The Spectacular Merger Event in A3411: Shock Fronts and Radio Relics

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Abstract: The study of galaxy cluster merger events is of major astrophysical interest as they have a profound and long-lasting impact on the thermodynamic evolution of the ICM. Observed as part of our large Chandra XVP program on the Planck ESZ sample, we discovered that the cluster A3411 is undergoing a spectacular merger event. Radio observations also reveal the presence of large-scale diffuse emission, suggesting the presence of shocks and turbulence in the ICM. Most interestingly, in the Chandra observations we indeed find evidence of a brightness discontinuity, roughly at the location of the radio emission. This suggests that a shock could be responsible for the acceleration of particles to relativistic energies and makes A3411 an ideal laboratory to study this poorly understood process.

Radio Relics: Giant radio relics are located in cluster outskirts. These giant radio relics sometimes show symmetric or ringlike structures, are often polarized and likely the signatures of electrons (re)accelerated by large-scale shocks (e.g., Ensslin et al. 1998; van Weeren et al. 2010, 2012). How the radio emitting particles can be accelerated by low-Mach number cluster merger shocks (M ~ 1-3) is still being debated.

Preliminary Results: We measure a surface brightness discontinuity in the south-east region of A3411 corresponding to a Mach number of 1.15. It is located roughly at the radio relic position, suggesting that a merger shock (re-)accelerated electrons to relativistic energies causing them to emit synchrotron radiation in the radio band. Thus, even low-Mach number shocks are capable of producing bright radio relics. This result indicates that our understanding of particle acceleration at shocks is incomplete (Guo et al. 2014), or it requires a pre-existing fossil electron population.

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