SCIENCE NEWS

Science Service, Washington, D. C.

NEW STELLAR SYSTEMS

THE limits of the universe have been pushed outward and great stellar systems comparable to our own tremendous galaxy are shown to exist by the astronomical research of Dr. Edwin Hubble that won for him half of the $1,000 prize for the best paper before the American Association for the Advancement of Science.

Using the largest telescope in the world, the 100-inch reflector at the Mount Wilson Observatory of the Carnegie Institution at Pasadena, California, Dr. Hubble has solved the mystery of the great heavenly objects that look like pinwheels in the sky, the spiral nebulae.

Nearly overhead in the sky at the present time, in the constellation of Andromeda, there is the most famous of these spirals, the Great Nebula of Andromeda. To our eyes, viewing it from the earth, it has several times the area of the full moon, although it is so faint that good sight is required to spot it in the heavens.

In small telescopes it looks merely like a cloud of matter, but when Dr. Hubble turned the great Mt. Wilson 100-inch telescope upon it, he found that the outer ends of the spiral contain immense numbers of very faint stars, a hundred thousand to a million times fainter than the stars that the naked eye can see.

A study of such photographs and the application of known astronomical laws led Dr. Hubble to the following facts about the Andromeda nebula:

It is so distant that it takes light nearly a million years to travel from it to the earth. That is, it is some 6,000,000,000,000,000,000 miles away. It is the most distant object known to science. It is as large and has as much material in it as our own galaxy. Its total light is one billion times that of the sun. It contains some three or four thousand million stars. In shape and form it is not unlike the great stellar system or galaxy of which the Milky Way and most of the stars we see at night are a part and in which the sun and its revolving planets are but pin points. It is at four times as great a distance as ever previously established for any celestial object, with the exception of the faint star cloud N.G.C. 6,822 which Dr. Hubble has shown to be 750,000 light years from the earth. It is an "island universe," a concentration of stars, gaseous material and perhaps even planets, out in the space of the great all-inclusive or super-universe and billions of miles away from other universes or galaxies like our own. And the spiral in the constellation Triangulum seems to be nearly a twin to that in Andromeda.

How can evidence of such gigantic "universes" be obtained? First of all Dr. Hubble's photographs, better than any previously obtained, showed "dense swarms of actual stars" in the outer parts of spiral nebulae. Then it was found, by taking photographs night after night, that some of these stars were what is called Cepheid variables. They fluctuate in brightness, going through a period of sudden rise to brilliance and slow fall to dimness in times ranging from a few hours to 50 days. At maximum they range from 4,000 to 8,000 times the sun's brightness. This was the clue to the determination of the great distance of the nebulae.

Some years ago Dr. Harlow Shapley, of Harvard, worked out a useful relationship between star brilliance and the period of these Cepheid variables, so named because they are most prevalent in the constellation of Cepheus. He found that if the period of variation was known, the absolute brightness, dependent only upon the temperature of the star and not upon its distance from the earth, could be determined. A simple comparison of absolute brightness of the star with the brightness shown through the telescope tells the distance of the star from the earth.

When Dr. Hubble applied this law to the variable stars he discovered in the Andromeda nebula, he found that they were all about 930,000 light years away in another island universe.

While Dr. Hubble is the first man to prove the distant existence of such vast conglomerations of matter outside our own locality of space, their character has been suspected for about a century. Sir William Herschel, English astronomer of 100 to 125 years ago, when he saw the spiral nebulae poetically called them "island universes." The name persisted and now Dr. Hubble has given it justification.

Undoubtedly more distant spiral nebulae, now known to be stellar galaxies, lie even farther out in space. There are more than 100,000 of these spirals known to astronomers and most of them, instead of being great patches of light like the one in Andromeda, appear merely as points of light in telescopes and on photographs.

Imagination totters when it attempts to conceive of the distances that must intervene between these galaxies or "universes" and our own.

Space, or the super-universe, with the aid of Hubble, Einstein and other scientists, has been swollen enormously in the past few years.

NEW METHODS OF KILLING PROTOZOA IN THE DIGESTIVE TRACT

KILLING of the thousands of minute animals that inhabit termites or "white ants" and digest their woody food for them may seem an unimportant accomplishment. Yet this is what won Dr. L. R. Cleveland, National Research Council fellow working at the Johns Hopkins University, Baltimore, half of the annual prize of the American Association for the Advancement of Science.

The microscopic protozoa that live in the digestive tracts and blood systems of man, animals and insects are mostly harmless or helpful, yet there are some that cause serious diseases like malaria, sleeping sickness and dysentery. The importance of Dr. Cleveland's success in killing the protozoa of termites without hurting their involuntary hosts lies not in the practical application of

this one accomplishment, although the method may be used in destroying troublesome "white ants," but in the promise of new biological and medical methods that it contains. His new technic has possibilities of application in widely different fields ranging from the cure of disease to the protection of property.

Dr. Cleveland's studies began about five years ago, on the protozoa that inhabit the digestive systems of termites, or "white ants," wood-eating insects very destructive to all timber structures in the southern states and in all warm countries. He found that they played a very important rôle in the lives of most species of these insects. In some termites half the body weight is made up of swarms of protozoa. Dr. Cleveland, wondering whether these internal guests might not be necessary to the termites, sought for methods to kill them without killing the hosts. He found that this could be accomplished in any one of three ways: (1) By keeping his termites at a temperature of about 95 degrees Fahrenheit for 24 hours; (2) by starving them for a time; (3) by exposing them to air or pure oxygen under pressure. Under any one of these treatments the protozoa perished and the termites survived.

But they did not survive long. Deprived of their "inhabitants," they starved to death in three or four weeks, even though they had plenty of wood to eat. Apparently they can not digest their customary diet without the assistance of their colonies of protozoa. Dr. Cleveland suggests a method for taking advantage of this discovery to rid a house of termites. "Close it up thoroughly," he says, "Cut off the termites' retreat through the basement to the ground. Fire the furnace to the limit, until you get a temperature of 95 degrees or higher. Keep it that way until you are sure the walls have been heated through for twenty-four hours. Or if you can get a temperature of 110 degrees or more, a much shorter period should suffice. With their protozoa dead, the termites should die of starvation in the midst of plenty."

More important, however, in Dr. Cleveland's opinion are the possible uses of his discovery in promoting health, through adaptations of his methods of killing protozoa with oxygen. He found that if pure oxygen were substituted for air at ordinary atmospheric pressure or, what amounts to the same thing, if air, with its twenty per cent. content of oxygen, were supplied at five times the usual pressure, the protozoa in the bodies of termites could in some cases be killed in a relatively short time, while the insects could stand the treatment for long periods—in some cases indefinitely. When pure oxygen was applied under pressure, the protozoa died even more quickly and there was less risk to the host animal. Cold-blooded vertebrates like frogs also survived this treatment, but success has not yet been attained with warm-blooded animals. Dr. Cleveland is now contemplating further experiments on rats in an endeavor to find and eliminate the causes of failure.

For more immediate results, Dr. Cleveland, in a second series of experiments on the warm-blooded animals, is searching for a chemical that will release oxygen to kill the internal protozoa without injuring the body tissues. He has had partial success with those already tried, and is now awaiting the arrival from Germany of a new compound which is claimed to be particularly efficient.

THE SUN AND THE WEATHER

THERE seems to be evidence to show that very moderate changes in the sun's heat, without much affecting the average temperature of the world as a whole, may yet make the difference between prosperity and failure in some localities here on earth.

The studies of H. H. Clayton, an American meteorologist, show plainly that major changes of the barometer and temperature in the United States come from solar variations. About 10 years ago Mr. Clayton, then chief forecaster for the Argentine government, began a long thorough investigation of just exactly what happens to barometers, thermometers and rain gauges all over the world when the sun's heat changes. By 1920, he was actually employing solar measurements of the Smithsonian Institution to make public official forecasts a week in advance for the temperature and rainfall of Buenos Aires. These weekly forecasts are still maintained.

At first sight the matter is very simple. You would all probably say that if the sun sends more heat the weather would grow warmer, if less heat, cooler. But the subject is more complex. A place tends to be warm or cold according as its prevailing winds come from tropical or polar directions. In the atmosphere there are regions of low barometer and regions of high barometer. Look on the weather map and you will see that in the United States the winds blow counter-clockwise all around the low centers, and clockwise all around the high centers. Meteorologists call these effects cyclones and anti-cyclones.

If now the system of cyclones and anti-cyclones is shifted north, south, east or west by any cause, there will be a change of wind and consequently a change of temperature. Rainfall also is modified. According to Mr. Clayton's researches this is exactly what happens when the sun's heat changes. The barometric highs and lows move a few hundred miles and alter the wind directions, and with them the weather.

Data for stations all over the world and for all seasons of many years must be compared with recorded solar changes before meteorologists will be able to begin predicting from the state of the sun's heat. This great work is only begun. That is why our Weather Bureau does not use these methods for forecasting.

The part of the Smithsonian Institution in this new movement is to secure regularly accurate measurements of changes in the sun's heat. We began to make these studies over 20 years ago in Washington, but soon found it necessary to move to clearer skies. We discovered that the sun's heat varies and after years of research that took us to three continents we established in 1918 an observatory in the Nitrate Desert of Chile where it almost never rains and where there is neither animal, insect, reptile nor vegetable life and where all water and supplies must be hauled many miles. From this observatory nearly 10,000 feet above sea-level, and at another station on a mountain in Arizona, over a mile high, daily solar observations are made and daily tele-

graphic reports are sent to the Smithsonian Institution.

There is great difficulty in making observations accurate enough. The sun's changes seldom exceed 3 per cent., though sometimes reaching 5 per cent. or more. Mr. Clayton's results indicate that solar changes as small as 1 per cent. or less are yet great enough to produce noticeable effects on the weather. It is only lately that we have succeeded in refining methods to this degree of accuracy. But for about two years past our two stations, which lie over 4,000 miles apart, have agreed to about one half of one per cent. on the average of all good days, and have agreed in showing solar changes of from one to five per cent. For over two years they have indicated that the sun's heat has been generally from one to two per cent. below normal, but at present it is nearly up to normal again, and apparently seems marching towards higher values.

Between summer and winter and between night and day, enormously greater changes than three or five per cent. occur and we adjust ourselves to them. Why should we consider such seemingly small changes in the sun's heat?

The answer is that the food plants, the great cities and others of the most important things in the world are found exactly where they are because they are all adjusted to exactly the climatic conditions which prevail. And those adjustments are apparently very capricious. Why do palms grow in southern England, which lies as far north as our bleak Labrador coast, for instance, and why do people winter in south France, as far north as Ottawa, while in America people go to Florida or southern California to get mild winters?

The point is that a little change in the quantity of solar heating might alter the distribution of heat over the earth in such a way as to produce perfectly astounding changes. One per cent. change of the heat available to warm the air over the enormous area of the tropics may be of little effect there but may easily produce very much larger effects towards the poles. For the areas of the zones grow less towards the poles. It is like the tides. On the open oceans they oscillate only a foot or two, but in the confined Bay of Fundy the tidal wave is over 40 feet high.

One looks forward to a time when daily telegrams shall come to a central station from at least four solar radiation observatories instead of from two as now, and the condition of the sun shall be broadcasted for the use of meteorologists the world over. For, after all, the temperature and all life on the earth depends on the sun's rays. They ought to be thoroughly investigated so that we may be informed in advance what we are to expect as the consequences of changes in the sun.—*Charles Greeley Abbot.*

THE USE OF HYDROGEN PEROXIDE IN DETERMINING FERTILITY OF SOILS

FERTILIZER needs of any soil can be learned in two days with almost no expense, instead of requiring a couple of years of costly field tests, by a new method devised by M. D. Chonchack, a French agricultural scientist.

M. Chonchack's system depends on two facts that have been known for a long time as matters of pure science, but were never thought of as possibilities in economic application. It is well known that the fertility of the soil depends on the activity of the microscopic organisms it contains, largely bacteria and fungi. It is also well known that the mineral salt requirements of these bacteria are about the same as those for the higher plants that make up our crops. Therefore, reasoned M. Chonchack, a soil that harbors a rich growth of bacteria will produce a good harvest.

A difficulty arose in the matter of determining the bacterial content of the soil, for methods of direct counting under a microscope are difficult and inaccurate. Here again M. Chonchack made use of the fact, well known to every one who has ever used hydrogen peroxide as a mouth wash or as an antiseptic on a scratch, that bacteria cause this chemical to give off oxygen. The amount of oxygen given off is always in proportion to the total quantity of bacteria present. Therefore, by treating his soil samples with hydrogen peroxide and measuring the oxygen that bubbles out, M. Chonchack was able to get a measure of the bacterial life present.

Preliminary tests have shown that the method holds good within certain limits in determining the fertility of soils, and more extended investigations are planned for the coming season.

ITEMS

A POINT which will change, on being heated, from brilliant red to black has been prepared by Henry A. Gardner, Washington chemist, for use on automobile radiator caps. When the water in the radiator starts to boil the cap changes first to maroon and then to black. When the engine is running normally again the pigment returns to bright red. The paint is a combination of metallic iodides. The cap may be made to change color at least fifty times before it shows any sign of losing its original red.

COLORED pictures with only one exposure of the object are possible by means of a new German invention told of by the Berlin correspondent of the *Journal of Industrial and Engineering Chemistry.* Instead of using three exposures of the same object with red, yellow and blue filters the same effect is possible by exposing three negatives at the same time with a system of mirrors to reflect the image. The different colored filters are used in front of the negatives and the whole is projected upon specially prepared gelatin paper. A naturally colored print resembling a good three-color print results. The process is equally successful in portraits, interior views or landscapes.

AN observatory for avalanches, believed to be the first of its kind, has been erected in Tamischbachturm in the province of Steiermark, Austria, by the state railway. Its object is both scientific and practical. It has been fitted with instruments for the recording of exact data, and it will also send out warnings to stations below when avalanches threaten. It is also planned to "set off" incipient avalanches and so prevent them from launching themselves later spontaneously and without warning.