for many years taken an active part in the administration of the Association.

Prof. Henry Norris Russell, Princeton University astronomer, who was elected president will preside at the Boston meeting during Christmas week 1933 and deliver the principal address of the 1934 meeting as retiring president.

Dr. Burton E. Livingston of Johns Hopkins University who for many years was permanent secretary, was reelected general secretary and John L. Wirt of the Carnegie Institution of Washington was reelected treasurer. Dr. Livingston was also nominated as representative of the A. A. A. S., on the board of trustees of Science Service.

Science News Letter, January 7, 1933

SEISMOLOGY

Catastrophic Earthquake Rocks Interior of China

CHRISTMAS brought to the isolated interior of China a very severe earthquake that was probably extremely destructive to life and property.

From reports wired Science Service by eight seismological observatories in different parts of the world, the U. S. Coast and Geodetic Survey determined that the shock occurred Saturday, December 24, 9:04.5 p. m., Eastern Standard Time at 38 degrees north latitude, 96½ degrees east longitude. This location is near Tsaidam Swamp.

It is likely that news of the probable disaster will not reach the outside world for several weeks.

Science News Letter, January 7, 1933

COSMOGONY

Beginning and End to Universe May Fall Before New Physics

Prof. Tolman Pictures Infinite Life in Past and Future Instead of Universe Eventually Dying of "Heat Death"

SCIENCE and mankind are relieved of the necessity of considering that they live in a universe that was created at a definite time in the past or fated for stagnation and death in the future, if new principles of relativity and thermodynamics developed by Prof. Richard C. Tolman, California Institute of Technology "universe maker", stand the test of future discoveries.

Delivering the Josiah Willard Gibbs lecture before the American Association for the Advancement of Science, Prof. Tolman, who is a world authority on thermodynamics or the science of heat-energy and motion, extended thermodynamics to Einstein's special and general theories of relativity.

He arrived at findings that promise to have profound influence on philosophy and even religion as well as on science.

Now Expanding

Old-fashioned, classical science viewed the universe as running down in energy like a clock, eventually dying a "heat-death" when all heat and energy arrives at a dead level. Prof. Tolman's greatly simplified cosmological models hold the hope that under the new relativistic thermodynamics the universe can forever and ever experience a succession of irreversible expansions and contractions.

This fits in with the astronomical observations that we live in a rapidly expanding universe in which the great stellar galaxies are rushing away from us at speeds of thousands of miles a second. Prof. Tolman's tentative idea of the universe explains how it is possible that it is now expanding, that it previously contracted, that it will contract in the future and that this cycle will continue unendingly.

A creation or beginning of the universe is necessary under our ordinary, every-day, classical ideas. Prof. Tolman's marrying of thermodynamics with relativity may have removed the necessity of thinking of the universe having a beginning. In the "cautious position" to which he is taken by his mathematics and physics: "we no longer dogmatically assert that the principles of thermodynamics necessarily require a universe created at a finite time in the past."

Gibbs was the great American scientist who gave the classical principles of thermodynamics their most complete and comprehensive expression. Delivering a memorial lecture named in Gibbs' honor, Prof. Tolman told why it has become necessary to extend the classical thermodynamical principles to relativity that has so greatly influenced all science in the last two decades.

Classical thermodynamics was developed with the assumption that the things about him were at rest with respect to the observer. Prof. Tolman found it necessary to develop thermodynamics for observers in uniform relative motion to each other as is the case in the Einstein special theory of relativity.

The old-fashioned thermodynamics applied to space and time that had limited range and lacked strong gravitational fields. Prof. Tolman found it necessary therefore to extend thermodynamics to Einstein's general relativity in order to consider the heat-energy behavior of large portions of the universe. The older ideas of heat and energy needed refining in just the same way that Einstein found it necessary to develop a theory of gravitation that is more precise than Newton's.

Ordinary Principle Fails

Prof. Tolman detailed the technical modifications in thermodynamic theory needed to extend it to relativity and then gave examples of its "essential novelty and the inherent rationality of its consequences."

One strange consequence is that a system in which there is heat equilibrium will have higher temperatures where the gravitational field is stronger, although in classical thermo- (*Turn to page* 12)

nities having fluorine-bearing water supplies.

The results of the communities' experiment will not be fully apparent for about six or seven years, when the teeth formed subsequent to the change of water will have erupted into the mouth.

Areas effected have been found in Arizona, Arkansas, California, Colorado, Idaho, Illinois, Minnesota, New Mexico, North and South Dakota, Texas, Virginia, Kansas, North Carolina, Oregon, Washington and foreign countries.

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PHYSIOLOGY

Secretion From Crustacean Eyes Causes Color Changes

EYES act as glands, in certain animals at least, secreting a substance that causes the contraction of color-bodies in their skins and thus controls their chameleon-like color changes. Experiments pointing to this hormone-production by eyes were reported by Prof. Lloyd M. Bertholf, of the University of Western Maryland before the American Society of Zoologists.

The animals furnishing the color-changing extract were crustacea, the great zoological family comprising lobsters, crabs, crayfish and their kin. The hormone was found in their eye-stalks.

The eye-stalk extract, when injected into the body, produced color changes not only in crustacea, but in frog tadpoles and several species of fishes—animals far removed in the zoological realm from the invertebrate crustacea.

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come a part of it. Neutrons would not be repelled, and would probably have a better chance of going in. We do not know enough about them yet to estimate the chances; but a tolerable idea of the probability of penetration of a proton can be obtained by means of wave-mechanics. The chances are best for the lightest nuclei, which have the smallest charges and repulsive forces. Calculations by Atkinson and Houtermans show that such penetrating collisions would begin to become important when the temperature of the gas rose above a few million degrees."

The rate of heat-production by atomic synthesis increases very rapidly with the temperature. In a gas containing hydrogen, oxygen, nitrogen and carbon, all of which are very abundant in the stars, heat should be produced fast enough to keep the stars shining at temperatures of about 20 million degrees, Prof. Russell estimates. The internal temperatures of most of the stars appear to be just of this order, and it is probable that they are deriving their heat supply from processes of atomic synthesis of this general nature. What supplies the giant stars, which must be much cooler inside, unless they have dense cores, is still unknown.

The Russell theory is greatly strengthened by a kind of energy-releasing element building demonstrated this year by Drs. J. D. Cockcroft and E. T. S. Walton at Cavendish Laboratory, Cambridge, England. Lithium, lightest metallic element, was bombarded with protons or the hearts of hydrogen atoms, accelerated by a potential drop of 300,000 volts. Alpha rays, which are helium nuclei, were given off with a total energy corresponding to 16,000,000 volts.

A proton evidently enters a lithium nucleus, produces a beryllium isotope which breaks up into two alpha particles. The energy due to loss of mass sets the alpha particles in very rapid motion.

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dynamics it would necessarily have uniform temperature throughout.

Another example cited by Prof. Tolman is "the possibility for reversible processes at a finite rate" which would be impossible under classical theory.

The ordinary principle of energy conservation fails under relativistic mechanics and Prof. Tolman holds out the idea that under the new thermodynamics "an unending succession of irreversible expansions and contractions which seems very strange from the point of view of classical thermodynamics" can actually occur. And this would happen without "a final state of maximum entropy" or a running down of the system to a dead level of heat.

These extensions of relativity to heat, energy and motion made by Prof. Tolman will sound as bizarre to those accustomed to physics as now taught as Einstein's new physics seemed when first made known to the world.

In present the new models of the universe possible under his new relativistic thermodynamics, Prof. Tolman warned that they were very highly simplified and idealized and that at best they are constructed to agree with the small sample of the actual universe that is within range of the most powerful telescopes. Those reach only some hundred million light years.

It is also possible, he warned, to construct a model universe that would expand never to return. Only research of the future will determine whether the real universe is expanding and contracting indefinitely, expanding like a balloon inflated by limitless breath or acting in some unknown way.

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Scientists, recording the intensity of sounds in decibels, give the following figures: hammering on steel plate, 113 decibels; riveter, 101; subway, 97; lion roaring, 87; radio loudspeaker, 81; church bells, 61.