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ORIGINAL ARTICLE

Nature of singularity formed by the gravitational collapse in Husain space-time with electromagnetic field and scalar field

Ujjal Debnath · Prabir Rudra · Ritabrata Biswas

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Abstract In this work, we have investigated the outcome of gravitational collapse in Husain space-time in the presence of electro-magnetic and a scalar field with potential. In order to study the nature of the singularity, global behavior of radial null geodesics have been taken into account. The nature of singularities formed has been thoroughly studied for all possible variations of the parameters. These choices of parameters has been presented in tabular form in various dimensions. It is seen that irrespective of whatever values of the parameters chosen, the collapse always results in a naked singularity in all dimensions. There is less possibility of formation of a black hole. Hence this work is a significant counterexample of the cosmic censorship hypothesis.

Keywords Gravitational collapse · Electromagnetic field · Naked singularity · Accretion

1 Introduction

When a massive star is on the verge of completing its nuclear cycle, then the thermonuclear reactions in the interior of the star cannot counter balance the immense gravitational pull of the star. Under most general conditions general relativity predicts that such a collapse must end in a singularity, which may or may not be clothed by an event horizon. A singularity may be physically described as a region in the space-time with extreme curvature, vanishing volume and unbounded gravitational forces. However, general relativity remains silent on the nature (BH or NS) or physical properties of such a singularity. This is basically due to the fact that mathematical structure breaks down preventing analysis at and beyond the singularity. This has triggered extensive research on Gravitational collapse during the past few decades. After all one would always like to know whether, and under what conditions gravitational collapse leads to the formation of a black hole (BH). A few decades back Penrose (1969) proposed the cosmic censorship hypothesis (CCH), which states that the singularities formed in gravitational collapse of physically reasonable matter cannot be seen by any distant observer in the universe. It implies that the singularities formed in asymptotically flat space-times are always bounded by event horizons and hence are destined to be black holes. With the announcement of this proposal, study of gravitational collapse has gained special importance, because one would always like to know that whether there exists any physical collapse solutions that lead to naked singularities (NS), which will serve as counterexamples of CCH.

Till date there has been a lot of significant work in gravitational collapse. The pioneering work of gravitational collapse appeared in the famous paper of Oppenheimer and Snyder (1939) in which they studied the gravitational collapse of adiabatically flowing dust. The outcome of the experiment led to the conclusion that the end state of collapse is a BH. Since then extensive research has been carried out to find more generalized results. But it took no less than 30 years since the Oppenheimer-Snyder model that the feasi-

U. Debnath · P. Rudra (✉)
Department of Mathematics, Bengal Engineering and Science University, Shibpur, Howrah 711 103, India
e-mail: prudra.math@gmail.com

U. Debnath
e-mail: ujjaldebnath@yahoo.com

U. Debnath
e-mail: ujjal@iucaa.ernet.in

R. Biswas
Department of Mathematics, Jadavpur University, Kolkata 700 032, India
e-mail: biswas.ritabrata@gmail.com