CHAPTER - I

INTRODUCTION

I. INTRODUCTION :

There are several illustrations of astrophysical systems that enhance the theoretical and observational importance of the study of shearfree fluids. The well known Einstein's static model followed by spatially homogeneous and isotropic Friedmann solutions under the prescribed conditions of state can be characterised by various kinematical conditions that include the case of shearfree fluid (Ellis 1971). According to him the features of Godel model with closed timelike worldlines can be described by the kinematical conditions like $\sigma_{ab}=0$, $\dot{u}_a=0$, $\theta=0$ and $\omega_{ab}\neq 0$. A necessary and sufficient condition for a shearfree perfect fluid to be ≠ rotational is established by Glass (1974). Barnes (1973) with the use of restrictions $\sigma_{ab}=0$, $\omega_{ab}=0$, found a class of solutions of Einstein's field equations which are mainly of Petrov type I, D or O. The investigations of Kransinski (1978) are about the space times filled with perfect fluid satisfying the conditions $\sigma_{ab}=0$, $\theta=0$, $\omega_{ab}\neq 0$. Moreover among the other symmetries , a killing vector is chosen parallel to velocity. Many investigations related to stationary axisymmetric and cylindrically symmetric fluid spacetimes in which the flow is assumed to be rigid ($\sigma_{ab}=0$, $\theta=0$) are discussed by Kramer etal,(1980). By considering shearfree perfect fluid, Barnes (1984) has examined the electrictype and magnetic type components of Weyl tensor. If the Weyl tensor is purely electric type or purely magnetic type, it is shown that the flow vector U_a is necessarily irrotational unless this spacetime has constant curvature. Recently in series of papers, Collins and White (1984 I-1984 II) under the restrictions of rotating shearfree perfect fluid and with the decomposition of Weyl tensor in terms of electric type and magnetic type Weyl tensor, have studied a class of general relativistic models. Further analysis of these solutions show that, in general the spacetimes may be regarded as being locally stationary and axisymmetric, although various specialisation can occur with the most special case being the Godel model.This brief historical reporting of shearfree fluid is supplemented below with some motivating aspects of the study of shearfree fluids.

Motivating Aspects : The study of some above illustrations of shearfree fluids have played a keyrole in the development of general theory of relativity. As far as the applications of shearfree fluids in general relativity are concerned, shearfree solutions will retain the features of isotropy of local motions (Collins,1984). The formulation of a link between the kinematical parameters and the observational aspects has been established by Ellis (1971). According to him the relative motion of galaxies and the relative redshift of galaxies is predictable through the relations involving kinematical parameters. It follows from these relations that the condition $\sigma_{ab}=0$ is the common requirqment for physically reasonable partial isotropy. Thus in general for shearfree motion these are two observationally prefer~ed distinct directions. The nonlinearities of Einstein's field equations may easily be dealt with conditions on kinematical parameters instead of impossing geometrical conditions like isometry. These conditions may provide better informaiton about the evolution of self gravitating fluids governed by Einstein's field equations. Furthermore, as examined by Ellis, the investigations of shearfree perfect fluid flows provide a rather natural counter part to the fairly extensive studies in the case of propagation of null congruences. In connection with relativistic kinematical theory Treciokas and Ellis 1971, have shown for isotropic distribution function, the requirement of Einstein-Boltzmann equations demanding that the shear is zero, expansion is zero, or veroticity is zero. This imparts to the shearfree solutions a special status and provides as a motivation for their further studies.

These above stated reasons have tempted us to investigate shearfree magnetofluid spacetime along with the asymptotic state of the spacetime. We are interested mainly to observe the effects of magnetic fields on the features of the spacetime coupled with the kinematical constraints. The second chapter mainly deals with the kinematical and dynamical aspects of the spacetime filled with the infinitely conducting charged fluid with constant magnetic permeability (magnetofluid). Our main target is to exploit the behavioural aspects of shearfree magnetofluid.

Throughout our dissertation we deal with a 4-dimentional manifold which is time oriented and has the signature -2(-1,-1,-1,+1). The round and square brackets around the suffixes denote symmetrisation and skew symmetrisation respectively. The semicolon is used to denote covariant derivative, whereas comma is used to denote partial derivative.