Preface

The present thesis on the topic "Study of Magnetohydrodynamics Shock Waves in Gases" submitted for the award of Ph. D. degree in Mathematics/Science Faculty, VBS Purvanchal University, Jaunpur is a bonafide research work carried out by me under the guidance of Dr. Nand Lal Singh, ex-Reader, Head Mathematics Department, T. D. Postgraduate College, Jaunpur. The thesis consist of six chapters, each followed by the comprehensive upto-date references.

In chapter – I, the general introduction of the subject matter is given. Shock wave is a type of propagating disturbances, which carries energy and passes through a medium (solid, liquid or plasma) or in some cases in the absence of material medium, through a field such as the electromagnetic field. There are different types of shock waves. (i) A moving shock wave propagates into a stationary medium. The gas ahead of the shock front is stationary and the gas behind it is supersonic in the laboratory frame. The shock propagates with a wavefront which is normal to the flow direction. (ii) A detonation wave is essentially a shock supported by a trailing exothermal reaction. (iii) Detached shocks are curved in nature and form a small disturbance in front of the body. (iv) The attached shock appears as "attached" to the tip of a sharp body moving at supersonic speed. (v) The shock in a pipe appears when a supersonic flow in a pipe is decelerated.

MHD shock Wave : If a conducting fluid moves in a magnetic field, electric fields are induced and electric currents flow. The magnetic field exerts forces on these currents which considerably modify the flow. The study of MHD shock wave was systematically begun in the year 1950 with the paper of Hoffman and Taylor, (MHD shocks, Physics Review, Vol. 80, pp 692 - 703). The basic properties of MHD shock waves, as determined by the conservation laws have been developed further by different authors. The differential effects of shock front on the rear flow field have been investigated. A considerable amount of work has also been done on the shock structure.

In II chapter, we have studied the propagation of cylindrical imploding shock wave in magnetogasdynamics. Assuming a single imploding strong cylindrical shock till collapse along axis of symmetry and moving in a continuum medium, many authors have obtained a solution of gas dynamics equations in cylindrical symmetry and have analysed the problem of implosive shocks in detail. By considering axially symmetric implosion model, the effect of MHD implosive shock on flow pattern has been discussed. We have seen that for a particular value of γ (= 0), the magnetic field is maximum behind shock only at the point where gas dynamic pressure attains its maximum. The value of self similarity exponent remains unaltered and for this value of γ, interaction of magnetic field with other flow variables has no impact on the position of maximum pressure and gas dynamic behavior as if no magnetic field were present.

Chapter – III is devoted to the study of "propagation of diverging spherical shock wave in a self gravitating gas". The shock waves produced due to the explosion or implosion in the presence of magnetic field have received much attention in the past decades. Many authors have derived the numerical estimate for shock velocity relation in analytical way. In this study we have derived the expressions representing the velocity of a spherical shock wave propagating through an exponential atmosphere due to its own gravitation for weak and strong cases. It is observed that, for the given initial condition, the shock velocity increases with propagation distance γ in case of weak shock, whereas for strong shock it decreases.

In chapter – IV, we have studied "effect of overtaking disturbances on the motion of diverging MHD shock wave in an ideal gas". Effect of overtaking disturbances have been included in CCW (Chester, Chisnell and Whitham) prediction for the motion of diverging plane cylindrical shock waves in an ideal gas in the presence of magnetic field having only constant azimuthal component. It has been found that the dependence of flow variables upon governing parameters remains unchanged even after inclusion of EOD qualitatively. Correction percentage in flow variables have been computed only at permissible shock front locations. Weak and strong cases of shocks are considered. It is very useful to mention that the present analusis serves as description of propagation of plane and cylindrical shock waves in an ideal gas in presence of magnetic field having only constant azimuthal component with better degree of accuracy by applying the correction due to behind the flow to the solutions obtained by CCW method.

In chapter – V, we have "studied the plane MHD shock waves propagation in a self gravitating gas". In this chapter, the propagation of plane shock waves in a self gravitating gas in presence of a magnetic field having only constant axial and azimuthal component of magnetic field, simultaneously, for the two situations, (i) when the shock is weak and (ii) when it is strong, represented by CCW approach, has been better described by taking into account the effect of overtaking disturbances behind the flow on their motion. Expressions for flow variables have been obtained.

In chapter – VI, we have carried out the analysis of conservation laws and the behavior of fast and slow MHD shock waves. As similar to that of gas dynamics, the conservation laws are understood to be the mechanical relation. Disturbance in a small amplitude wave can be identified as the condition for contact discontinuities across which there is no flow of fluid. From the study, it has been concluded that magnetic field strength increases across a fast shock and decreases across a slow shock. Due to the conservation of magnetic flux, the flow and magnetic field are parallel both behind and ahead of the shock.

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