GLOBULAR CLUSTERS AND DARK CLUSTERS

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Fall and Rees[1] have suggested that thermal instability in the collapsing gas of a protogalaxy gives rise to cool clouds embedded in a hot medium. They argue that the temperature of the clouds cannot fall below 10^4K, since metals and molecular coolants are absent. Clouds with masses exceeding $10^6 M_\odot$ are gravitationally unstable and are identified as the precursors of globular clusters. This model has difficulty in explaining high-metallicity globular clusters, since metals provide cooling down to $\sim 10^2$K or below, thus considerably reducing the cloud Jeans mass. The same problem arises if H_2 cooling occurs.

We present a theory in which most protogalactic gas is processed into dark clusters of jupiters, with only a small fraction of the gas forming visible clusters. We associate the dark clusters with the dark matter in galactic halos and the visible ones with globular clusters. The formation of two distinct populations of clusters is a consequence of the different possible cooling histories of the precursor clouds. There are three routes to star formation for clouds cooling from the galactic virial temperature $T_i \sim 10^6$K to $T_f \sim 10^4$K:

(a) isobaric cooling; stars form at the intial pressure P_1
(b) isochoric cooling + repressurisation; stars form at P_1
(c) isochoric cooling + collapse; stars form at $P_2 = P_1 T_f/T_i$

This is analagous to the situation in cluster cooling flows, where most material forms dark objects (jupiters), with some luminous stars also being formed. The suggested cause is a pressure-dependent stellar IMF. In our model, routes (a) and (b) produce dark clusters, while (c) gives globular clusters.

The theory predicts a mass of $\sim 10^6 M_\odot$ for globular clusters, insensitive to metallicity and the parent galaxy mass. The predicted radius of the dark clusters agrees with the Carr-Lacey[2] model in which such objects heat the Galactic disc. We also explain the different distributions within the Galactic halo of the two cluster populations.

REFERENCES

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