

# *On Magnetohydrodynamic Shock Waves*

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**1. Introduction.** In the earlier attempts at finding the jump conditions across a hydromagnetic shock wave [1, 2, 3] various simplifying assumptions regarding the shape of the shock and the dimensions and the character of the motion are made. From that analysis it is possible to write down the jump conditions in a higher degree of generality [4].

The shock conditions for magnetohydrodynamic flows can, however, be derived in their full generality with the help of the transport equation as used by THOMAS [5] in the derivation of shock conditions in conventional gas dynamics.

The purposes of this paper are:

- (a) To derive the shock conditions by extending THOMAS's analysis to cover the present more general case.
- (b) To rearrange the results in such a way that every flow and field quantity downstream from the shock wave is expressible separately in terms of the known values of these quantities upstream from the shock wave. In this rearranged form of the equations, various effects of the shock wave can be easily read off.
- (c) To discuss the differential effects of the shock conditions along the same lines as in conventional gas dynamics [6, 7, 8, 9, 10].

It is found that in principle the differential effects of the shock conditions can be discussed in their full generality as in gas dynamics [10] but the algebra becomes very involved. The complete discussion is therefore limited to the unsteady plane flows. It is further assumed that the magnetic field lies in the direction normal to the plane of the flow. The equations governing the flow and field, as well as the shock conditions, then take a relatively simpler form. This enables us to obtain the jumps in vorticity, the gradients of all the flow and field quantities, and the jump in current density. For the sake of simplicity we assume the flow and field upstream from the shock wave are uniform.

It is further assumed, as is usual, that the dissipative mechanisms, such as viscosity, thermal conductivity and electrical resistance, are absent.

**2. Equations of motion.** The equations governing the coupled motion of magnetohydrodynamics under the aforementioned assumptions are [11]