Building the Hot Intergalactic Medium in Galaxy Groups: A Chandra view of Stephan’s Quintet

E. O’Sullivan¹, S. Giacintucci¹, J.M. Vrtilek¹, S. Raychaudhury², L.P. David¹, D.J. Saikia³


**Motivation**

The majority of galaxies in the Universe reside in galaxy groups, with the most common environment being spiral-rich groups similar to the Local Group (Eke et al. 2004). Mergers between such systems build more massive groups and clusters, and drive the development of their elliptical galaxy populations. Development of a hot intergalactic medium is linked to galaxy transformations - groups containing ellipticals are statistically more X-ray luminous, and the X-ray brightest groups all have dominant giant ellipticals (Mulchaey et al. 2003). However, while we understand galaxy evolution relatively well, the origin of the extensive hot gas haloes of groups and clusters is as yet poorly known. Possibilities include accretion of primordial material, stellar winds and supernovae, and shock-heating of cool gas.

**Origin of the IGM**

We estimate the total hot IGM mass to be 2.8x10¹⁴ Msol within ~80 kpc. This is very similar to the HI deficit of the group, ~2x10¹⁴ Msol (Verdes-Montenegro et al. 2001), suggesting that it could be shock-heated HI. However, its extent is large compared to the expected extension of a shocked heated filament, suggesting that it is hot IGM in the group before the current interaction.

**Temperature of the shock**

Spectral fitting shows the ridge to have kT=0.6 keV and 0.3 solar abundance, with a power-law component consistent with that expected from High-Mass X-ray Binaries. Spectral fits are plotted above. The X-ray ridge overlaps spiral arms of NGC 7318b. Hα map from Williams et al. (2005). The X-ray/radio ridge connects with the Hα regions, suggesting the collision has shock-heated the cool gas.

**Morphology**

From the UV, the star formation rate in the ridge is estimated to be 1.5 Msol/yr. We estimate the rate of cooling of X-ray gas to be ~1.4 Msol/yr, sufficient to fuel star formation. We estimate a supernova rate of 4.9x10⁻¹⁰ SN/yr, which should enrich the ridge gas to ~0.27 solar abundances, consistent with X-ray measurements.

**Conclusions**

1) The shock driven by the collision of NGC 7318b with a tidally stripped HI filament is at a similar temperature to its surroundings, and cooler than the large-scale IGM. It seems likely that the shock was oblique, with angle ~30°.

2) The mass of the hot IGM matches the HI deficit, suggesting that it was shock-heated in previous galaxy interactions.

3) Star formation has enriched the gas in the ridge to ~0.3 solar, and may be fueled by radiatively cooling gas. Regions of strong star formation contribute to the radio and X-ray flux, but cannot be responsible for the ridge as a whole.