

Simulating Molecular Cloud Regulated Star Formation in Galaxies

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Abstract

This thesis is primarily concerned with understanding the process of galaxy formation via the simulation of the interstellar medium, star formation and supernova feedback. In order to probe galaxy formation it is necessary that we first obtain a basic knowledge of the cosmological framework in which we are working. Therefore in chapter 1 we provide a brief overview of the salient features of the current cosmological paradigm in addition to discussing in some detail the physics of the interstellar medium

In chapter 2 we focus on the numerical methods necessary to perform accurate cosmological simulations. We begin by providing an overview of the different simulation techniques currently in use in the field before performing comparisons of two simulation codes that work via two completely different methods. We then introduce a code for generating high-resolution initial conditions for the simulation of individual objects and investigate the numerical effects of mass resolution in cosmological simulation.

In chapter 3 we describe a statistical model of the interstellar medium, in which the conversion of cooling gas to stars in the multiphase interstellar medium is governed by the rate at which molecular clouds are formed and destroyed. In the model, clouds form from thermally unstable ambient gas and get destroyed by star formation, feedback and thermal conduction.

In chapter 4 this statistical model is applied to the simulation of isolated disk galaxies. We show that it naturally produces a multiphase medium with cold clouds, a warm disk and hot supernova bubbles. We illustrate this by evolving an isolated Milky Way-like galaxy. Many observed properties of disk galaxies are reproduced well, including the molecular cloud mass spectrum, the molecular fraction as a function of radius, the Schmidt law, the stellar density profile and the appearance of a galactic fountain.

Finally in chapter 5 we perform an investigation into more dynamic situations, namely the evolution of gravitationally interacting disk galaxies and the formation of a galaxy in a fully cosmological simulation. It is found that the sticky particle model does a good job of reproducing many of the observed properties of interacting galaxies, including the properties of the ISM in the resulting elliptical galaxy.

Simulating Molecular Cloud Regulated Star Formation in Galaxies

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Declaration

The work described in this thesis was undertaken between 2003 and 2006 while the author was a research student under the supervision of Dr. Tom Theuns in the Department of Physics at the University of Durham. This work has not been submitted for any other degree at the University of Durham or any other University.

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