

The loss of complete geodesic integrability is one of the important consequences (and thus indicators) of deviation from the Kerr-type space-time. Indeed, it has been confirmed many times in the literature that even a highly symmetric perturbation of the Kerr or Schwarzschild metric can make the free test-particle motion chaotic. In this thesis, we study the test-particle dynamics in the field of a Schwarzschild black hole surrounded by a thin disc or ring, using, however, Newton's gravity with a simple "pseudo-Newtonian" potential to mimic the black hole. The Poincaré sections show that the (pseudo-)Newtonian system is slightly more chaotic than the general relativistic one. The difference seems to be correlated with the phase-space allowed region being more open towards the center in the pseudo-Newtonian case.