ABSTRACT

It is believed that stars are formed by the gravitational collapse of interstellar clouds, which often have large magnetic field. Because of nearby new born stars, associated emission nebula or other ionising sources, some parts of the gas in the cloud are always ionised. Dusts present in the cloud pick up charges from the plasma environment. Thus, the cloud contains not only the neutral gases and dusts, but also electrons, ions and charged dusts. Therefore, electrostatic forces between different charge species come into existence. The aim of this thesis is to study the effects of the electrostatic forces in star formation process in molecular cloud. ‘Star formation’ is the early phase of evolution of a star. The effects of electrostatic forces in Jeans instability of self gravitating dusty plasma system (which prevails in a molecular cloud where star formation can take place) are studied in this thesis. The neutral drag effect on the charged dust grains is then included for a more complete analysis. To study the simultaneous effect of the magnetic field and the electric field, a magnetised dusty plasma is considered, containing electrons, ions, charged dust grains, neutral dust grains and neutral gases. Finally the frozen-in condition
of charge species in the magnetic field is derived and the magnetic flux leakage time is determined.

Different chapters are organised as given below:

The first chapter deals with the basics of star formation processes in molecular cloud. It contains the necessary background required for the particular field of study.

The second chapter contains the survey of literature. This chapter discusses the work done by different researchers which are available in journals and advanced level books in this particular field. This chapter justifies the necessity of the study of the electrostatic effects of charged dust grains in star formation process in interstellar cloud.

The third chapter contains study of Jeans instability in a partially charged dust mass which prevails in a star forming cloud. The dynamics of various components, e.g., electrons, ions, neutral gas, neutral dust grains and charged dust grains is studied under the influence of electrostatic force besides gravitational force and thermal pressure approximating the ion and electron distribution to be Boltzmannian. Considering Jeans swindle as a local approximation and a perturba-
tion of the form \( f \sim \exp(ik - i\omega) \), a dispersion relation is derived for the fluctuation. The dispersion relation is solved analytically and different modes are explained with reference to star formation in such clouds.

The fourth chapter deals with the study of the neutral drag force on charged dust grains in the star forming cloud. Here, considering a molecular cloud, with ions, electrons, charged dust grains, neutral dust grains and neutral gases, the dispersion relation for the fluctuation under influence of the force of gravity, gas pressure, electrostatic force and neutral drag force, is derived. In realistic situation with all these forces, the Boltzmannian approximation for electrons and ions may not be always justified. Therefore, to include the neutral background resistance (drag) during the gravitational collapse of the weakly ionised dusty plasma, the distribution for electrons and ions is calculated which is non-Boltzmannian. The equations of motion of different species of the multi fluid plasma are linearised by assuming the perturbation (fluctuation) response in radial direction as a mathematical analogue of x-direction in plane geometry approximation in the form \( f \sim \exp(ikx - i\omega t) \). Jeans swindle is used as a local approximation for the equilibrium and the usual normal mode analysis is done to derive the dispersion relation. An analytical solution to the
dispersion equation is given with an explanation of the effects on star formation.

In the fifth chapter, the neutral drag effect in a partially charged magnetised multi-fluid plasma is discussed. This chapter deals with the statistics followed by electrons and ions on the basis of neutral drag force and magnetic force on them along with the other usual gravitational and thermal forces. This distribution is again non-Boltzmannian like the distribution that was derived in the fourth chapter. The magnetic field enters in calculations through the Larmour gyromagnetic frequency of different charge species in the multi-fluid plasma. The equations of motion for different species are considered for a partially charged dusty plasma of multi-fluid where along with the usual gravitational, thermal, and frictional dragging forces, there exists Lorentz force. These equations of motion of different species of the multi-fluid plasma are linearised and like the previous chapter an analytical solution to the dispersion equation is given for different situations with an explanation of the effects on star formation.

The sixth chapter deals with the effect of electrostatic forces on the charged particles frozen into the magnetic field present in the cloud. Considering a magnetised molecular cloud of multi-fluid plasma con-
taining electrons, ions, charged dusts, neutral dusts and neutral gases in quasi-static equilibrium the dynamics is studied. From the equations of motion, the condition for attachment of different particles with the magnetic field is determined. The velocity of electron is determined under the influences of above mentioned forces and hence, the magnetic flux leakage time is calculated. A comparison of the velocities of different species with that of electron is made, which gives the frozen-in condition for these species.

Results obtained with discussion on them are included in the seventh chapter.

Finally the references cited and used in the thesis are listed at the end.

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