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A Chandra Study of Temperature Substructures in Intermediate-redshift Galaxy Clusters

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By analyzing the gas temperature maps created from the Chandra archive data, we reveal the prevailing existence of temperature substructures on 100 kpc scales in the central regions of nine intermediate-redshift (0.1) galaxy clusters, which resemble those found in the Virgo and Coma Clusters. Each substructure contains a clump of hot plasma whose temperature is about 2-3 keV higher than the environment, corresponding to an excess thermal energy of 1e58-1e60 erg per clump. Since if there were no significant non-gravitational heating sources, these substructures would have perished in 1e8-1e9 yrs due to thermal conduction and turbulent flows, whose velocity is found to range from about 200 to 400 km/s, we conclude that the substructures cannot be created and sustained by inhomogeneous radiative cooling. We also eliminate the possibilities that the temperature substructures are caused by supernova explosions, or by the non-thermal X-ray emission due to the inverse-Comptonization of the CMB photons. By calculating the rising time of AGN-induced buoyant bubbles, we speculate that the intermittent AGN outbursts may have played a crucial role in the forming of the high temperature substructures.