

**TATA INSTITUTE OF FUNDAMENTAL RESEARCH**  
**DEPARTMENT OF ASTRONOMY & ASTROPHYSICS**

***ASTRONOMY SEMINAR***

April 5, 2010

Speaker : Mandar Patil  
TIFR-DAA

Title : Dynamics of self-similar massless scalar fields  
in general relativity.

Day, Date & Time : Tuesday, 13 April, 2010 at 16.00 hrs

Venue : Lecture Room (AG-66)

(H.M. Antia)

***Abstract***

*In this talk, we will discuss the dynamics of the self-similar scalar field from the perspective of the gravitational collapse as well as applications in cosmology. I would begin by describing the self-similarity in the general relativity which is the constraint imposed on the spacetime metric in terms of existence of a homothetic killing vector field. We introduce the first and second type of self-similarity and then restrict attention to the self-similarity of the first kind in the spherically symmetric spacetimes for rest of the talk. For the spacetime with massless scalar field as a matter field, I will discuss in detail the three subcases of the self-similarity where homothetic killing vector field is parallel, orthogonal and neither parallel nor orthogonal to the gradient of the scalar field. Nonexistence of the solution to the Einstein equation in the self-similar spacetime with the homothetic vector parallel to the scalar field gradient will be shown. We describe a two-parameter family of solution obtained in the case, when homothetic vector is orthogonal to the scalar field gradient. I shall briefly discuss the salient features of this solution. The relevance of this model from the perspective of the cosmic censorship will be discussed. I will describe the model of the hypothetical exploding star constructed from this solution by C1 matching with Vaidya radiation metric at the surface of the star. I will also touch upon the use of this solution to describe the inhomogeneous cosmological models with interesting features. I will then go over to the case where homothetic killing vector is neither parallel nor orthogonal to the scalar field gradient and explore it from the perspective of the cosmic censorship hypothesis. I will show that unlike the other cases, it is possible to have a regular hypersurface on which one can define the initial data at the onset of the gravitational collapse. Condition for the formation of blackhole or naked singularity as an end state to the continual collapse will also be discussed. Finally we shall conclude the talk with a brief discussion on the possible directions for the future work.*