GLOBULAR CLUSTER SYSTEMS AS CLUES TO GALAXY EVOLUTION

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Abstract

We investigate the properties of systems of globular clusters in light of the hypothesis that galaxy mergers play a major role in galaxy evolution. In a previous paper we presented a model in which the formation of globular clusters occurs during galaxy interactions and mergers. We discussed several predictions of the model, including the existence of young globular clusters in currently merging galaxies and the presence of two or more metallicity peaks in the globular cluster systems of normal elliptical galaxies. Here we present recent observational evidence which supports both of these predictions and suggests that mergers may have a significant influence on the formation and evolution of galaxies and their globular clusters.

1. Introduction

The great age of many globular clusters and their presence around nearly all galaxies make them excellent fossils through which the process of galaxy evolution can be traced. If galaxy mergers play a major role in galaxy evolution, then the properties of globular cluster systems must reflect these processes. In particular, if elliptical galaxies are formed by mergers of spiral galaxies, then the formation of new globular clusters during mergers is necessary to explain the higher number of clusters around ellipticals relative to spirals of the same luminosity. Ashman & Zepf (1992) examined the implications of such a model and found that many well-known properties of globular clusters are consistent with such a hypothesis. For example, a thick disk population of globular clusters similar to that present in our Galaxy and M31 is predicted by this model. Moreover, the globular clusters are required to be metal-poor compared to the underlying light of an elliptical galaxy as is observed. Ashman & Zepf (1992) also made several new predictions. Among these were that young globular clusters should be found in mergers of gas-rich galaxies, and that there should be at least two peaks in the metallicity distribution of the globular cluster systems of elliptical galaxies.

2. Young Clusters in Merging Galaxies

The most obvious prediction of a model in which globular cluster formation occurs during mergers and interactions is that young globular clusters should be found in galaxies

which are now experiencing this phenomenon. Until recently, this prediction seemed at odds with the belief that all globulars are old (although there has been an ongoing debate about the nature of the young clusters in the LMC and the "populous" blue clusters discussed by Kennicutt & Chu 1988). However, observational evidence is now mounting which suggests that some globular clusters are young. For example, Zepf & Ashman (1992) suggest that in NGC 5128 several of the very blue globular clusters near the center of the galaxy may be young rather than extremely metal poor clusters. Another example is the observation by Lutz (1991) of compact blue objects in the ongoing merger NGC 3597. The properties of these objects are consistent with those expected of young globular clusters, although the spatial resolution of the ground-based data is not quite sufficient to show that these clusters are as compact as galactic globular clusters. Recently, Holtzman *et al.* (1992) have reported the detection of young globular clusters in NGC 1275, which they interpret as being the result of a recent merger. Further HST observations of merging galaxies are likely to be very fruitful.

3. Metallicity Distributions of Globular Cluster Systems of Elliptical Galaxies

One of the interesting results to come out of recent surveys of the globular cluster systems of elliptical galaxies is that the metallicity distributions are not smooth and uniform but appear to have two or sometimes three peaks (Zepf & Ashman 1992). These distributions provide dramatic support for our models which predict that the metallicity distribution of the globular cluster system of an elliptical galaxy should have at least two peaks. These peaks correspond to the two populations of globular clusters: the low metallicity clusters formed during the collapse of the progenitor disk galaxies, and the higher metallicity clusters which form during the merger. More generally, the metallicity distribution of globular clusters around normal ellipticals is a powerful tool for understanding the evolution of these galaxies. In particular, the multi-peak prediction of the merger scenario contrasts sharply with the rather uniform and single-peaked distribution expected if elliptical galaxies (and their globular clusters) have a single formation phase.

References

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