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When Galaxy Clusters Collide: Recent Results from the NuSTAR and Chandra X-ray Observatories

DANIEL WIK, University of Utah

Clusters of galaxies are the most massive gravitationally bound structures in the universe, growing through mergers with galaxies and other galaxy clusters. Collisions between clusters release huge amounts of energy—more than any other event since the Big Bang. Hot, X-ray emitting gas fills the volume between the galaxies in clusters, and cluster-cluster collisions drive shock waves and turbulence through the gas, which can also accelerate cosmic ray electrons and ions to close to the speed of light. I will present work on several different merging galaxy clusters observed with the X-ray telescopes NuSTAR and Chandra, where we expect to find shock fronts in X-ray images—and sometimes do—and evidence for cosmic ray electrons—which we generally do not. These results will be discussed in the larger context of how galaxy clusters grow and evolve over time and their implications for using clusters as a way to study cosmology.