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DISSIPATIVE EVOLUTION OF PROTOGALACTIC CLOUD SYSTEMS

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Abstract

Following the standard scenario, a protogalaxy is assumed to consist of clouds with a typical mass of 10^5–10^6 $M_\odot$ and a temperature of 10^4 K (Larson 1969). The mutual motion of these clouds leads to collisions and to dissipation of kinetic energy. As a consequence, the mean velocity dispersion is decreased, a collapse sets in and will be accelerated until a large fraction of gas is converted into stars or the cloud-cloud collision rate decreases strongly.

With a typical mass of 10^{11} $M_\odot$ for a protogalaxy, 10^5 clouds are expected. In early models the evolution of protogalaxies was treated within a hydrodynamical approach using a statistical description for the cloud-cloud collisions (Larson 1969). Due to methodical and numerical reasons, many assumptions were necessary, e.g., homogeneous clouds, no cloud mass spectrum, isotropic decrease of the velocity dispersion by collisions or local treatment of the collision rate. By way of contrast, modern N-body codes, like TREE-schemes, allow calculations to be performed with a very high number of particles. Hence it is possible to follow the orbit of each *single* cloud and to consider each collision on its own. Additionally, TREE-codes are not restricted to special grids as particle-mesh methods and, therefore, it is possible to study very different dynamical situations with *one* code.

We extended the TREE-code of Hernquist (1987) for inelastic cloud-cloud collisions and included a detailed cloud model following

observations of Rivolo & Solomon (1988). By this the density profile of a cloud and a more realistic collisional cross-section are used. The influence of different collisional processes, like suppression of cloud merging due to thermal heating, conservation of angular momentum (by transferring orbital angular momentum into the spin of the resulting cloud), the effects of gravitational focusing, or star formation were investigated. Additionally, we studied the effect of different initial virial coefficients, density profiles and rotation velocity profiles on the evolution of the system and compared the results with dissipationless models.

We found that the formation of the galactic disk, as well as the formation of a bulge is strongly influenced by dissipation via cloud-cloud collisions. However, the corresponding timescales are a factor of 5–10 larger compared to "standard" dissipation by cooling in a smoothly distributed gas.

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