

**ELECTRICITY AND
MATTER.
WITH DIAGRAMS**

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Electricity and Matter. With Diagrams by J. J. Thomson

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J. J. THOMSON

**ELECTRICITY AND
MATTER.
WITH DIAGRAMS**

YALE UNIVERSITY
MRS. HEPSA ELY SILLIMAN MEMORIAL LECTURES

ELECTRICITY AND MATTER

ELECTRICITY AND MATTER

BY

J. J. THOMSON, D.Sc., LL.D., Ph.D., F.R.S.

FELLOW OF TRINITY COLLEGE, CAMBRIDGE; CAVENDISH
PROFESSOR OF EXPERIMENTAL PHYSICS, CAMBRIDGE

WITH DIAGRAMS



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THE SILLIMAN FOUNDATION.

In the year 1883 a legacy of eighty thousand dollars was left to the President and Fellows of Yale College in the city of New Haven, to be held in trust, as a gift from her children, in memory of their beloved and honored mother Mrs. Hepsa Ely Silliman.

On this foundation Yale College was requested and directed to establish an annual course of lectures designed to illustrate the presence and providence, the wisdom and goodness of God, as manifested in the natural and moral world. These were to be designated as the Mrs. Hepsa Ely Silliman Memorial Lectures. It was the belief of the testator that any orderly presentation of the facts of nature or history contributed to the end of this foundation more effectively than any attempt to emphasize the elements of doctrine or of creed; and he therefore provided that lectures on dogmatic or polemical theology should be excluded from the scope of this foundation, and that the subjects should be selected rather from the domains of natural science and history, giving special prominence to astronomy, chemistry, geology, and anatomy.

It was further directed that each annual course should be made the basis of a volume to form part of a series constituting a memorial to Mrs. Silliman. The memorial fund came into the possession of the Corporation of Yale University in the year 1902; and the present volume constitutes the first of the series of memorial lectures.

PREFACE

In these Lectures given at Yale University in May, 1903, I have attempted to discuss the bearing of the recent advances made in Electrical Science on our views of the Constitution of Matter and the Nature of Electricity; two questions which are probably so intimately connected, that the solution of the one would supply that of the other. A characteristic feature of recent Electrical Researches, such as the study and discovery of Cathode and Röntgen Rays and Radio-active Substances, has been the very especial degree in which they have involved the relation between Matter and Electricity.

In choosing a subject for the Silliman Lectures, it seemed to me that a consideration of the bearing of recent work on this relationship might be suitable, especially as such a discussion suggests multitudes of questions which would furnish admirable subjects for further investigation by some of my hearers.

Cambridge, Aug., 1903.

J. J. THOMSON.

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ELECTRICITY AND MATTER

CHAPTER I

REPRESENTATION OF THE ELECTRIC FIELD BY LINES OF FORCE

My object in these lectures is to put before you in as simple and untechnical a manner as I can some views as to the nature of electricity, of the processes going on in the electric field, and of the connection between electrical and ordinary matter which have been suggested by the results of recent investigations.

The progress of electrical science has been greatly promoted by speculations as to the nature of electricity. Indeed, it is hardly possible to overestimate the services rendered by two theories as old almost as the science itself; I mean the theories known as the two- and the one-fluid theories of electricity.

The two-fluid theory explains the phenomena of electro-statics by supposing that in the universe there are two fluids, uncreatable and indestruc-

tible, whose presence gives rise to electrical effects; one of these fluids is called positive, the other negative electricity, and electrical phenomena are explained by ascribing to the fluids the following properties. The particles of the positive fluid repel each other with forces varying inversely as the square of the distance between them, as do also the particles of the negative fluid; on the other hand, the particles of the positive fluid attract those of the negative fluid. The attraction between two charges, m and m' , of opposite signs are in one form of the theory supposed to be exactly equal to the repulsion between two charges, m and m' of the same sign, placed in the same position as the previous charges. In another development of the theory the attraction is supposed to slightly exceed the repulsion, so as to afford a basis for the explanation of gravitation.

The fluids are supposed to be exceedingly mobile and able to pass with great ease through conductors. The state of electrification of a body is determined by the *difference* between the quantities of the two electric fluids contained by it; if it contains more positive fluid than negative it is positively electrified, if it contains equal quantities it is uncharged. Since the fluids are uncreatable