PRAMANA
—journal of
physics

© Printed in India

Vol. 50, No. 4,
April 1998
pp. 307–314

Schwarzschild black hole with global monopole charge

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MS received 2 September 1997

Abstract. We derive the metric for a Schwarzschild black hole with global monopole charge by relaxing asymptotic flatness of the Schwarzschild field. We then study the effect of global monopole charge on particle orbits and the Hawking radiation. It turns out that existence, boundedness and stability of circular orbits scale up by $(1-8\pi\eta^2)^{-1}$, and the perihelion shift and the light bending by $(1-8\pi\eta^2)^{-3/2}$, while the Hawking temperature scales down by $(1-8\pi\eta^2)^2$ the Schwarzschild values. Here η is the global charge.

Keywords. Black hole; Schwarzschild solution; global monopole; Hawking radiation; particle orbits; topological defect.

PACS Nos 04.20; 14.80; 04.50

1. Introduction

The Schwarzschild solution is the unique spherically symmetric solution of the vacuum Einstein equation. It represents a static black hole. It turns out [1] that a global monopole charge accompanies spontaneous breaking of global 0(3) symmetry into $U(1)$ in phase transitions in the Universe. Putting on global charge to the Schwarzschild black hole will amount to breaking the vacuum and asymptotic flatness of the Schwarzschild spacetime. It still represents a localized object with a horizon. Our main aim in this paper is to study the effect of global monopole charge on particle orbits and the Hawking radiation.

The spacetime of pure global monopole charge, when the Schwarzschild mass vanishes, can be regarded in some sense to be 'minimally' curved for gravitational charge density, $4\pi\rho_c = R_{ik}u^iu^k, u^iu_i = 1$, vanishes. That means the relativistic (active gravitational) mass is zero for the spacetime [2]. All radial trajectories will always remain parallel. Thus introduction of global monopole charge does not significantly alter the nature of the Schwarzschild field. We wish to investigate what effect does its introduction entail on physically measurable quantities. Recently a similar investigation has been carried out for a global monopole in the Kaluza–Klein spacetime [3].

In § 2 we shall briefly outline the derivation of the metric for a static black hole with a global monopole charge followed in § 3 by field theoretic considerations. The effect of