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COSMIC-RAY LIGHT ON NUCLEAR PHYSICS[1]

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(1) ENERGY RELATIONS COMPATIBLE WITH ASTON'S CURVE

IT was Aston's success in 1927 in measuring with his isotope method the exact masses of most of the elements and then in plotting a smooth curve connecting the mass of the hydrogen atom as it appeared in each element against the atomic weight that first gave us a quantitative, thermodynamic way of getting definite information about nuclear transformations. For if the mass-energy equation of Einstein, $E = mc^2$ (1905), was a valid generalization—and every week is now adding new proof of its validity—it and Aston's curve together told at once what kind of nuclear transformations were possible and what impossible among the 92 elements which make up the entire physical world as we now know it. Cameron and I then first tested whether this method would predict correctly the observed release of energy in known radioactive transformations, and its success in so doing[2] at once emboldened us to try to use it for the interpretation of the banded structure of the cosmic rays brought sharply to light by our 1925 and 1927 and 1928 studies of the absorptive characteristics of these rays as a function of depth beneath the surface of the atmosphere. These measurements, carried out in deep mountain lakes, extended from about 8 equivalent meters of water beneath the top of the atmosphere to 80 meters, and could only be interpreted as due to three or more cosmic-ray bands, to the absorption coefficients of which per meter of water we had given at that time the values .35, .08, .04 and .02, respectively,[3] though we pointed out with great care

[1] Address delivered at the "Century of Progress" meeting of the American Association for the Advancement of Science held in Chicago on the evening of June 21, 1933. It immediately followed Dr. F. W. Aston's address on "The Story of the Isotopes," SCIENCE, 78: 5, 1933.

[2] Millikan and Cameron, *Phys. Rev.*, 32: 537, 1928.

[3] Millikan and Cameron, *Phys. Rev.*, 31: 929, 1928, and 32: 548, 1928.