Assignment 4

ID2090 Students

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2.1   Introduction

Hawking radiation is thermal radiation thought to be emitted by black holes due to quantum effects. Black holes are sites of immense gravitational attraction into which surrounding matter is drawn by gravitational forces. by doing a calculation in the framework of quantum field theory in curved spacetimes, Hawking showed that quantum effects allow black holes to emit radiations in a thermal spectrum.

2.2   Equations

A black hole emits thermal radiation at a temperature, $T_H = \frac{\kappa}{2\pi}$, in natural units with G, c,$\hbar$ and κ equal to 1, and where κ is the surface gravity of the horizon.

The radiation from a Schwarzschild black hole is black-body radiation with temperature:

$$T = \frac{\hbar\, c^3}{8\pi G M k}$$

where $\hbar$ is the reduced Planck constant, c is the speed of light, k is the Boltzmann constant, G is the gravitational constant, and M is the mass of the black hole.
The power emitted by a black hole in the form of Hawking radiation can easily be estimated for the simplest case of a nonrotating, non-charged Schwarzschild black hole of mass M:

$$P = \frac{\hbar\, c^6}{15360\,\pi\, G^2 M^2}$$

where P is the energy outflow, $\hbar$ is the reduced Planck constant, c is the speed of light, and G is the gravitational constant.