Astrophys Space Sci
DOI 10.1007/s10509-013-1740-7

ORIGINAL ARTICLE

Collapse and expansion of anisotropic plane symmetric source

G. Abbas

Received: 22 November 2013 / Accepted: 28 November 2013

Abstract This paper deals with the collapse and expansion of relativistic anisotropic self-gravitating source. The field equations for non-radiating and non-static plane symmetric anisotropic source have been evaluated. The non-radiating property of the fluid leads to evaluation of the metric functions. We have classified the dynamical behavior of gravitational source as expansion and collapse. The collapse in this case leads to the final stage without the formation of apparent horizons while such horizons exists in case of spherical anisotropic source. The matching of interior and exterior regions provides the continuity of masses over the boundary surface.

Keywords Anisotropic fluids · Expansion · Gravitational collapse

1 Introduction

Oppenheimer and Snyder (1939) are the pioneers who studied gravitational collapse of dust. This was the special problem because dust was unrealistic matter and one cannot ignore the effects of pressure on singularity formation during gravitational collapse. A more analytic analysis was made by Misner and Sharp (1964) with perfect fluid in the interior region of a star. They formulated the dynamical equations governing adiabatic relativistic collapse. In both cases, vacuum was taken in the exterior region of a star. Also, Misner and Sharp (1965) formulated the problem of collapse for anisotropic fluid. Since then there has been a growing interest to study the gravitational collapse of anisotropic fluid spheres (Herrera et al. 2008a, 2008b). The general solution of anisotropic models has attained a considerable interest in Einstein theory of gravity because of applications to stellar collapse of spheres (Bowers and Liang 1974, Cosenza et al. 1981; Bayin 1982; Sharif and Abbas 2013 and Bondi 1992). Barcelo et al. (2008) have studied the gravitational collapse in semiclassical theory of gravity. They pointed out that in this approach Hawking radiations might prevent the formation of trapped surfaces and apparent horizons. In this way they proposed a new class of collapsing objects with no horizons. Several authors (Nojiri and Odintov 2005, Nojiri et al. 2006, Cognola et al. 2007 and Gasperini and Veneziano 1993) have discussed the anisotropy of dark energy in modified theories of gravity. Also, Herrera and Santos (1997) have investigated the some properties of anisotropic self-gravitating system and determined the stability of the perturbed system. Herrera et al. (2008a) have discussed the possibility of a single generated function, that possibility has been developed in this paper.

The method of generating the gravitational collapse of non-adiabatic collapse was initially developed by the Glass (1981). In this method he used a perfect fluid static or non-static solution of shear-free collapse to a shear-free collapse model with radial heat flow. In a recent paper, the same author (Glass 2013) has constructed a solution of adiabatic anisotropic sphere which leads to either expansion and collapse depending on he choice of initial data. In the present paper, we extend this work to plane symmetric objects. The models exhibiting plane symmetry can be used as test-bed for numerical relativity, quantum gravity and contribute for examining CCH and hoop conjecture among other important issues.

G. Abbas (✉)
Department of Mathematics, COMSATS Institute of Information Technology, Sahiwal 57000, Pakistan
e-mail: ghulamabbas@ciitsahiwal.edu.pk