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THE STRUCTURE OF THE UNIVERSE[1]

THE phrase, "the structure of the universe," is apt to bring to mind only the great and majestic forms which are revealed to us by the telescope, the stars, nebulæ and galaxies. In the present discussion however I wish to include in one view the entire range of physical things from the infinitesimal to the infinite; for to the mathematician there is no such thing as absolute size—a thing is either large or small only by comparison.

Up to the present time we have succeeded in extending our vision equally, so to speak, in both directions. We find ourselves almost midway in a series of physical units. On the one side we have the electrons, atoms and molecules, and on the other we have the ordinary masses, stars and galaxies. The galaxies are more or less definite aggregations of stars. The stars are amazingly great organizations of hot gases. The gases in turn are resolved into their constituent molecules; the molecules yield up their atoms, and finally we find that the atoms are built up of two kinds of electrons. Each physical unit is analyzed into units of the next lower order, and synthesized into those of the next higher order. Each unit is an organization endowed with the proper amount of energy to carry on its existence and to insure its identity.

Our direct vision is bounded on the one side by the electrons and on the other side by the galaxies. But the common properties of energy and organization lead us naturally to imagine that the electrons in their turn are organizations of still smaller units, let us call them sub-electrons; and the sub-electrons are organizations of still smaller units, and so on, ad infinitum. Turning to the other end of the series we can fancy that there are organ-

[1] Read before the Chicago chapter of the Sigma Xi, March 11, 1920.