The Formation of a Proto-Globular Cluster Cloud by Thermal and Gravitational Instabilities

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We have performed three-dimensional hydrodynamic simulations in order to study the formation of a Proto-Globular Cluster Cloud (PGCC) in a primordial halo environment through thermal and gravitational instabilities. The first set of simulations, which are designed to understand roles of each physical process, is to follow up an idealized spherical density perturbation with i) cooling only, ii) cooling and heating, and iii) cooling, heating and self-gravity. From these simulations, we have confirmed the results of one-dimensional spherical simulations done by Kang et al (2000). At early time, due to shorter cooling time than free-fall time, the central density increases by two to three orders of magnitude by the thermal instability. Afterwards, the gravitational instability dominates over the thermal instability and can increase the maximum density by more than four orders of magnitude. The second set of simulations is to see the formation of a PGCC in a turbulence halo environment. We adopt Kolmogorov and Zeldovich type power spectra for density perturbation. The overall evolutionary picture of both models is qualitatively similar; In early stage many small clouds are formed by the thermal instability, followed by subsequent merging of the clouds and the eventual formation of a single big PGCC by the gravitationally instability. This formation scenario will be clearly demonstrated by a movie of the simulations. We will also discuss the physical implications from our initial results on the formation of a PGCC cloud.