COLLISIONAL STELLAR DYNAMICS AROUND A CENTRAL GALACTIC BLACK HOLE

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1. Introduction

Massive but invisible black holes (BH) are often assumed to lurk in the center of many galaxies but definitive proof of their existence has not yet been established. However, in the surrounding stellar cluster stars are unavoidably being destroyed by tidal disruptions and stellar collisions liberating of order $1M_\odot$ in each event. The subsequent accretion of this gas by the BH could bring it back to "life" and reveal its presence.

To understand the interplay between the BH and the stellar cluster and quantify the frequency and magnitude of these accretion "events", we are developing a three-fold approach:

1. Simulation of stellar collisions (section 2) and tidal disruptions (Fulbright, 1996) with a 3D hydrodynamics code.
2. Development of a stellar dynamics code to compute self-consistently the evolution of the star cluster as a result of relaxation, stellar collisions and tidal disruptions (section 3).
3. Study of the gas accretion on the BH and determination of the observable radiation (not discussed here).

2. Stellar collisions

As shown by former studies (Duncan & Shapiro, 1983; Lee, 1987; Quinlan & Shapiro, 1990), stellar collisions are of crucial importance both as a source

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of gas and for the dynamical evolution of the cluster as they keep modifying the orbits, masses and numbers of stars.

To improve on previous collision models, we use a SPH code (Benz, 1990) to simulate these events realistically. We are in the process of building a database (to be used by the stellar dynamics code) of stellar collisons large enough to cover the wide initial conditions parameter space. The initial structure of the stars are mapped from stellar structure models (Schaller *et al.*, 1992). To optimize this entire procedure, we have designed a specialized software package to run tens of simulations concurrently on different computers and analyze the outcome automatically. So far, our database includes the results of more than 4000 simulations of collisions between main-sequence stars.

3. Collisional stellar dynamics code

To simulate the collisional evolution of the central stellar cluster, we adopted a Monte Carlo numerical approach based on a method first proposed by Hénon (1973) and . This method has the flexibility to allow the treatment of all required physical ingredient which include 2-body relaxation, collisional and tidal destruction of stars, velocity anisotropies, mass spectrum, stellar evolution, BH growth, etc.

In this approach, the cluster is modeled as a set of spherical shells each of which is composed of stars with fixed energy and angular momentum. The radius of a shell is randomly chosen according to a probability distribution reflecting the amount of time spent at each point along the orbit. Relaxation is simulated by allowing for 2–body gravitational encounters between stars belonging to neighboring shells. The main advantage of this procedure is a correct sampling of the "real" velocity distribution. A binary tree is used to compute the potential. Individual time steps are based on the properly orbital–averaged relaxation time.

We are currently testing the first version of our code by simulating the relaxation–driven evolution of an isolated star cluster (Cohn, 1980).

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