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Author	飯吉, 厚夫(Iiyoshi, Atsuo)
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Strong Shock Waves in the Electromagnetic Shock Tube

Atsuo IIYOSHI*

The strong shock waves such as produced in the electromagnetic shock tubes were studied experimentally and theoretically.

In the first part, the shock waves were observed with a rotaing camera, a photomultiprier and a piezo electric probe. Shock speeds were found to be in proportion to a factor $V/\sqrt{p_0}$ within the observed ranges of initial pressure (p_0) from 0.1 to 10 mmHg and of dischage voltage from 5 to 25 KV. This results agreed qualitatively with those of a simple analytical consideration based on a pinch expansion model. It was shown that behind a typical strong shock wave gas was partially dissociated and ionized, but it was practically observed as a local luminous region (radiation overshoot phenomenon). This radiation overshoot was also found to be mainly caused by radiation cooling.

In the second part, a unified theoretical analysis on the strong shock wave in Argon accompanying ionization phenomena were presented. In the relaxation phenomena accompanying dissociation and ionization, a considerable duration of time is required until the equilibrium is attained, and thus the shock front has certain thickness in strong contrast to the weak shock front which is taken mathematically as a discontinuous surface in the ordinary shock theory. The equilibrium state hehind the shock wave was examined numerically on the basis of Saha's equation and the Rankine-Hugoniot relations which was modified to ionized gases. Further, the analysis of the inner structure of the shock front were carried out taking account of the kinetics of the approach to equilibrium of ionization, which showed that atom temperature was higher than electron temperature in the relaxation region and the relaxation time was very sensitive to the electron temperature.

*飯 吉 厚 夫