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Formation of Star Clusters in the LMC and SMC

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Abstract. We demonstrate that single and binary star clusters can be formed during cloud-cloud collisions triggered by the tidal interaction between the Large and Small Magellanic clouds. We run two different sets of self-consistent numerical simulations which show that compact, bound star clusters can be formed within the centers of two colliding clouds due to strong gaseous shocks, compression, and dissipation, providing the clouds have moderately large relative velocities ($10 - 60$ km s^{-1}). The impact parameter determines whether the two colliding clouds become a single or a binary cluster. The star formation efficiency in the colliding clouds is dependent upon the initial ratio of the relative velocity of the clouds to the sound speed of the gas. Based on these results, we discuss the observed larger fraction of binary clusters, and star clusters with high ellipticity, in the Magellanic clouds.

1. Young GC formation in colliding gas clouds.

The details of numerical methods and models for GC formation in colliding gas clouds are given by Bekki et al. (2004, ApJ, 602, 730), therefore we here describe the results briefly. Strong gas compression and dissipation during the collision leads to an elongated slab-like structure formed at around $T = 17.1$ Myr, where T represents the time elapsed since the two clouds began to collide. As the dissipative merging proceeds, the density of gas becomes very high in the shocked regions which are originally the central regions of the two clouds ($T = 22.8$ Myr). Two compact clusters are formed in these high-density gas regions and begin to orbit each other ($T = 22.8$ Myr). This result implies that the orbital angular momentum of the two gas clouds is efficiently converted into that of the binary star clusters during the dissipative cloud-cloud collision. The star formation is akin to an instantaneous "starburst" with a maximum star formation rate of 0.095 $M_{\odot}$ yr^{-1}, and 40 % of the gas is converted into stars within 10 Myr. We do not observe any new stellar particles escaping from the parent clouds because they are initially in the deepest potential well (i.e., the center of the clouds). Thus a single star cluster with a very smooth and homogeneous mass distribution would finally form.