

Ph 236 – Homework 15

Due: Friday, March 9, 2012

Note: this is a half-homework.

1. Orbits around a Kerr black hole. [18 points]

Write a computer program to plot an orbit around Kerr with a given energy, angular momentum, and Carter constant. You may set up the initial conditions however you choose (i.e. you may specify the integration constants c_t , c_ϕ , c_θ , and c_r ; or you may specify an initial t, r, θ, ϕ ; etc), solve the problem however you choose (standard numerical integrators or elliptic functions), and use whatever language you feel most comfortable with.

The output of your program should include plots of r vs. t , θ vs. t , and of the “Cartesian” coordinates $X = r \sin \theta \cos \phi$, $Y = r \sin \theta \sin \phi$, and $Z = r \cos \theta$ versus each other (either a 3D plot or 2D plots of X vs Y , Y vs Z , and Z vs X).

Run the following cases:

- (a) An eccentric orbit in Schwarzschild at the radius where the periastron advance per orbit is $\approx 2\pi/3$.
- (b) An inclined, nearly circular orbit in Kerr at $I = \pi/4$, $r = 10$, for values of $a = 0.1, 0.5$, and 0.9 .
- (c) A “generic” (both eccentric and inclined) orbit in Kerr.

Give your values of the energy, angular momentum, and Carter constant for each case. Also attach a printout of your source code/Mathematica notebook/etc.