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Caught in the Act: Witnessing a Transforming Spiral in a Galaxy Group

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Abstract. Ram pressure stripping of galaxies is believed to be inefficient in galaxy groups, but *Chandra* X-ray observations of the starburst spiral NGC 2276, a member of a small galaxy group, shows that this galaxy is being stripped of its gas at a rate of ~ 5 $M_\odot$ yr^{-1} due to its motion through hot intragroup gas. This provides direct evidence that mechanisms associated with ram pressure can strip galaxies of their gas in systems much smaller than galaxy clusters.

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Conventional wisdom holds that stripping of galactic gas by the ram pressure $P_{\rm ram}$ of a surrounding medium ($P_{\rm ram} \propto \rho_{\rm gas} v_{\rm gal}^2$) is inefficient in galaxy groups, due to the relatively low galaxy velocities $v_{\rm gal}$ and intragroup medium (IGM) densities $\rho_{\rm gas}$ found in groups. There are potential counter-examples, however, one of which is NGC 2276 moving through the hot IGM in the NGC 2300 group of galaxies. This spiral galaxy boasts a high star formation rate and disturbed optical and radio morphologies, indicative of a strong interaction with the surrounding group gas. To test this, we obtained *Chandra* X-ray data of the galaxy and the ambient IGM (see Rasmussen *et al.* 2006 for details).

The data show the presence of a shock front preceding the galaxy, indicating that NGC 2276 is moving through the surrounding group gas at a velocity $v_{\rm gal} \sim 850$ km s^{-1}, corresponding to Mach 1.7. This compresses the IGM in front of the galaxy and can have triggered the strong star formation activity seen at the leading edge of the galaxy, likely leading to supernova outflows of hot gas. A tail of hot gas is seen trailing the galaxy, and a detailed mass model of NGC 2276 suggests that this gas tail is unbound, thus representing material stripped from the disk. The mass of the tail, combined with $v_{\rm gal}$, indicates a mass loss rate of 3–6 $M_\odot$ yr^{-1}. While this cannot be explained by sheer ram pressure alone, a combination of turbulent viscous stripping and starburst outflows being swept back by ram pressure provides a likely explanation for the gas tail. The strong starburst activity thus aids the stripping of gas in this case, by puffing up the galactic ISM, making it more susceptible to the effects of ram pressure.

At the current mass loss rate, NGC 2276 could have been losing gas for 1–2 Gyr, and will have lost its remaining supply within another 1–2 Gyr. The associated truncation of star formation will likely transform this spiral into a quiescent, more bulge-dominated system similar to S0 galaxies. This demonstrates, for the first time, that a relatively tenuous intragroup medium can strip a galaxy rapidly enough to transform its type.

Reference

Rasmussen, J., Ponman, T.J. & Mulchaey J.S. 2006, *MNRAS* 370, 453.