Kapitel 7

Summary

In this work the interaction of a disc galaxy with a dwarf galaxy has been investigated. The aim was to study whether star formation is induced by this so called *minor merger*. At first it was necessary to construct stable starting models of the disc galaxy and the dwarf galaxy. The stability for the isolated models has been sucessfully tested. The investigation of the interaction was concentrated to the study of the development of the disc structure and the structure of the satellite galaxy. Besides the orbit of the center of mass of the satellite galaxy was studied. The evolution of the vertical disc structure was compared with a sample of observed *edge-on*-galaxies. After implementing a star formation algorithm changes in the gas dynamic and the influence of the interaction to the starformation rate were studied.

The starting model of a disc galaxy was obtained with a program developed by KUIJKEN & DUBINSKI (1995) which was kindly made available. Test runs proved the stability of isolated disc models. Gravitational forces were calculated with the TREE-Code (chapter 2.4.2). In addition the development of a gasous component, consisting of cloud particles capable of merging with each other, was calculated. For these particles gravitational forces are calculated in the same way as for the stellar particles. Merging of clouds will be performed if an inelastic collision takes place. This is done with the implementation developed by THEIS & HENSLER (1993). The results are

- The mass spectrum of the gasous component changes in a way that the number of gas particles decreases but the masses of single particles increases.
- The massive gas particles will be found in the central region of the disc. This causes a significant decay of the half mass height and a significant increase in the surface density in the central region of the disc galaxy.

Models with a satellite without star formation

The investigations of the interaction of the disc model with the satellite model have confirmed earlier results discussed in chapter 2.5. The essentail results are:

- The disc experiences a strong vertical heating.

- The path of the satellite evolves in two major phases:
  1) The orbit of the satellite inclines into the disc plane caused by the transfer of vertical energy of the satellite to the disc. Meanwhile the radial distance of the satellite doesn't change significantly.
  2) Afterwards the satellite will sink into the center of the disc within a short time scale.

The models in this work don't form any kind of global structure like spirals or bars.

A comparison of samples of simulated models with observed samples of *edge-on* galaxies has been performed. The investigated parameter is the fraction R_d/z_0, the radial to the vertical extent.[1] At first a sample of *edge-on* galaxies deals with non interacting (isolated) galaxies. The sample of simulations has been chosen analogous to the observed sample, varying only the scale height z_0. With this sample corresponding interactions have been simulated. A comparison of the state after $1.5{\cdot}10^9$ years with an observed sample of interacting *edge-on* galaxies shows good qualitative agreement. Because of not varying all other parameters like the mass of the satellite galaxy, quantitative deviations result from the simulations as can be seen in tab. 4.3.

Models with star formation

In the implementation for a gasous compomenent from Theis & Hensler (1993) the important process of clumping of matter is performed. But there is an inverse process to clumping of matter, a fragmentation, caused by star formation. In this work the development of an algorithm simulating quiet star formation is described. A collision induced star formation is not implemented. With this algorithm various simulations have been performed. The most essential results are:

- The mass spectrum will be shifted to lower particle masses, since the formation of massive clouds is prevented by the fragmentation process.
- All young stars form in a thin disc.
- The interaction causes an increase of the total volume and hence a decrease in the star formation rate.
- A higher gas fraction in the disc galaxy causes a significant increase of the collisional rate in interacting systems. But no starburst is induced.

[1] Observational data have been provided by Uwe Schwarzkopf, Ruhr-Universität Bochum.

Future prospect

The results in this work raise new questions, which could be of interest in future work. In the diploma thesis of N. Faehling (1996) the gas component in the disc has been calculated with the same method, though different starting models have been used, which have e.g. no bulge component. The results of his work differ from my work in the way, that no radial structure like spirals or bars form in my work. Furthermore he gets a larger number of massive clouds (Faehling has no star formation implemented) leading to the conclusion that he must have a higher rate of coalscences. In this context the following questions raise:

- Is the higher rate of coalscences in the work of Faehling connected with the formation of global structures?
- Would the higher rate of coalscences lead to a higher star formation rate?

To answer these questions the starting models used in Faehling (1996) must be calculated with the new star formation algorithm with statistics for the rate of coalscences and the star formation rate.
In my work the satellite galaxy contains no gasous component, even though dwarf galaxies contain significant amounts of gas. Therefore it would be of interest to clarify,

- whether a gas component in the satellite causes a different star formation rate, and
- whether a local star formation rate at the position where the satellite passes the disc, would be increased by the interaction.

In the works of Olson & Kwan (1990a,b) an interaction between two galaxies of equal mass is regarded. They find out, that the rate of quiet star formation doesn't change significantly, but their collisional rate increases tremendously. This result raises the question:

- Would the implementation of a collision induced star formation produce a starburst caused by the minor merger?

As can be seen on the front page, star formation is obviously induced by the encounter of a disc galaxy with a satellite galaxy. The question whether this is a *star burst* can not be answered in this work, the implementation of a collision induced star formation could give more insight.