteries which abound in the planet he inhabits but also launched his mind upon the Sea of Infinity to explore its unknown shores and answer the riddles that he meets. Indeed, it is this instinct which differentiates a man from beasts that whereas the latter are content to live their lives without troubling about their environments, the former would never feel satisfied with his sourroundings and would find no peace until he can better his circumstances in the light of the future events that are likely but none the less surely to happen around him in the universe. The most important point in a man's psychology is his instinct of fathoming the contents of future.

From the earliest times, the human mind has been confronted by problems of this nature. The early races—Chinese, Hindus, Egyptians and Babylonians -seem to have made considerable progress in astronomical observations but they hopelessly brought in their train a confusion of Theology and Science. To them Nature was full of Deities. Gods of land and of sea, of sun and stars, of storms and tempests. The sun was worshipped because it was a source of a thousand benefits to mankind, its comforts, luxuries and beauties—because man depended upon it for life, warmth and light and because its constant supply of heat was necessary to prevent the ocean and even the air from freezing. Similarly mighty influences were ascribed to other planets according to their individual characteristics A large number of interesting facts were ascertained by these people but they were guesses at the riddle of the universe, a jumble of theology and astrological superstitions; and here we find how astrology saw its birth. The Hebrews coming after the Babylonians

partly succeeded in disentangling religion from crude naturalism and pseudo-science and finally the Greeks were the founders of actual scientific observation and based their theories on actual facts.

The Greek methods were certainly an improvement upon the existing ones but they were all the same crude and inelegant. Still they succeeded in making predictions with a fair degree of accuracy. The Chaldean or better the Assyrian astronomers discovered what is called the Chaldean Saros, a period consisting of 6585 days after which the solar and lunar eclipses recur in the same order and thus they predicted the occurrence of eclipses. The fine constellation of Great Bear, or Dipper as it is called in popular language, was made to tell the hour of the night approximately by two particular stars of the group. It was also used by the Greek and Phœnician sailors for finding out the direction of the polestar *i.e.* the North. Besides these, the legends connected with the famous Constellations of Perseus, Andromeda, Pegasus, Cassiopæ and many other constellations bear testimony to the interetst they took in the observation of stars. They also found out the effects of the solar and the lunar attractions on the tides and could predict high and low tides with a fair degree of accuracy. There is another cycle still in vogue, called the Metonic Cycle after the astronomer Meton, after which the phases of the moo repeat themselves in the same order and this was used in determining the particular phases by studying those of the previous cycle.

Thanks to the rapid advance that Science has made, the rough and crude methods of old have now been replaced by elegant and refind ones and not a year passes without some contribution to the stock of knowledge in this branch of sublime science. With the opening of new fields of research new instruments are being constructed to meet the situation. The prosition of eclipses of occultation, conjunction and opposition of planets,of the visit of comets etc. are considered but the simplest. Indeed from the tables that are now ready

at hand these can be calculated within a remarkably short time. Man can now handle more difficult problems of the universe. Situated at at a distance of 92 million miles, he is in a position to predict when the sun will cool down to the tem peratureour earth and will be as inhabitable as it. His learning enables him to predict from the mass of a nebula the various stages of its evolution by the procees of gravitation and cooling, how new worlds are going to be created out of it. He has predicted of the cosmic process - evolution—a cyclic process without beginning and without end, progressive and continuous. He is in a position to predict when in the dim distant future the earth will become uninhabitable like the moon by the process of cooling and contracting. Not only this, he can predict discovery of other worlds. The discovery of Neptune is an evidence of his ability and acumen in this direction.

So man, though but a mote in an infinity of infinities, is no larger frightened at any question relating to the universe, howver difficult it may appear. By his mathamatical training and reasoning, he carefully judges the data found by a series of observations snitably arranged and proceeds to make an assertion, the truth of which is borne out on some future date.

Accurate calculation must in all cases precede an astronomical prediction and this calculation again must be based on sufficient data and soundness or some scientific principle utmost care and precaution must be exercised before making a prediction; for as Goethe once remarked, "Nature knows no trifling, she is always sincere, always serious, always stern. She is always in the right and the errors and mistakes are invariably ours." Imagination also, coupled with knowledge, reasoning and correctness of judgment is an essential attribute of an astronomer. He uses imaginative insight in his theoretical conceptions and it enables him to project known facts into unknown region and see the picture produced upon the new mental plane. But though imagination plays such a prominent part in all astronomical

calculations, one has to guard himself against its excesses. A conclusion which represents an effort of imagination not founded upon a wide range of facts may pass as a fiction but it has no place in science.

Astronomical predictions have been rendered rather easy in these days of scientific advance by the preparation of tables from a series of data. The Nautical Almanac that is published year after year is nothing but a collection of tables. We have also got Newcomb's tables, Hansen's tables and a number of others. In these, we come across results or formulæ in which we are to substitute the elements for some particular phenomenon and we get the answer directly. A good deal of precaution is necessary for the compilation of tables and they speak of the indefatigable labour of the scientists. The Hindus also have certain tables from which Bengali almanacs are prepared every year, but as no correction seems to have been introduced ever since their preparation, an amount of error has accumulated therein and the results as contained in the almanacs are erroneous to a certain degree. It is high time that the correction of them should be undertaken.

Insufficiency of data and unsoundness of the scientific principle underlying a prediction, on the other hand, often leads to an assertion which does not stand the test of time and experiment. It not only renders the man who makes such a predections ridiculous but also tends to do some injustice to Science itself. The latest example is furnished by Prof. Porta's prediction about the 17th December last, * the astounding nature of which filled the world with horror and dismay for sometime, thinking that the Doomsday of our earth was at hand. The mystery that hanged about the day has at last cleared up and science stands vindicated in her temple in full glory and splendour.

Porta's argument was that owing to a peculiar grouping of several planets in almost a line on the above date, huge

* The writer's contradiction of the prophecy was published in the *Statesman*, of the *December 1919*.

sun spots would be created on the solar surface which would give rise to severe weather cataclysm throughout the world. Let us examine his arguments. Let us first see whether the planets can produce any disturbance on the solar surface and can give rise to a sunspot and then whether meteorological disturbances are the natural consequences of the appearance of sunspots. Considering the first question, we see, that the only way in which the planets can influence matter on the solar surface is by gravitational pull. The matter on the Sun's surface is mainly subject to the gravitational pull of the Sun itself which is a huge self-attracting mass. The distances of the planets from the sun vary from 36 to 2800 million miles and even if they are all situated in one line and in one plane, their combined effect would not amount to a millionth part of the solar attraction itself. Hence we find planets cannot produce any disturbance on the solar surface.

The next question is how sun spots are produced and how far they influence the meteorological conditions on our earth. Several theories have been propounded as to how sun spots are produced, but the one which has the authority of experts like Hale, St. John and Evershed, holds that the spots are huge vortical masses produced by convectional streams of gases issuing from within the sun and they can be compared to the cyclones taking place on our earth. No satisfactory theories have yet been propounded as to their cause, but all agree in this that it is entirely internal. Hence it is absurd to think that huge sun spots can be created by the influence of planets.

Coming to the next point, we cannot deny that there is some connection between the meteorological conditions on the earth and the periodicity of sun spots, for the meteorological conditions are mainly influenced by the amount of heat received from the sun and if this quantity varies, they can be greatly modified.

From a series of investigations published in 1870, 1880 and 1881 Koppen concluded that the Earth's

temperature is higher at sun spot minimum than at sun spot maximum. This conclusion has been confined by Stone, Gould, Nordmann, Newcomb, Abbot and others. Attempts have been made to find out the effective solar insolation on the surface of our earth and Abbot, Director of the Smithsonian Solar Observatory, Washington, finds that the solar insolation fluctuates in a regular manner with the area of the sun covered by sun spots. According to his careful measurements, the solar insolation (*i.e.* the amount of heat received by a perfectly black surface of unit area placed normally to the rays of the sun) is given by the formula 1·92 +·07 (sun spot number) A variation of the solar insolation by 10 or 15 per cent would materially alter the mean temperature of earth, as can be seen *a priori*. But no one has yet worked out the consequences of this effect, not to speak of the discussion of meterological data from this point of view.

We see then, how Porta's prediction was based upon insufficient knowledge and data and its success is what the world knows to-day. Now we shall take side by side the case of Einstein, the famous scientist, whose celebrated principle of the Theory of Relativity has earned for him an immortal name. It was his genius that recast and elaborated the principle first formulated by the great Dutch Physicist, Lorentz. Working out his theory, he had predicted as far back as 1915 that light from a star just on the limbs of the sun would be deflected by 1″·74 as it reached us. These statements met with considerable opposition at that time and Sir Oliver Lodge thought this "unnecessary." But the total solar eclipse in May last has fulfilled his prediction in a brilliant manner and the scientific circles all over the world now pays their tribute of respect to the great scientist who has taught them a new way of looking at certain things.

The advance of this branch of science to day is fortunately so rapid, that methods of many other useful predictions can be safely expected to come out in no distant future. Nor would they involve the Sisyphean labour it seemed a few years ago. By the extraordinary development of

novel methods, the pace of inquiry has been quickened all along the line. Particulars are accumulated faster than they can be assorted and arranged. Time has virtually expanded as if for the purpose of gratifying curiosity which becomes keener, as its sublime objects loom more distinctly above the horizon of thought. Ten years now count for a century of the old plodding advance and we can now reasonably look forward to a day when the genius of astronomers will render the future as distinct as the present.

THE OBSERVATION OF SUN-SPOT

(A Note read on the 24th March 1920.)

BY PROF. KHAGENDRA NATH CHAKRABARTTY, M. SC.

The solar disc is much too bright to be looked at with the unprotected eye, hence to a casual observer the sun appears to be uniformly bright. With a fairly high powerful telescope fitted with a special eye-piece however, this aspect is changed. The solar surface then appears granulated and we find certain small areas consisting of a dusky part (*umbra*) surrounding a dark central nucleus (*penumbra*). These are the typical sun spots. There are other sun spots as well, which appear to be very minute and consist of only the umbral part.

If we watch a particular sun spot for several days in succession, we find that it has changed its position with respect to the edges of the solar disc. This is due to the motion of the sun which rotates about its axis so as to make a complete revolution in about 28 days. Hence after the appearance of a sun spot for the first time on the eastern limb of the sun, it disappears from view in about 14 days on he western limb and may again make its appearance after