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Kerr-Newman metric in deSitter background

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Abstract. In addition to the Kerr-Newman metric with cosmological constant several other metrics are presented giving Kerr-Newman type solutions of Einstein-Maxwell field equations in the background of deSitter universe. The electromagnetic field in all the solutions is assumed to be source-free. A new metric of what may be termed as an electrovac rotating deSitter space-time—a space-time devoid of matter but containing source-free electromagnetic field and a null fluid with twisting rays—has been presented. In the absence of the electromagnetic field, our solutions reduce to those discussed by Vaidya.

Keywords. Kerr-Newman metric; deSitter universe; electromagnetic fields.

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1. Introduction

The Kerr-Newman (Newman *et al* 1965) solution is believed to represent the ultimate state of collapsing body with rotation, mass and electric charge. Therefore considerable significance is attached to the Kerr-Newman solution. When the charge is absent, the Kerr-Newman solution reduces to the well-known Kerr solution (Kerr 1963). Patel and Trivedi (1982) considered the Kerr-Newman metric in cosmological background, the background metric being the Robertson-Walker metric. In the absence of the electromagnetic field, their solution reduces to the Vaidya solution (Vaidya 1977) which describes the Kerr metric in the background of the Robertson-Walker universe.

We know that the deSitter metric can be expressed as a particular case of the general Robertson-Walker metric. But the deSitter model has features which are geometrically distinct from those of Robertson-Walker model. Again the simple deSitter metric represents an empty and expanding universe. The deSitter space-time is an immediate generalization of Minkowski flat space-time. These facts inspired Vaidya (1984) to discuss the Kerr metric in the background of deSitter universe. The main purpose of the present article is to obtain the electromagnetic generalizations of the solutions discussed by Vaidya (1984). Our earlier paper (Patel and Trivedi 1982) will be referred to hereafter as I. In this paper we merely report the main results by avoiding the computational details and the lengthy expression for some of the quantities.

In §§ 2 and 3 we use the following Einstein-Maxwell field equations

$$R_{ik}-\tfrac{1}{2}g_{ik}R+\Lambda g_{ik} = -8\pi E_{ik}, \tag{1}$$

$$E_{ik} = -g^{lm}F_{il}F_{km}+\tfrac{1}{4}g_{ik}F_{lm}F^{lm}, \tag{2}$$