

trons are travelling too fast—actually about 30,000 to 100,000 kilometers per second. Brüche and his colleague Mayer decided that if only slow electrons were used under the same circumstances the deflection by the earth's magnetism would be big enough to be seen. This proved to be the case. Using only 200 volts instead of 2,000 volts, electrons of 8,500 kilometers per second were found to be bent towards the east nearly half an inch from their true course. Thus the electron-compass points to the east instead of to the north like the magnetic compass.

A great advantage of the new compass is that the electrons are without inertia and therefore show changes in direction instantaneously. An ordinary magnetic needle, because of its massiveness, takes a definite time to respond to changes in the magnetic force imposed upon it.

On the other hand the position of the glowing spot on the fluorescent screen is difficult to read and the batteries for heating the cathode and speeding up the electrons make the compass as a whole too heavy, in fact about 33 pounds. The invention is still in the stage of development.

*Science News Letter, June 20, 1931*

## SEISMOLOGY

## New Seismograph Records Earthquakes Beneath It

**A** SEISMOGRAPH designed especially for the job of recording an earthquake going on right underneath it was described before the meeting of the eastern section of the Seismological Society of America at Columbia, S. C., last week, by Arthur J. Weed of the University of Virginia. An instrument of this kind has been long desired by students of earthquakes, because all the existing types of seismographs are designed more for the detection of earthquakes occurring at long distances, and are so delicate that if a quake occurs near at hand their records go clear off the paper; or the instrument may be wrecked outright. They are also usually very costly.

What was wanted was a less sensitive instrument, costing not more than \$50, which would automatically start its record as soon as a strong earth motion disturbed it and keep going for a few minutes, registering amplitude and direction of each movement. These requirements, Mr. Weed stated, are met in the instrument he demonstrated before the society.

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## ASTRONOMY-PHYSICS

# Death of Universe Required by Physical Law May be Avoided

## Prof. Tolman Explains a Mathematical Universe Which Reverses the Belief That the World is Running Down

**T**HE UNIVERSE may be immortal. The universal truth of one of the greatest laws of all physics, the second law of thermodynamics which requires a dying universe, was seriously questioned by Prof. Richard Tolman of the California Institute of Technology before the American Association for the Advancement of Science at Pasadena.

This law, invulnerable since it was formulated by the great physicists of the last century, Clausius and Kelvin, leaves no escape from the conclusion that the universe must eventually cool down and all its motions slow up until a meaningless inactivity pervades everything. Prof. Tolman, by a detailed analysis, has shown a way out from this unattractive conclusion, which heretofore has been criticized only on the vaguest grounds.

Prof. Tolman has reached this result by incorporating the principles of the relativity theory in classical thermodynamics. It is made all the more acceptable by the fact that his reasoning gives an explanation for one of the greatest of modern astronomical mysteries: the fact that the universe is apparently bursting apart at a tremendous rate.

Prof. Tolman begins by setting up a hypothetical simplified universe of his own, whose behavior he can study with some certainty. He finds that in it an observer provided with a rigid meter stick for making measurements, would make certain deductions about

that part of the phantom universe in which he found himself, but these would be quite wrong for the universe as a whole. Dr. Tolman believes that this is just what may be happening to our scientific men, who, after all, can study only a small part of the whole universe at one time.

### A Simple Universe

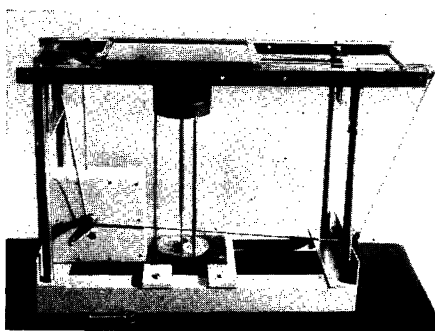
Prof. Tolman's universe is a very simple one in which only a mathematician would be happy. It is filled evenly with a mixture of gas and radiation—something very different from the universe as astronomers know it and yet useful for certain scientific purposes.

The hypothetical observer would conclude that the "entropy" or mixed-upness of his universe was increasing and yet the entropy of the universe would actually be constant, taken as a whole. He would also find that matter in this region was being annihilated, that the energy and temperature of the region was dropping, and that radiation was flowing out of the region into surrounding space, which would thus appear to be at a lower temperature than the material in his own vicinity. It is from just these facts that scientists at present draw their pessimistic conclusions as to the fate of our world.

However, from the standpoint of the relativistic thermodynamics invented by Prof. Tolman himself, all the processes in such a hypothetical system would be taking place reversibly without increase in entropy and no final dissipation of energy would occur within it.

Such a universe, said Prof. Tolman, would continuously expand by the transformation of matter into radiation. As a matter of fact our own universe appears to be doing just this. The distant nebulae are rushing away from us at tremendous speeds and thus the real universe is constantly expanding. This conclusion has been drawn by Dr. Edwin P. Hubble of the Mount Wilson Observatory as a result of the red shift observed in the spectra of light received from these distant outposts of space.

*Science News Letter, June 20, 1931*



**WHEN THE EARTH SHAKES**  
—directly underneath this new seismograph, it will write a record of the occurrence on a moving paper strip.