ASTRONOMY

Atom Building Keeps Stars Shining, Says A.A.A.S. Head

4,200,000 Tons of Heat Per Second From Sun Called Mass Left Over From Element Forming Process

THE BUILDING up of other heavier atoms out of hydrogen stokes the internal heat of the stars, including the sun, Prof. Henry Norris Russell, Princeton University astronomer recently elected president of the American Association for the Advancement of Science, suggested in the Maiben lecture before the Association.

The hardest problem of all star study is the source of the energy which keeps the stars shining, he explained. Synthesis and annihilation of atoms are the only two processes so far suggested which would supply enough heat to last for the millions of years of geological time.

Present theories indicate that the mutual annihilation of the positive and negative particles, the protons and the electrons, would not happen except at temperatures of many billions of degrees such as do not exist within the stars.

Prof. Russell's provisional theory is therefore that atomic synthesis makes the sun and stars give off heat and light.

"A Pound of Heat"

"The rate of loss of heat from a star is almost incomprehensively great," Prof. Russell said. "We can come nearest to realizing it by remembering that, according to the theory of relativity, heat, like other forms of energy, possesses mass. It is as proper to speak of a pound of heat as a pound of ice; but a pound of heat is a very large amount—enough, in fact, to melt 30 million tons of rock and turn it into white hot lava. The sun radiates heat away into the depths of space at the rate of 4,200,000 tons per second—and the sun is a smallish star! Upon what vast stores of energy can it draw to keep going?"

The mechanism for building heavier atoms out of hydrogen visualized by Prof. Russell is that suggested by the new and attractive theory of Prof. Werner Heisenberg, German physicist. Atomic nuclei are built up of protons and the recently discovered neutrons. The incorporation of a proton into a nucleus would in many cases change an

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atom of a known element into one of the following elements. For instance, beryllium of mass 9 would change into boron of mass 10, boron 11 would change into carbon 12. The introduction of a neutron would change an atom into an isotope of the same element, but with atomic weight greater by one, as for example, lithium 6 to lithium 7 and boron 10 to boron 11. By alternation of these processes the heavy elements might be built up, step by step.

1/130 of Mass Lost

The important feature of this process from the standpoint of keeping the stars stoked is that when a proton or hydrogen atomic heart is built into a heavier element, about 1/130 of its mass disappears and must be represented by heat liberated in the process. This is the loss of mass that has caused physicists to say that there is enough energy in a spoonful of water to run a liner across the Atlantic. Building in a neutron probably liberates heat in the same way.

"At distances greater than 1/1000 of the outer diameter of an atom," Prof. Russell explained, "protons and nuclei repel one another. A fast moving proton, rushing directly at a nucleus might, however, get so near it that attraction succeeded repulsion, and thus penetrate the nucleus and be- (*Turn to page* 12)

NUTRITION

Artificial Feeding Keeps Up Weight of New-Born Babies

A SOLUTION of dextrose or grape sugar, gelatin and common salt has been successfully used in combatting birth shock and keeping down to a minimum the weight usually lost by new-born babies, Dr. I. Newton Kugelmass, New York baby specialist, reported to the American Association for the Advancement of Science.

Studies of animals and of primitive tribes of men have convinced Dr. Kugelmass that the customary loss of weight in civilized babies just after birth is neither necessary nor normal. He criticized the usual modern practice of awaiting an ample food supply from the mother before feeding the new baby, and declared that the consequence is an initial period of starvation.

The birth mechanism produces the condition that he calls birth shock, he explained. New-born babies show all the characteristic signs and symptoms of shock, including low blood pressure, low blood sugar, sleepiness, stupor and lack of appetite. Refusing to accept these as normal, Dr. Kugelmass devised the gelatin-sugar-salt solution which he gives every two hours for the first 24 hours beginning immediately after birth. He finds it better than artificial feeding during the first two days of life and although it contains less calories than such feedings, it nevertheless reduces the loss of weight to the irreducible minimum of less than two per cent.

Science News Letter, January 7, 1933

GENERAL SCIENCE

American Association Elects New Permanent Secretary

AT THE MEETING of the American Association for the Advancement of Science in Atlantic City, Prof. Henry B. Ward of the University of Illinois was elected permanent secretary, to succeed Dr. Charles F. Roos, resigned. Prof. Ward is a veteran among American zoologists, and has (*Turn Page*)

PROF. HENRY B. WARD

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)