SCALAR WAVES IN THE EXTERIOR OF A SCHWARZSCHILD BLACK HOLE

S. PERSIDES
Astronomy Dept., University of Thessaloniki, Thessaloniki, Greece

Abstract. Fourier and Laplace transforms are used to study rigorously the properties of a test scalar field Ψ in the exterior of a Schwarzschild black hole of the mass m. In the Fourier analysis we examine the properties of the solutions of the radial wave equation and the relations of the exterior and interior solutions of the following four cases: (i) $\omega \neq 0$, $m \neq 0$, (ii) $\omega = 0$, $m \neq 0$, (iii) $\omega \neq 0$, $m = 0$, (iv) $\omega = 0$, $m = 0$.

In the Laplace analysis we show rigorously the following theorem: *If* $\Psi(t, r, \theta, \varphi)$ is the field of a point test particle falling into the black hole,

$$[\partial \Psi / \partial t]_{t < t_0} = 0,$$

and $\lim \Psi$ exists, *then* $\lim \Psi = 0$. The proof of this theorem is based on the facts that (a) $t + 2m \ln(r - 2m)$ is finite for the particle even on the horizon, and (b) the behavior of Ψ as $t \to +\infty$ is related to its Laplace transform near the origin of the complex plane.

References

Persides, S.: 1973, *J. Math. Phys.* **14**, 1017.
Persides, S.: 1974, *J. Math. Phys.*, to appear.

C. DeWitt-Morette (ed.), Gravitational Radiation and Gravitational Collapse, 95.