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ASTRONOMY AT NORTHFIELD

In spite of all attacks, the theory of relativity is still on a firm foundation, according to Dr. Charles E. St. John, of the Mt. Wilson Observatory, who has been attending the meeting of the American Astronomical Society at Northfield, Minn. All the tests of the theory suggested by Einstein, and several he did not think of, have supported the theory when put to trial.

One of the crucial tests of relativity consists in measuring the spectrum shift. If light has mass, as the Einstein theory postulates, it is subject to gravitational attraction. Therefore the sun would tend, at least slightly, to pull back its light even at the moment it sends it out. This would lead to the displacement of the color lines in the sun's spectrum as compared with the spectrum of a source of light having little gravitational attraction, like an arc light here on earth. Dr. St. John made this test with delicate instruments and found the predicted shift.

Since then other astronomers have looked for this effect, and they say that there is such a shift, but that it varies with the lines, the stronger ones showing more shift than the fainter, which is not in accord with the relativity theory. However, Dr. St. John, working with the world's most powerful spectroscope on the 150-foot tower telescope at Mt. Wilson, has not found this variation.

Finally, the work of his colleague, Dr. Walter S. Adams, director of the Mt. Wilson Observatory, has shown the Einstein shift elsewhere in the heavens. The dog-star, Sirius, which is a conspicuous object in the late summer sky, has a small companion star, not visible to the naked eye. Though small, it is enormously heavy, denser by far than anything known on the earth; it has been calculated that a pint of its substance would weigh twenty-five tons. Such density gives it an enormous gravitational pull, which makes it an especially advantageous sun for the testing of the Einstein shift. With the aid of the great Mt. Wilson telescope Dr. Adams has made photographs which show the displacement of the lines corresponding to this great density, according to Einstein's predictions.

Dr. St. John explained also how he learned of the Martian drought by means of the spectroscope mounted on the great 100-inch telescope, the largest instrument of its kind in the world. He stated that if Mars has any inhabitants, they must be able to get along on about one twentieth of the water one finds on the tops of the semi-desert mountains in southern California.

When light passes through a substance, certain colors are absorbed, and what these colors are can be learned by means of the spectroscope. Specifically, light passing through water vapor of a certain density will always be absorbed in the same way. By catching the light from the planet with the great reflector and analyzing it with the spectroscope, Dr. St. John was able to determine the amount of moisture in the Martian atmosphere.

There was a possible source of error in the absorbing effect of water vapor in the earth's own atmosphere. This was corrected by taking spectrographic pictures of the sky. When the absorbing effect shown in these was subtracted from the total in the plates from the planet, the remainder represented the absorption in the atmosphere on Mars. This proved to be only five per cent. as great as the absorption of the very dry atmosphere above the summit of Mt. Wilson, indicating that the surface of Mars must be highly arid.

Measured by the same method, the amount of oxygen on the neighboring planet also is relatively very low; according to Dr. St. John, it is only 60 per cent. as great as the oxygen supply on Mt. Everest, where exploring expeditions have had to resort to the use of oxygen tanks in order to keep alive.

Though deficient in water and oxygen, there is no doubt that Mars still possesses an atmosphere. E. C. Slipher, of the Lowell Observatory at Flagstaff, Arizona, showed that photographs made with red-light filters made the planet appear larger and showed greater detail than those made with blue-light filters. Red light is known to have greater powers of penetration through the atmosphere than blue; so that the photographs would tend to indicate the presence of an atmosphere on Mars.

Mars is more thrifty than the earth of the radiation it receives from the sun, according to Dr. C. O. Lampland, who, using the Coblentz radiometer, found that though Mars receives less energy from the sun it absorbs all but 15 per cent. of what it receives, whereas the earth reflects nearly half of the light and heat falling on it. The temperature of Mars, Dr. Lampland concludes, may not be greatly different from that of the earth. Dr. Lampland has also studied the planet Mercury with the radiometer, but finds Venus unapproachable because of its dense envelope of presumably cloudy atmosphere.

Dr. Otto Struve, of Yerkes Observatory, brought the question "What is that distant sun, known to astronomers as Kappa Draconis, doing with its hydrogen?" before his colleagues. He has not found the answer yet himself; all he has discovered is that at times this inconspicuous member of the stellar universe seems to have plenty of the lightest of the elements, and after the lapse of a number of years that the hydrogen is gone again.

In 1890 Dr. E. C. Pickering, then the director of the Harvard College Observatory, discovered bright lines in the hydrogen region of this star's spectrum. Making a study of the photographic records filed at Yerkes Observatory, Dr. Struve has discovered that these lines grew fainter and fainter, until they disappeared completely in 1904. They reappeared in 1911, became brighter until 1919, and have remained steady since that time. Now Dr. Struve expects them to weaken and disappear once more. But he has no explanation to hazard for such erratic behavior on the part of a distant sun. Dr. Struve also discussed and described the clouds of calcium, the element responsible for lime, marble, chalk and a number of other familiar things, but which blown out to atomic fineness and fiery heat, wander in stellar space.

In some places double stars, pairs of twin suns, rotate about each other in the midst of such an eddying celestial limelight. His attention was first drawn to the existence of these calcium clouds because certain lines from double stars did not shift when photographed through the spectroscopic telescope, as they should have if the light emanated from the twin suns of a double star, as they alternately advance and retreat. Further observations led him to the conclusion that these lines were due to the element calcium, which formed a sort of envelope of glowing stellar mist about the whole of the double solar systems. Further search of the heavens discovered other calcium clouds without any stars in them; such masses lie mostly along the line of the milky way.—*James Stokley.*

THE BREEDING HABITS OF THE SALMON

SOME of the secrets of how and why the salmon, year after year, finds its way to its spawning ground by navigating a maze of forking rivers have been discovered by Professor Henry B. Ward, of the University of Illinois.

No single factor is adequate to explain all the activities of an aquatic animal; but some have greater influence than others. In an intensive study of the fresh-water life of the Pacific salmon, he discovered that temperature plays a large part in the salmon's life.

The life history of the Pacific salmon may be divided readily into three chapters: first the early life of the young fish in fresh water; second, the period of growth in the ocean, and third, the wandering of the adult through fresh water to the spawning grounds, in which the reproductive process is invariably terminated by death.

The red or sockeye salmon follows a definite course in its migration, moving steadily up-stream against the current. This positive response to the current stimulus is not adequate to explain its action at two points, first at stream junctions and second in selecting a precise place to spawn. When the red salmon reaches a fork in the stream, it does not necessarily select the larger, the clearer, the deeper or the swifter branch, but in an extensive series of observations I have found that it always selects the colder water. The determining influence appears to be the relative temperature of the two branches rather than the absolute temperature of either. If both branches should have the same temperature, some other factor would determine the choice, and it may be that such a factor might in special cases overrule the temperature stimulus. But no such cases have been observed. In testing this stimulus, observations must be made at the exact time when the fish are moving up the stream.

The red salmon regularly spawn in a lake, and in all cases observed it selected that part of the lake margin where an inflow of seepage water was demonstrated. At such points the water is distinctly colder than elsewhere along the shore. During the winter, however, these areas would be warmer and the water would be protected from freezing. In the exceptional cases when the red salmon does not spawn in a lake, it still deposits its eggs in spring-fed areas. This response to the temperature stimulus is of fundamental importance since it protects the eggs against the destruction which would be inevitable if they were actually frozen.

The movements of aquatic animals are directed by influences which are partly internal and partly external or environmental. Even though the latter be complex, careful and continued observation will serve to show what influences are most significant in directing and controlling the activities of a particular species. Confusion easily results from applying to one form conclusions reached in the study of other species.

MOUNTAIN AGRICULTURE

AMERICAN mechanical genius is beginning to revolutionize mountain agriculture. In the last twenty years the art of rice-growing has been taken out of the hands of the Asiatics and adapted to machine methods so successfully that our high-priced workers now produce the crop as cheaply as the eight-cent-a-day Chinese coolie. But this is nothing compared with the changes being wrought in the handling of hillsides down south.

For years the Appalachian slopes have been washing away with terrific losses to the farmer, because men of western European stock applied the tricks of flat-land farming to the steeps. They had never heard of the terraces and water holes which the Corsican mountaineer, the Javan farmer and the persistent Japanese make to hold the rains and the rich earth on slopes as sharp as a house roof. When news of these methods first came to the American, he was unwilling to use them because of the vast amount of heavy labor required to build such dirt architecture. But, after a while, he began wondering whether machines couldn't turn the trick. And, surely enough, machines would.

A retired engineer, Lawrence Lee, of Leesburg, Virginia, seems to have been the first to hit on a way of using tractors and a specially designed scraper for such work. Even in the heaviest thunderstorms of summer, hardly a drop of water runs off the sixty acres which Mr. Lee now has terraced and planted as orchard. Some parts of this tract have a pitch of about forty degrees—which is quite as great as most of the remarkable mountainside terraces in the Philippines and Java, where for centuries the banking of soil and care of crops have all been done by the most laborious of handwork.

In the last few years progressive farmers in North and South Carolina have adopted this new technique. Especially in the badly eroded stretches along the Catawba River, thousands of acres have been delivered from the ravages of the rains. Applied to the millions of acres in Appalachia which are being washed away, this method will conserve many hundred million dollars' worth of top soil; and it will convert what is now an unprofitable wilderness into a rich empire. Land worth nothing to-day can, in a few seasons, be transformed into forage crop acreage worth at least thirty dollars per acre; and, after ten or fifteen years of tree planting along the terrace ridges, this same land, as had already been demonstrated in Virginia, yields a return that makes it worth from seventy-five to two hundred dollars per acre.

Professor J. Russell Smith, the economic geographer at Columbia University, has made a special study of the Old World terrace methods and of these new American ways. He has found rough mountainsides in Corsica yielding nut crops as heavily as Illinois bottom lands yield corn. He states that a new dividend-paying country about the size of France will be added to the United States as soon as the Appalachian region adopts generally the tractor-built terraces of the Lee type and develops fast-growing hardwood trees to plant on the land.

That oaks, walnuts and hickories can grow much faster than the common run of them now do is quite as certain as the improvements which have been wrought in corn, wheat, apples and many other crops. Were it possible to increase, by selective breeding, the rate of wood growth by only twenty or twenty-five per cent., this would eventually add many millions of dollars to our national wealth.—*Walter B. Pitkin.*

TRANSPARENT STEEL

THE new method of making sheets of metal of unprecedented thinness, invented by Dr. Karl Mueller, of the Physical Technical Institute of Berlin, seems likely to prove of considerable industrial as well as scientific importance. He has succeeded in producing sheets of steel so thin that they are as transparent as the clearest glass. The test plates used to determine the transparency of optical glass, and ruled with lines one twenty-five hundredth of an inch apart, were photographed through such a metal sheet, and when enlarged to four hundred diameters the scale lines showed distinctly without any distortion. This absence of aberration proves that the structure of the film is perfectly even and equal in all directions. The metal sheets are so thin that atoms will pass through them without impediment. Alpha rays from radium, that consist of streams of the stripped atoms of helium, and are completely blocked by a sheet of paper, are not perceptibly weakened in passing through such metal sheets. It is calculated from the specific gravity of the metal that in these sheets there are not more than thirty layers of atoms in thickness. Yet the sheet of metal is so strong that when fastened in a frame it may be bent out by blowing on it to a sixteenth of an inch without rupture.

Dr. Mueller makes these sheets by depositing an extremely fine film of the metal on a smooth surface by means of the electric current and afterwards separating the film from the foundation on which it was fixed.

Many applications have already been made by scientists and inventors to secure these transparent metal sheets for experimental purposes. They seem likely to serve as semi-permeable membranes for the separation of gases. They may greatly advance the progress of telephotography and television. They also seem likely to prove serviceable in metallurgical research, and in the making of galvanometers, radio receivers and apparatus for measuring the action of the heart.

SODIUM HYPOCHLORITE

THAT sodium hypochlorite, the common disinfectant used in drinking water and swimming pools, does not sterilize by direct contact, but by means of germ-destroying invisible rays which it gives off when it comes into contact with organic matter, is the conclusion drawn from experiments made by French chemists, M. Philippe Bunau-Varilla and M. Emile Techoueyre, and communicated to the Academy of Sciences by M. Jean Perrin, professor of physical chemistry at the Sorbonne.

It used to be thought that the purifying power of the compound was due to chemical reaction, as it oxidized organic matter and decomposed itself. But while M. Bunau-Varilla was trying to determine the smallest amount of sodium hypochlorite necessary to sterilize a given amount of drinking water and not leave the usual chlorine taste, he found that the quantity necessary was too small to enter into any appreciable chemical reaction, and this fact suggested his ultra-violet ray theory.

A series of experiments was then devised to prove or disprove the theory. A tube of quartz, which, unlike glass, is transparent to ultra-violet rays, was filled with a dilute solution of sodium hypochlorite and placed within a larger tube of quartz. The interspace was filled with water contaminated with colon bacilli, and the combination immersed in a bath of hypochlorite solution. An identical arrangement of quartz tubes, but lacking the surrounding disinfectant, was prepared and the sets were allowed to stand twenty-four hours.

In order to find out if the hypochlorite had really given off death-dealing radiations, drops of the contaminated water were taken out of both tubes and "planted" in dishes of gelatin—a sort of bacterial dinner pail—where they were allowed to grow. The solution containing the most bacteria would grow the largest number of "colonies," and *vice versa*. In 51 times out of 60 the contaminated water that had been surrounded for 24 hours by the hypochlorite solution grew fewer bacterial colonies than water not so exposed.

It appears from these experiments that the hypochlorite gives off ultra-violet rays which, passing through the quartz, destroy the microbes that they reach.

ITEMS

EARLY Egypt was populated, about 13,000 B. C., by kinsmen of the cave-dwellers of Europe, according to Sir Flinders Petrie, foremost archeologist. He discovered beneath the oldest known previous habitation site a still older settlement, with flint instruments similar to those of European stone age culture known as Solutrean. An ivory statuette links Egypt with Asia at an exceedingly early date. Pottery, finer and thinner than any subsequently made in ancient Egypt, was also found. The culture thus marked has been named the "Badarian," from the place of its discovery, near Asyut. Its antiquity was determined by a study of the record of the floods of the Nile. The early civilization of Britain was connected with that of the Egypt of Tut-ankh-amen's day by Sir W. Boyd Dawkins, who discovered buried at the famous and mysterious Stonehenge a number of Egyptian beads dating from the reign of Tut-ankh-amen's predecessor and father-in-law, Akhnaton, in 1360 B. C. This is the first clue to the date of these magelithic monuments, which have long been one of the great archeological riddles of the world.