

*Electrohydrodynamics I.*  
*The Equilibrium of a Charged Gas*  
*in a Container*

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*Summary.* The equilibrium of a uniformly charged gas in a perfectly conducting container is studied. Equilibrium occurs when the electric forces in the gas just balance the pressure forces. It is found that for any container and for each total mass of gas there is exactly one equilibrium distribution of that mass of gas in the container. In equilibrium the density and pressure attain their maxima at the container surface, and they are both constant on this surface. Furthermore, the density and pressure increase at each point as the total mass of gas increases. However, inside the container the density and pressure do not increase indefinitely as the total mass of gas does. Instead at each inner point the density and pressure both approach finite upper limits as the total mass of gas becomes infinite. Most of the gas accumulates in a thin layer near the surface when the total mass is large. The fact that the density and pressure cannot be made arbitrarily large at inner points by putting more gas into the container is considered to be the main physically interesting result.

1. **Introduction.** By 'electrohydrodynamics' we mean the science of the motions of fluids under the influence of electric fields. Such motions occur in vacuum tubes, where the fluid is an electron gas, in plasmas where the fluid is a neutral mixture of ions, in the ionosphere, *etc.* Whereas most previous studies of these motions have been based upon kinetic theory, the present investigation is completely macroscopic. The fluid is treated as a continuum, and this makes it possible to deal with more general fluids and to obtain more complete results.

In this article we consider the equilibrium of a mass  $M$  of uniformly charged gas (*e.g.*, an electron gas) within a container. If the gas had no pressure, we should conclude that all the charge would come to rest on the container wall, due to the mutual repulsion of the charges constituting the gas. However when