MODEL CALCULATIONS ON THE LARGE SCALE DISTRIBUTION OF BUBBLES IN GALAXIES

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Introduction

One main characteristic of the ionized and neutral component of the interstellar medium in galaxies is the appearance of shells and bubbles in all sizes up to 1 kpc diameter (Hodge,1974; Heiles, 1979). Between different galaxy types differences in size and radial distribution of these bubbles are observed as a function of galaxy type. The stochastic self-propagating star formation model is able to simulate such distributions on a global galactic scale.

The Model

The model includes the distribution of the stars as well as a two component gas (Feitzinger, Glassgold, Gerola, Seiden, 1981; Seiden, Schulman, Feitzinger, 1982). We track of both active and inactive gas for each cell in the model. Active means that the gas is ready for star formation (i.e. cool). Inactive gas is not ready for star formation because it has been heated or thrown out of the plane of the disk by previous star formation events. Creation of a star cluster (association) modifies a cell by converting the active into inactive gas by action of ionization fronts, stellar winds and supernova explosions. The inactive gas is allowed to return to the active state with a given time constant. The bubbles are created and maintained by this star-forming process.

In Fig. 1 the star and gas distributions are shown for a typical time step. The cold gas disk (black) shows many various sized bubbles (white). For a whole sequence of models we have determined(maximum rotation velocity is taken as a crude measure of the galaxy type) the sizes and radial distributions of bubbles. The decreasing shear (lower differential rotation) and the decrease of the gas density as function of the galaxy radius causes an increase of the diameters of the bubbles as function of the distances from the center of the galaxies. This depends on the bubble evolution time scale and the shear time scale.

Comparison with Observations

In Fig. 2 we compare the results of our model simulations with the bubble radius versus distance distribution for the Milky Way. The general trend

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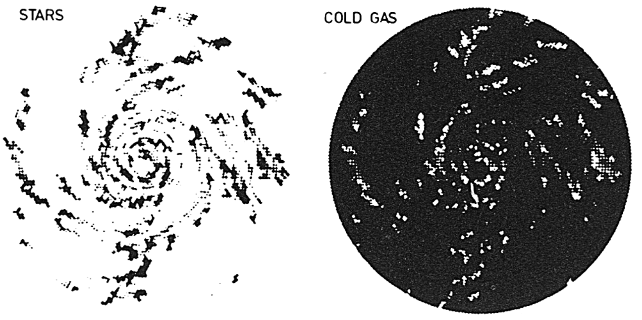

Fig. 1 The star and gas disk at a typical time step (Milky Way simulation)

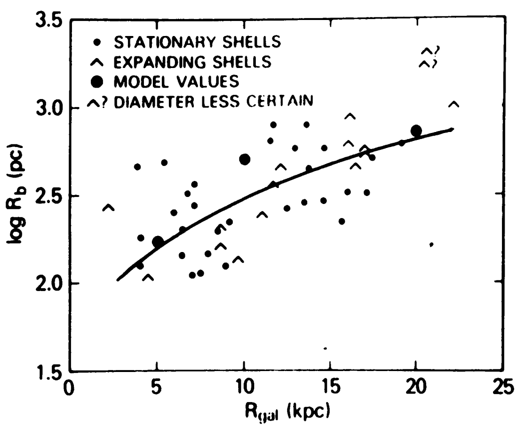

Fig. 2 Bubble radius versus distance for the Milky Way; data after Heiles (1979), adopted from Bruhweiler et al. (1980). The line represents our model simulation.

of increasing radius of the bubbles is very well reproduced by our models. The same accordance between observations and model simulations is obtained for the size distribution of the bubbles. The results of Bruhweiler et al. also agree well with our simulations.

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