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ORIGINAL ARTICLE

Shadow of Kerr-Taub-NUT black hole

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Abstract The shadow of a rotating black hole with nonvanishing gravitomagnetic charge has been studied. It was shown that in addition to the angular momentum of black hole the gravitomagnetic charge term deforms the shape of the black hole shadow. From the numerical results we have obtained that for a given value of the rotation parameter, the presence of a gravitomagnetic charge enlarges the shadow and reduces its deformation with respect to the spacetime without gravitomagnetic charge. Finally we have studied the capture cross section for massive particles by black hole with the nonvanishing gravitomagnetic charge.

Keywords Photon motion · Shadow of Black hole · NUT spacetime

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1 Introduction

At present there is no any observational evidence for the existence of gravitomagnetic monopole, i.e. so-called NUT (Newman et al. 1963) parameter. Therefore study the motion of massless and the massive test particles and particle acceleration mechanisms in NUT spacetime may provide new tool for studying new important general relativistic effects which are associated with nondiagonal components of the metric tensor and have no Newtonian analogues (see, e.g. Nouri-Zonoz 2004; Kagramanova et al. 2008; Morozova and Ahmedov 2009 where solutions for electromagnetic waves and interferometry in spacetime with NUT parameter have been studied). Kerr-Taub-NUT spacetime with Maxwell and dilation fields is investigated by Aliev et al. (2008). In our preceding papers (Morozova et al. 2008; Abdujabbarov et al. 2008) we have studied the plasma magnetosphere around a rotating, magnetized neutron star and charged particle motion around compact objects immersed in external magnetic field in the presence of the NUT parameter. The Penrose process in the spacetime of rotating black hole with nonvanishing gravitomagnetic charge has been considered by Abdujabbarov et al. (2011).

Although a black hole is not visible, it may be observable nonetheless, it casts a shadow if it is in front of a bright background. The apparent shape of an extremely rotating black hole has been first studied by Bardeen (1973), later a Schwarzschild black hole with an accretion disc around it has been visualized by Luminet (1979). Accretion discs around an extremely rotating black hole as viewed from the different angles of latitude have been studied in detail by Quien et al. (1995). Supplementing these numerical approaches, the closed photon orbits in general Kerr-Newman space-times has been analytically studied by de Vries (2000), even in cases where the so-called cosmic censorship is violated.