Chandra Observations of the Merger, Radio Relic, and the Disruption of the Cooling Flow in Abell 133

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Abstract

We present the results of Chandra observations of the central region of the merging cluster Abell 133. This cluster has a filamentary radio relic. Previous X-ray observations indicated that there was a cooling flow centered on the central cD, which also hosts a radio source. The X-ray image shows that the distribution of low temperature gas at the cluster center is not smooth and symmetric with respect to the central cD galaxy. Moreover, a plume of X-ray emission extends from the galaxy to the NNE. This plume extends in the direction of and partly overlaps the radio relic. The spectral analysis shows that the plume consists of low temperature thermal gas, rather than inverse Compton emission from the radio relic.

We consider the effects of the merger motion of the central cooling core of the main cluster through the lower density, shock-heated gas in the other subcluster. Ram pressure can displace the cool gas from the center of the dark matter potential, and Kelvin-Helmholtz instabilities can disrupt the cool core. The criteria for these two mechanisms to act is similar; both involve the competition between momentum in the flow and the gravitational acceleration. We estimate the critical velocity and time scale of the Kelvin-Helmholtz instability for the low temperature region around the cD galaxy and find that the region should suffer from the instability. Thus, we conclude that the complex X-ray structure at the cluster center is attributed to the effects of ram pressure and the Kelvin-Helmholtz instability. Moreover, the ram-pressure from the outer hot gas region may be responsible for the displacement of the low temperature region from the cD galaxy.

We compare the results with those of Abell 2142 and Abell 3667, in which sharp cold fronts have been observed and the low temperature gas has regular distributions. Contrary to Abell 133, the central galaxies and the low temperature gas in Abell 2142 and Abell 3667 are located at the center of deeper potential wells; the gas in these substructures is not vulnerable to the Kelvin-Helmholtz instability or ram pressure. This suggests that the depth of the potentials in dark halos around cD galaxies has more variety than expected from the similarity in the optical properties of the cD galaxies.

CATEGORY: CLUSTERS OF GALAXIES