Preface

The present investigations have been carried out towards the fulfillment of the requirements for the award of a Ph.D. degree in Physics of V.B.S. Purvanchal University, Jaunpur (U.P.), India under the supervision of Dr. A.N. Pandey, (ex) Reader and Head, Department of Physics, K.N. Govt. P.G. College Gyanpur, Sant Ravidas Nagar Bhadohi(U.P.) India.

The thesis deals with, "Gravitational Collapse In Higher Dimensional Spacetimes". It has been divided into four chapters. The first chapter is introductory. So, we have formulated and discussed some of the techniques and results which are relevant for our subsequent investigations. Hence, we have presented, inhomogeneous dust, gravitational collapse in higher dimensional spacetime and about a naked singularity.

In chapter II, we have obtained a large family of inhomogeneous non-static spherically symmetric solutions of the Einstein equation for null fluid in higher dimensions. It encompasses higher dimensional versions of many previously known solutions, such as, Vaidya, charged Vaidya and Husain solutions and also some new solutions describing global monopole or string dust. In this way we have presented the general version of the 4-dimensional spherically symmetric solutions describing Type II fluid to (n+2)-dimensional spherically symmetric solutions and essentially retaining their physical behaviour. In particular higher dimensional version of Husain solution that describes gravitational collapse leading to asymptotically flat black hole solutions for $k > 1/n$. The general metric depends upon the parameter k and two arbitrary functions of retarded coordinate u, which are constrained by the energy conditions. Also the long retarded time limit of the asymptotically flat solutions would fall between Schwarzschild and Reissner-Nordstrom solutions. However, it is possible to obtain more exact solutions of the similar kinds by imposing the equation of state $p = k\rho$. The linear combinations of all the cases presented above would also be a solution.

In chapter III, we have investigated gravitational collapse of radiation shells in a non self-similar higher dimensional spherically symmetric spacetime, showing that strong curvature naked singularities form for a highly inhomogeneous collapse, violating the cosmic censorship conjecture. As a special case, we have obtained, self-similar models. The proof and the rigorous formulation for either version of the cosmic censorship conjecture is not yet available. Therefore, examples showing the presence of naked singularities remain important and may be valuable if one attempts to formulate the notion of the conjecture in precise mathematical form. The Vaidya metric in the four-dimensional case has been extensively employed to study the occurrence of naked singularities in spherically symmetric gravitational collapse. We have extended this investigation to a higher dimensional Vaidya metric, and obtained that strong curvature naked singularities appear for slightly higher values of the inhomogeneity parameter and only for mass function $m(v) \sim v^2$. We have checked for naked singularities to be gravitationally strong by the approach given by Clarke and Krolak (1986) and by Nolan (1999) as well, and found that both are in well agreement. In general, the models obtained here are not self-similar, and as a special case the self-similar models are obtained. Now, it is a straight forward to extend the above investigation for non radial causal curves, and to spacetime of any dimensions i.e. $n \geq 4$. Hence, we may say that this study offers a counter example to the cosmic censorship conjecture.

In the last chapter, we have investigated the end state of the gravitational collapse of a null fluid in higher dimensional spacetimes, i.e. higher dimensional

Vaidya spacetimes. Both naked singularities and black holes are shown to be developing as the final outcome of the collapse. It is also presented that the naked singularity spectrum in a collapsing Vaidya four-dimensional spacetime gets covered with the increase in dimensions and hence higher dimensions favours a black hole in comparison to a naked singularity. We have studied the effect of the increase of dimension of the spacetime on the come in picture: first is an increase in inhomogeneity and the other a strengthening of gravitational field. The former favours naked singularity and the latter a black hole. We have obtained that in final analysis the black hole is formed and leads to the shrinkage of the naked singularity. The motivation for higher dimensional study came from the string theory where the effective action involves the dilaton scalar field or antisymmetric tensor field. The dilaton field couples nonminimally to the Ricci curvature. However, it would be trivial in this case, as the scalar curvature vanishes for the Vaidya solution. The case of the antisymetric tensor field would be similar as well. Hence, the results obtained here would also be relevant and valid for effective supergravity theories.

Every chapter has been divided in sections following decimal system: section (1.5) means fifth section of chapter first. On the same line, the equations in different chapters are also numbered i.e. Eq. (4.4) means, fourth equation of chapter four. At last references are given.