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TWO SCIENCES

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I

ASTRONOMY comes first. No science in all the long list of sciences has played a greater part in stimulating human progress. It entered the intellectual arena as a means of measuring time — of the day, the month, or the year; and it still continues to be our last referee in that line. But its greater stimulus has come in stretching our ideas of the enormous extent of space and in challenging us to measure it. In that process we have been compelled to develop mathematics in marvelous detail; and those who care not for numbers are equally inspired to visualize the enlarging universe and so build their own conception of the vast realm of creation in which man is less than a speck of dust.

To primitive man the universe was a small flat earth, consisting of his immediate locality, bounded often by mountain ranges; and overhead the clouds; and just beyond the clouds the sun, moon, and stars. He had no way of measuring the distance of these objects, and to him they were merely toys just out of reach. Then the Greeks in the day of their greatness invented geometry, or a method of 'measuring the earth.' This was one of the greatest discoveries of all time, and Greek thought was full of it. The fact that we study it to-day in the high school is a monument to their genius. They succeeded in measuring the diameter of the earth, but no objects beyond, even though they had invented methods of measuring the distance of objects out of reach.

The greatest book on science written in antiquity was by Ptolemy, an Alexandrian Greek, who lived more than a century after Christ. His book is about astronomy, but contains all the knowledge of his day in scientific lines. He treats of the earth and of geography and of mathematics and of the motion of the stars and planets, but he makes the mistake of placing the earth at the centre of the universe. His real reason for this was simple common sense. The stars and planets were believed to be near and small, and it would have been entirely absurd to think of those small objects as being stationary with the great earth moving around them; whereas it was entirely reasonable to think of the earth as stationary, with the little planets going around it every day.

This mistake lasted fourteen hundred years. In the meantime the Arabians improved their mathematical methods and got a real idea of the distance of the moon and therefore of its size, and by the sixteenth and seventeenth centuries it was realized that the sun was much farther off than the moon and consequently much bigger. Therefore Copernicus and Galileo, realizing that the vast sun was more likely to be stationary than the smaller earth, began the modern teaching of our solar system as we know it. Yet the people of their day could not

understand any new arrangement of the heavenly bodies, because as yet they were slow to learn the greater distance of the sun and moon, and they opposed these astronomers so violently that Galileo spent all of his old age in prison. Add to this the fact that the religious faith of that day had become tied to the idea of the earth as a centre; in short, people had made a religious idol of that thought, and they opposed the new idea with a fanaticism that we cannot realize to-day. But by 1650 the distance of the sun was known and generally accepted, and this religious idol was thrown down. It was seen that the sun is of immense size and situated in the centre, and the smaller planets move around in orbits, each in its own particular year. But the stars beyond were still thought of as a canopy off at the end of space, like a curtain hung about the universe.

It was two hundred years after the solar system was recognized that the distance of the first star was measured — a distance so great that it is impossible for us to realize it. The earth is 8000 miles in diameter. The moon is distant 30 times this, or 240,000 miles; and the sun is almost 400 times as far away as the moon, or 93,000,000 miles. If a traveler should go by express train across the continent and back continuously, it would take him four hundred years to travel that distance. That seems great enough, but the nearest star is 275,000 times that distance. That makes twenty trillion miles, or three and a half light years. Stellar distances are so vast that this new unit has been adopted to express them. Light travels 186,000 miles a second. The nearest star is so far that light takes three and a half years to come from it.

By 1900 some fifty or a hundred stellar distances had been measured by the Greek method, and then Kapteyn greatly extended that method by using as a base line not the diameter of the earth's orbit, as heretofore, but the motion of our sun in space. He was followed by Adams, of the Mount Wilson Solar Observatory, and others who worked out a spectroscopic method, by means of which more than 2500 stars are now known as to distance. Shapley, of the Harvard College Observatory, using an observation of Miss Leavitt's, has worked out the application of what is known as the Cepheid Luminosity Period Law and obtained distances as great as one million light years, so that now we can see past the nearer stellar trees and discover the forest of stars beyond. We find that the brighter stars are generally near us, but that they are at immensely different distances. They form a group of which our sun is a member, and this group is called our local cluster. Its members may be as much as two hundred light years away. Beyond that the stars thin out a little until we come to other local clusters. Many of these supply our constellation groups. For instance, Orion is one group, distant five hundred or six hundred light years. We know that vast numbers of these groups combine to form our galaxy or stellar system, of which the Milky Way is our direct evidence. This stellar system, which has long been called our universe, has the shape of a disk, thicker at the centre like a lens. Its thickness through is possibly 10,000 light years, and its full diameter is 75,000 to 100,000 light years. Beyond its edges are vast vacant spaces until we come to other stellar systems, some of the nearest of which are 1,000,000 light years away. With our giant telescopes of the present time these other universes are readily recognized, and to-day we know that more than half a million of them exist. These are the 'Island Universes.'

Such, then, is the vast conception which has come from the development of methods of measuring distance, and we feel that space is boundless. We have broken down the idol of past ages — the idea of a small or limited space. And we know that the whole matter of extension of space is not a religious matter at all.

II

The similar popular idea of time is a failure. It is still regarded as a religious matter, for many of our best people and our best friends visualize all prehistory as one day of beginning, and the vast possibilities of all future history as one day when the world shall come to an end. This reminds us of the poet under the Arizona stars who sees the stars merely as a canopy moving overhead; or it recalls the beautiful dome in the Vatican Observatory with the stars painted on the inside so that one can sit and see the constellations, but the stars are all at uniform distance, obviously made for man's amusement and without real existence of their own apart from man.

The people who look back upon all history and see only one day of beginning, and that not far distant, should visit the Hermit Trail in the Grand Canyon, where a rock is shown across which are animal tracks. Their identity is obvious; any small boy can recognize them; he has seen such markings thousands of times on the sand of the desert or the seashore. It is perfectly clear that an animal walked across this rock while it was still soft sand, but now his tracks disappear under a thousand-foot cliff. When that animal walked, the cliff of solid rock was not there. It took millions of years for that cliff to form and to be placed in its present condition.

Geology is full of illustrations of that sort, and scientists have made a very wonderful invention to bring these events of past time into an orderly sequence. This invention is our second science, evolution, which bears the same relation to the one-day-of-beginning idea that the moving picture bears to the ordinary photograph. Evolution is the commonest experience in human life. Every growing child is an illustration, and, of all people who have to do with this phase of evolution, teachers take the first place. They are contributing a most important part in the development of every individual. So evolution is not specially a question of man and his ancestry, but evolution is any orderly progress in the course of time.

The science of evolution would need days for a fair description and this is not the place for it, but one of its latest phases only will be mentioned. Dr. Conklin of Princeton says that man is not now going through any course of physical or mental evolution, but he is developing in social groups; and this is true, for, as you look about, you see that our activities today are devoted largely to organization of human endeavor in various groups, such as a school, a business company, or a woman's club. Your luncheon club, your lodge, school, church, city, state, and nation, are groups in a continuous state of competitive progress. I like to think of these groups as having living human personalities, and for the sake of distinction I like to call them 'super-persons.' They each include many people, or at least the interest and work of many people, and they last longer than any one person. For example, the United States is a living human super-person. In a recent address Dr. Moore, of Los Angeles, said that he asked his students, 'What is the United States?' Someone answered: 'Look at the map and see the mountains, the rivers, plains, and

valleys'; and he replied, 'All those were there five hundred years ago, but the United States was not there.' The United States, then, is a living human organism, and between great organisms of this sort is a higher form of competition, struggle for existence and survival of the fittest, than Darwin found among the lower animals.

Now the main element of these super-persons to which I wish to call your attention is that their lifetime far transcends the lifetime of the individuals composing them: for example, a nation lasts many hundreds of years. Therefore the interests of the nation cannot be the same as the interests of the individual, for the nation must look to needs of its later life which the individual cannot see or recognize. In order, then, to make the nation efficient, the individuals must and do feel within themselves instincts which deal with the larger and more distant interests. The same is true when we consider the whole human race; its best interests combine the best interests of all the nations and peoples, and deal with distant futures too far and too big for the individual to see or recognize, but he must and does feel within himself certain instincts which do deal with them. Such instincts dealing with futures out of reach are the religious instincts, the very wishes of God Himself touching the human heart; and this is the scientific approach to religion.

To many this scientific demonstration that religions must exist is the modern Holy Grail, and we observe that it is found in this science of evolution, which is conscientiously opposed by many people of to-day who cannot yet see the depth of time in past and future and the method by which Nature carries on her processes. Evolution, then, is inspiring progress in the human mind, for we are developing a method of measuring human futures out of reach, just as the Greeks invented geometry to measure the distance of material objects out of reach and gave us our universe. So evolution, if I mistake not, is going to be one of God's chief instruments in developing our knowledge of a coming spiritual and religious universe, the Future of Humanity.

In this approach to religion, with a little tolerance on each side, we find a complete identity between science and religion. What a wonderful future to look forward to; and it is surely coming and not far off.

So these two great sciences have helped the human mind to grow. Astronomy has given us a perspective of space and measured its depth; evolution gives us a perspective of time and measures its duration. Astronomy has pushed Heaven in its religious sense farther and farther away until we make the discovery that Heaven and God are not far off among the stars at all, but right here among us and in us; and evolution pushes the day of beginning farther and farther back and the day of ending farther and farther in the future until we find both beginning and ending — that is, evolution itself — going on now as God's method of creation, continuous and ever present. Astronomy showed us that mere space is not a religious matter; evolution has the same work to do to-day in showing us that time of itself is not a religious matter. Together these two sciences supply the greatest inspiration we possess in expanding our ideas of space and in compelling us to fill a part at least of endless time with definite life and progress.