Formation of Giant Molecular Clouds in Global Spiral Structures: The Role of Orbital Dynamics and Cloud-Cloud Collisions.*

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We investigate the different roles played by orbital dynamics and dissipative cloud-cloud collisions in the formation of giant molecular clouds (GMCs) in global spiral structures. The interstellar medium (ISM) is simulated by a system of particles, representing clouds, which orbit in a spiral-perturbed, galactic gravitational field. Detailed comparisons are made between the results of cloud-particle simulations in which the cloud-particles collide inelastically with one another and give birth to and subsequently interact with young star associations and the results of stripped-down simulations in which cloud-cloud collisions and star formation processes are omitted. Large "GMC-like" associations of smaller clouds are efficiently assembled in spiral arms and subsequently dispersed in interarm regions largely by the orbital dynamics alone. The overall magnitude and width of the global cloud density distribution in spiral arms is very similar in the collisional and collisionless simulations. The results suggest that the assumed number density and size distributions of clouds and the details of individual cloud-cloud collisions have relatively little effect on these features. In the simulations with shorter mean free paths, pronounced shock-like density and velocity profiles occur. In the simulations with longer mean free paths and in the collisionless simulations, we find more symmetric, less shock-like density and velocity profiles. The natural tendency of orbits to crowd together in spiral arms is enhanced by the temporary trapping of clouds in spiral arm potential minima for periods up to 50 Myr. Dissipative cloud-cloud collisions play an important steadying role for the cloud system's global spiral structure. Dissipative cloud-cloud collisions also damp the relative velocity dispersion of clouds in massive associations and thereby aid in the effective assembling of GMC-like complexes. The assembly of these GMC complexes from smaller clouds is remarkably efficient even if collisional coalescence of individual clouds is inefficient.

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