

COSMOLOGY

Universe Pulsating in Cycles Seen by American Scientist

Theory may End Present Dilemma Caused by Discovery That Gigantic Nebulae Rush Outward at Explosive Rates

LIKE a toy balloon that a child blows up and deflates, the universe may be expanding and contracting in cycles of many millions of years without running the risk of a death from reaching a dead-still level of energy.

This possibility is held forth by studies on model mathematical universes reported by Dr. Richard C. Tolman of the California Institute of Technology to the National Academy of Sciences, meeting at Yale University.

Dr. Tolman's study of the pulsating behavior of models of the universe may help astronomers and physicists out of their present dilemma, caused by the discovery that the gigantic nebulae are rushing outward at explosive rates.

Use Energy and Have It Too

In the relativistic cosmos that best fits space and time outside our own little corner of the universe, Dr. Tolman finds that it is possible, as it were, to use energy and have it too.

The time-honored conception of energy running downhill, known as the second law of thermodynamics or the conservation of energy, which is law in our ordinary physical world, is so changed in the relativistic thermodynamics that a model universe could expand and contract over and over without arriving at the point where there is no more energy to use.

Painting in mathematical equations pictures of several ideal universes, Dr. Tolman finds that in these active evolving cosmogonies light, heat and other radiations would flow out in space, and matter would be annihilated, just as we see in our actual universe; yet these events which we consider quite final and irreversible are capable of being repeated again and again when viewed from the standpoint of the relativity theory.

Prof. Albert Einstein's most recent model of the universe would also expand and contract, Dr. Tolman concluded. Prof. Einstein now abandons his earlier idea of a static cosmos filled with matter in favor of a non-static

universe, matter-filled but without light or other radiation.

Although even the mathematical physicist has difficulty visualizing the most plausible conception of the actual universe, Dr. Tolman uses the analogy of a balloon, of which all we can observe is its outside. A two-dimensional creature living on the skin of the balloon, playfully blown up by some childish *deus ex machina*, would see portions of his little Flatland circle of influence rushing outward, just as astronomers observe the great stellar aggregations of the heavens travelling away from us. He would feel that his cosmos was going to a perdition of expended energy. He would be wrong, as he would discover if air were let out of his balloon. Universe probes like Dr. Tolman are, through their formulae, attempting to see inside the balloon of our own existing universe, and in order to do so they are continually building models which they know are not true pictures, but useful simplified futuristic drawings.

Such models of the universe, including those of Dr. Tolman, assume that space-time outside the reach of telescopes is much the same as that in the small samples that astronomers can see.

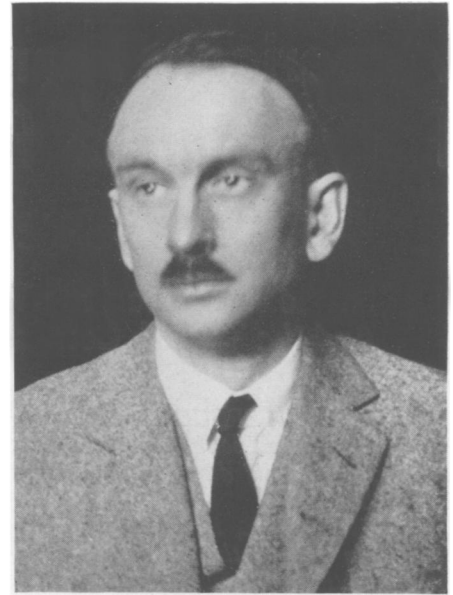
PHYSIOLOGY

Discovery Made that Liver Conserves Heat of Body

A NEW function of the liver, that of saving heat when the body is chilled or at the onset of fever, has been discovered by Dr. Henry G. Barbour of Yale University who reported his work to the National Academy of Sciences.

"The onset of fever resembles the reaction of the body to cold," Dr. Barbour explained. "The shivering or 'chill' produces extra heat and this heat is saved by withdrawal of most of the surface circulation."

Dr. Barbour found that when fever



DR. RICHARD C. TOLMAN

Of the California Institute of Technology who paints pictures of the universe in mathematical equations.

But it may be that the balloon of the actual universe is distorted into some queer form which we cannot yet know or express in mathematical formulae.

All of these models of the universe that mathematical physicists have created in the hope of explaining some phases of the actual universe are based on the assumption that matter is evenly distributed throughout space. But Dr. Harlow Shapley of Harvard College Observatory and his associates have found that the galaxies that dot the skies as spiral nebulae are not uniformly distributed in the heavens.

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is produced, the blood becomes more concentrated and loses part of its water content. At the same time, he found that the water content of the liver was increased. Since the chief way in which the body loses heat and becomes cool is by evaporation of water, as in sweating, he reasoned that the liver takes up the water lost by the blood at the start of fever, and thus saves heat for the body by preventing heat loss through water loss and evaporation.

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