PREFACE

Eversince Schwarzschild gave in 1916 the first complete solution for the gravitational field of a spherically symmetric static star filled with a perfect fluid of uniform (constant) density and non-uniform pressure surrounded by empty space-time there is a great proliferation of literature on this topic. However, from time to time the motivation for the study of static as well as non-static gravitational fields with spherical symmetry has been different. After the discovery of quasi-stellar radio sources in the early 1960 S and the possibility of formation of spherical black-holes the problem of gravitational collapse assumed added significance. Towards this end and to find the role played by the "free gravitational field" (the conformal Weyl tensor part) during spherical gravitational collapse we have presented in this thesis some new interior solutions. The Chapterwise summary is as below :

In Chapter 1 we have given a brief introduction of the spherically symmetric space-times and explained the concept of energy density of the free gravitational field. The matter fields (perfect fluid) are discussed and using the kinematical quantities the characteristics of gravitational radiation propagating in a perfect fluid medium are explained. The condition for interior Schwarzschild "trapped surfaces"

is obtained. Also, the junction conditions on the surface of a spherical body are given.

Chapter 2 deals with static gaseous spheres obeying the equation of state $p = k(\rho + \epsilon)$. The complete solution for the frozen black-body radiation ($k = 1/3$) has been obtained. In contrast to the B K Z and B K T solution the present analytical solution is valid throughout the sphere and free from singularity at the origin. It is shown that the maximum possible red-shift for this model is 0.415.

In Chapter 3 the free fall collapse (zero acceleration) of a spherical star has been discussed. The role of the energy density of the free gravitational field during collapse has been pointed out. Since the shear of the material congruence and the spatial gradient of energy density ($h^b_a \rho_{,b}$) are non-vanishing, we establish the presence of gravitational radiation in the envelopes of the collapsing spherical star.

Chapter 4 describes the criterion for the existence of interior Schwarzschild trapped surfaces. In analogy with the exterior Schwarzschild solution the roles of the r and t coordinates have been interchanged for this purpose. It is pointedout that the single differential equation which describes the evolution of

the model is similar to that of a non-linear oscillator.

In the final Chapter we have discussed the dynamics of spherical gravitational collapse with escaping neutrinos and pointed out the role of the free gravitational field during collapse. A generalization of the Schwarzschild interior solution with escaping neutrinos was given in a conformally flat coordinate system. It is pointed out that the conformally flat coordinate system resembles that of Kruskal's.