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

Felipe Andrade-Santos[1], Reinout van Weeren[1], Christine Jones[1], Georgiana Ogrean[1], William Forman[1], Stephen Murray[2], Kevin Fogarty[2]

[1]Harvard-Smithsonian Center for Astrophysics
[2]The Johns Hopkins University

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.

Shocks: We model the surface brightness as:

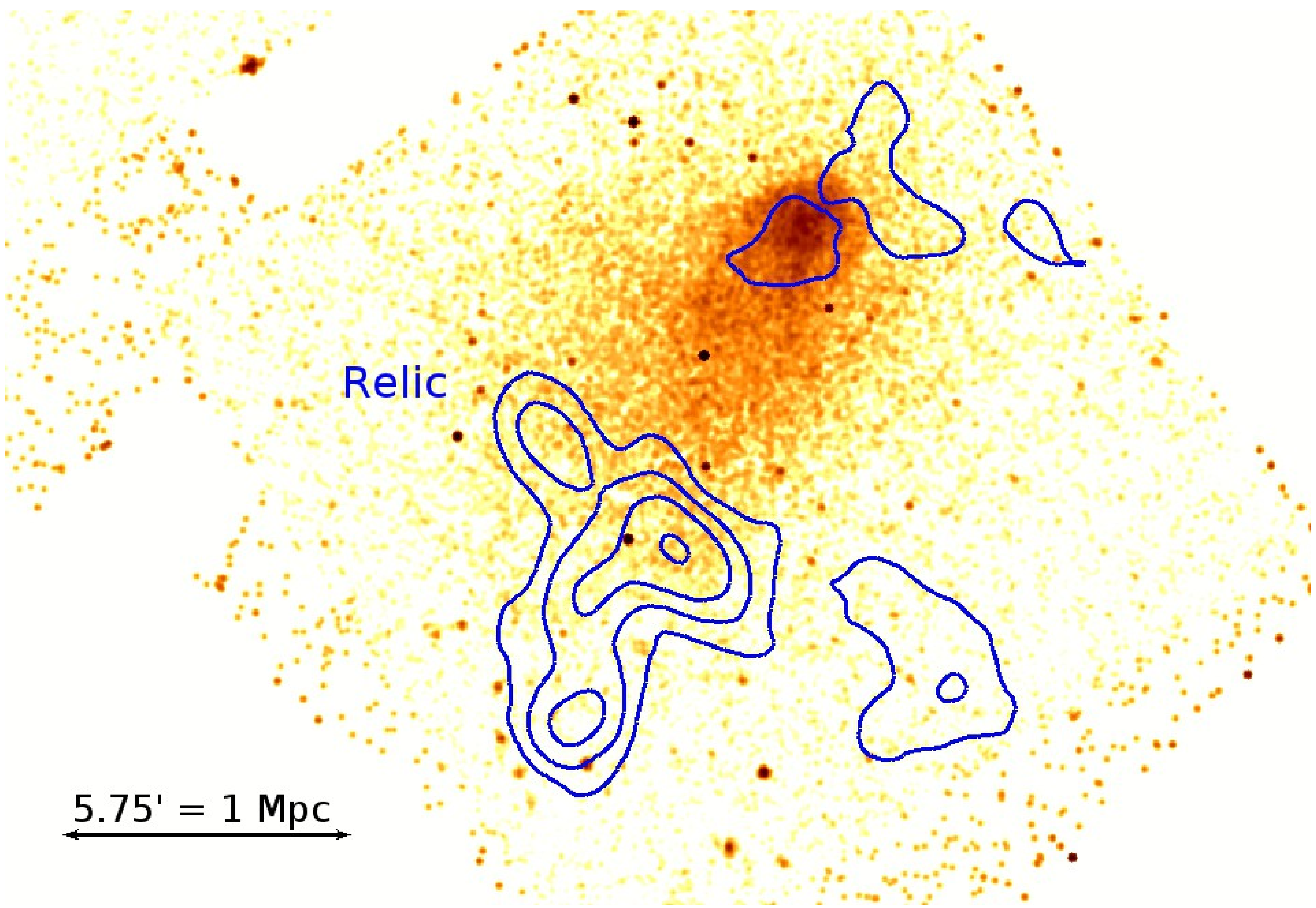
$$n(r) = C\, n_{0,2} \left(\frac{r}{r_{shock}} \right)^{-a_1}, r \le r_{shock}$$

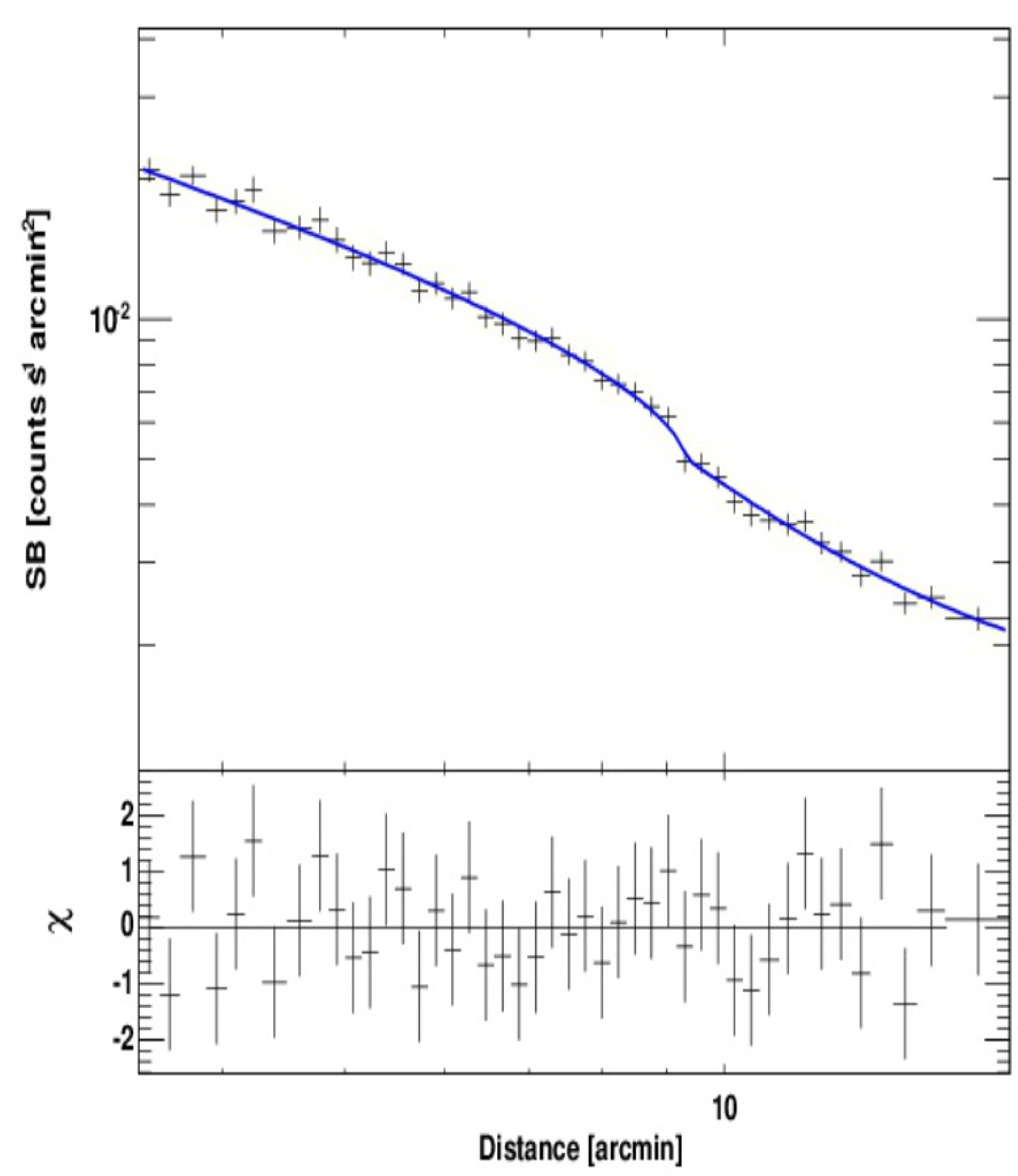
$$n(r) = n_{0,2} \left(\frac{r}{r_{shock}} \right)^{-a_2}, r > r_{shock}$$

The relation between the Mach number and the compression C is then given by:

$$C = \frac{4M^2}{3+M^2}$$

In the southern shock, C = 1.23 ± 0.09, which implies M = 1.15 ± 0.06.





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 or 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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