## Science and Philosophy

**Philosophy and our notions of the world around us are being modified by the recent revolutionary progress of the new physics. The latest impacts of science upon modern thought are explained by Sir Arthur Eddington, just arrived in the United States to visit American Universities. *(See also SNL, April 21, 1934.)***

tions. Basing the statement on the rate of occurrence observed in the past, we may predict that in the next thousand years there will be approximately a certain number of eclipses of the sun. This will not state the exact time of these eclipses but only the number. Here we have an example of statistical method. Or we can state the exact time of the next eclipse, basing the statement on astronomical laws of cause and effect, or classical law. Modern science does not invalidate this second calculation but merely considers its accuracy is the result of the large number of units with which it deals, making the probability of error so slight as to be negligible.

In the second illustration, applying the same reasoning to radioactive atoms, where the number of units involved is extremely small, statistical law holds, but classical law does not, for the number of explosions of such an atom in a given time can be determined but the exact time of any one explosion can not.

### Atoms Have Free Will

Science at present holds that the impossibility of predicting events of this kind is due not to any inadequacy of method of measurement but to an inherent quality of the atom itself, i. e., that atoms have free will. But to jump to the conclusion that free will is therefore possible for the individual is prevented by the fact that indeterminancy is present only when extremely small units are observed, so small that it is unlikely that the action of such small units could be responsible for initiating human action.

This change in scientific attitude and method is significant, however, since it admits the scientific possibility of free will, whereas classical theory absolutely prohibits such a possibility.

### New Maxim

"Never believe an experiment until it is checked by theory."

Sir Arthur Eddington would add this maxim to rules for science's guidance.

Theory and experiment must evolve together, he told University of Chicago scientists when he discussed the latest theories of the expanding universe.

Sir Arthur told the story of the expanding universe, which fills scientists with wonder and doubt. He went far in dispelling the doubts but at the same time retained the characteristic awe. Doubts arise over the statement that the galaxies are receding with velocities proportional to their distances from us.

Velocities are determined from the Doppler effect, in this case the shifting of the spectrum lines to the red—the more distant galaxies having the greater shift. Distances are obtained from the period in the luminosity of Cepheid variables by a relationship between this period and their distance. This relationship has been checked for nearer Cepheid variables.

### De Sitter's Theory

In 1917 Prof. Willem De Sitter, the Dutch scientist, brought forward a theory of the expanding universe which required this relationship between distance and velocity, but at that time the supporting evidence was meager; however since then a great deal of additional evidence has been accumulated. For galaxies 1,500,000,000 light years distant their velocities of recession are of the order of 15,000 miles per second.

What happens then with galaxies that might be so far distant that their velocity of recession should be greater than the velocity of light? Profs. Albert Einstein and Hermann Weyl surmounted this difficulty, which would contradict the fundamental basis of relativity, by assuming a closed curved space. This spherical space is such that it would take light approximately 6,000,000,000 years to come back to its starting point. If we intend to make this trip we should commence immediately as the space itself is expanding!

This mathematical curved space must be equivalent to a force of repulsion which force is causing the expansion. According to Newton, gravitational forces of attraction are exerted between objects, and these forces also must be taken into account but their magnitudes are negligible except when the distances between the objects are relatively small.

In the beginning of things, Sir Arthur believes that matter was so distributed that these forces of Newtonian attraction and cosmical repulsion balanced one another, the equilibrium however being unstable. In our own solar system where distances are relatively small the Newtonian attraction has the upper hand, whereas for the galaxies the cosmical repulsion predominates and such types of equilibrium are stable. Why one or the other took precedence it is impossible to say at present.

From astronomical data the total amount of matter in the universe is $10^{22}$ times the mass of the sun, or $10^{79}$ protons and electrons. The universe thus consists of 10,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000 particles. This figure should be fairly secure because of the difficulty of checking it, but Sir Arthur thinks that it can be checked from the wave mechanics of an electron.

The wave equation for an electron gives a relation between the size of an electron and the universe, is it not somehow possible to reverse this equation and get a relation which will tell the behavior of the universe in terms of an electron? This relation should somewhere hide the number $10^{79}$, and then would form one of the main pillars of science.

*Science News Letter, April 28, 1934*

PHYSIOLOGY

## Nerves Act Gland-Fashion In Causing Color Changes

WHEN A FISH changes its color, as some fishes do, becoming darker or lighter according to background, the color change is impelled by a gland-like action of the nerve ends, secreting a substance called a "neurohumor." So Prof. G. H. Parker of Harvard University told the American Philosophical Society.

Prof. Parker has given much attention to this long-suspected but only recently demonstrated gland-like activity of nerve endings. In the case of the color-changes in fish, he found that there are two opposing neurohumors at work. One set of nerves secretes a neurohumor that causes the color bodies, or melanophores, to spread their pigment through their cell processes, and the neurohumor from a second set of nerves causes them to concentrate.

*Science News Letter, April 28, 1934*

Two trees of the big South African lemon, which yields a pint of juice, are now bearing fruit at the University of California's Citrus Experiment Station.