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# Energy and Angular Momentum Flow into a Black Hole

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**Abstract.** The area of the event horizon round a rotating black hole will increase in the presence of a non-axisymmetric or time dependent perturbation. If the perturbation is a matter field, the area increase is related to the fluxes of energy and of angular momentum into the black hole in such a way as to maintain the formula for the area in the Kerr solution. For purely gravitational perturbations one cannot define angular momentum locally but one can use the area increase and the expression for area in terms of mass and angular momentum to calculate the slowing down of a black hole caused by a non-axisymmetric distribution of matter at a distance. It seems that the coupling between the rotation of a black hole and the orbit of a particle going round it can be significant if the angular momentum of the black hole is close to its maximum possible value and if the angular velocity of the particle is nearly equal to that of the black hole.

## I. Introduction

It has recently been shown [1, 2] that a rotating black hole cannot be stationary unless the surrounding space-time is asymmetric about the axis of rotation. This seems to imply that a black hole formed in the presence of non-axisymmetric fields would gradually lose its angular momentum to the sources of these fields and would approach a static, non-rotating state. There is no requirement for a static black hole to be axisymmetric. An estimate of this rotational damping has already been made by Press [3] for the case of a scalar field. He calculated the torque produced on its sources by the scalar field and equated this to the rate of loss of angular momentum of the black hole. In this paper we shall describe a different approach which can be used to determine the rate of loss of angular momentum caused by any matter field such as a scalar or electromagnetic field and also by purely gravitational perturbations produced by a non-axisymmetric distribution of matter at a distance from the black hole. In this approach we take the black hole to be represented by a sequence of Kerr solutions with slowly varying para-

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