The Cool Circumgalactic Medium in Group Environments

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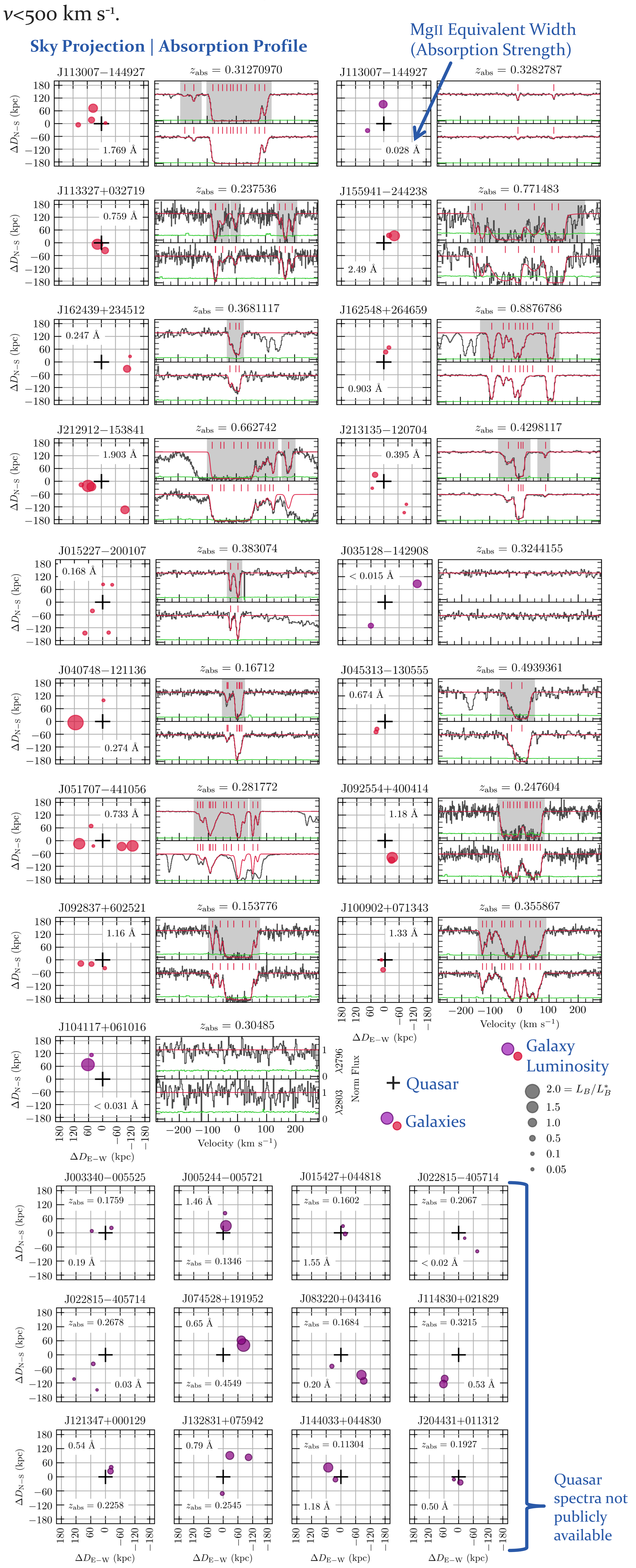
Introduction and Motivation

The baryon cycle is key to understanding the observed global properties of galaxies and plays a large part in governing galaxy evolution. Signatures of the baryon cycle such as accretion from the cosmic web and stellar-driven outflows are best probed in gaseous halos surrounding galaxies, i.e., the circumgalactic medium (CGM), which is a gas reservoir with a mass comparable to that within galaxies and extends out to ~300 kpc. Extensive work has gone into characterising these CGM gas flows in isolated galaxies using absorption in the spectra of background quasars. Cool (10^4 K) gas traced by MgII doublet absorption is commonly associated with outflows and recycled accretion, where gas kinematics and absorption strengths are larger for outflowing gas.

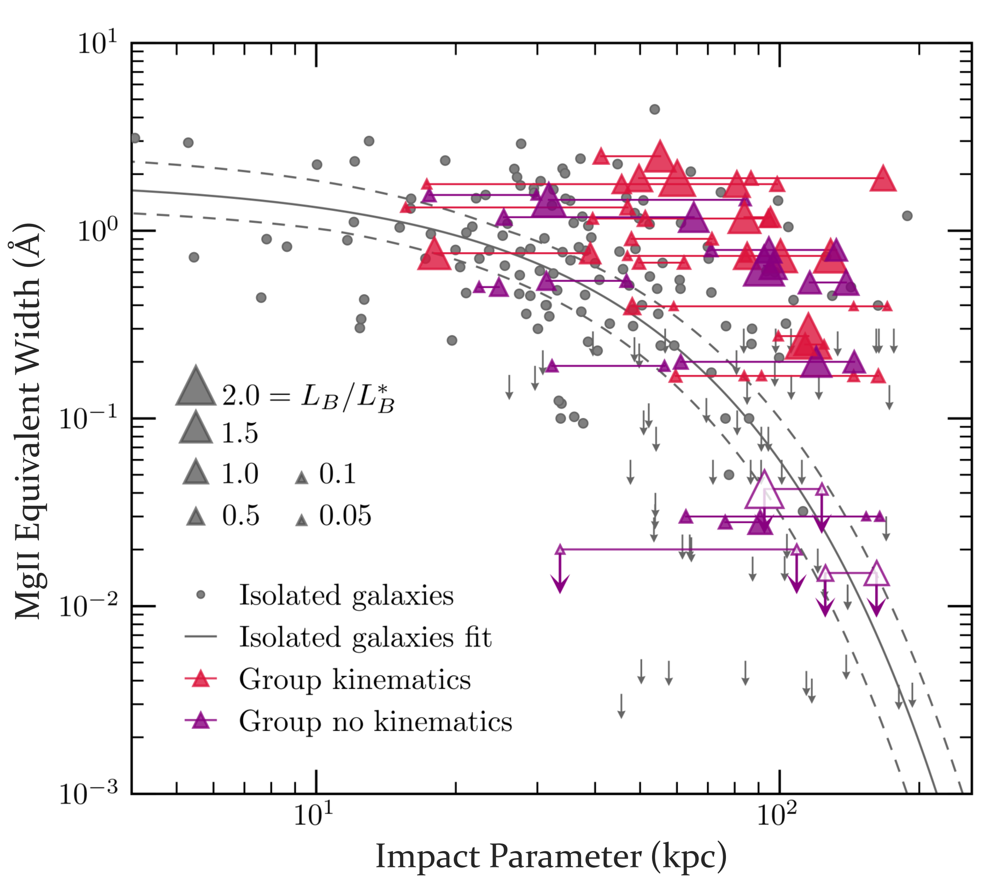
However, **little work has been done to characterise the CGM in group environments, where other processes such as tidal stripping due to galaxy interactions may contribute to the observed CGM properties.**

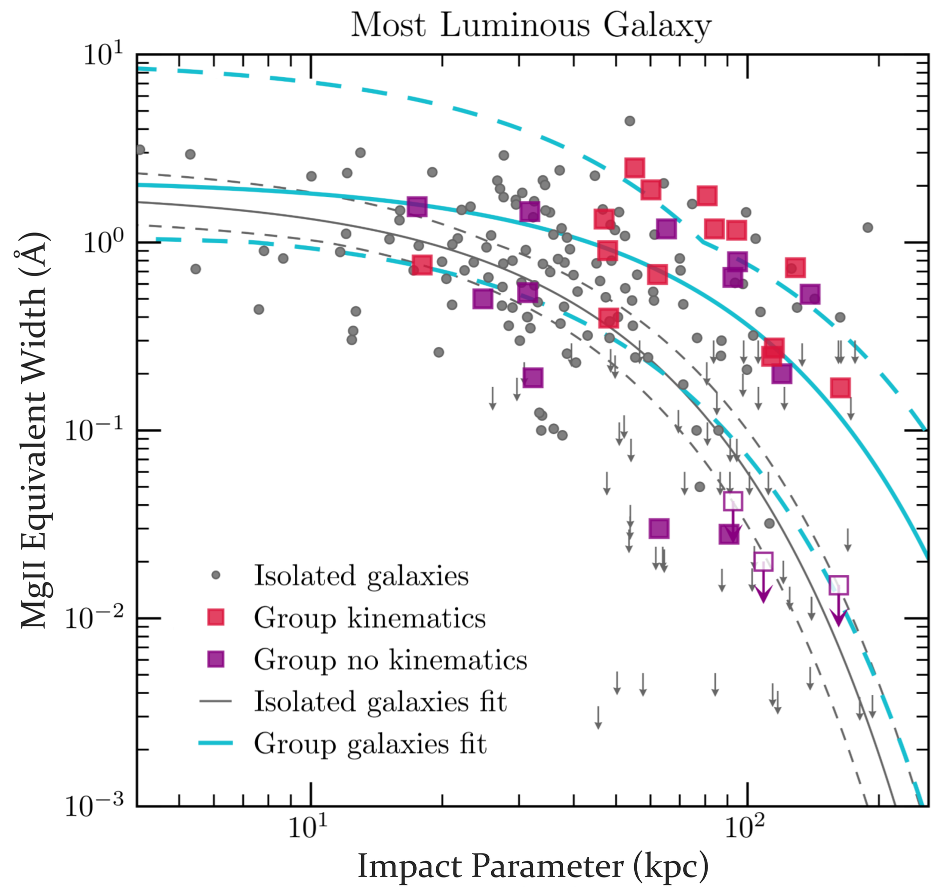
MgII Absorber–Galaxy Catalog (MAGIICAT) Groups

We identified **~30 MgII absorbers associated with group environments at z~0.5.** A group is defined as 2 or more galaxies within 200 kpc of a quasar sightline and with a velocity separation of v<500 km s^{-1}.



CGM Absorption Strength and Radius



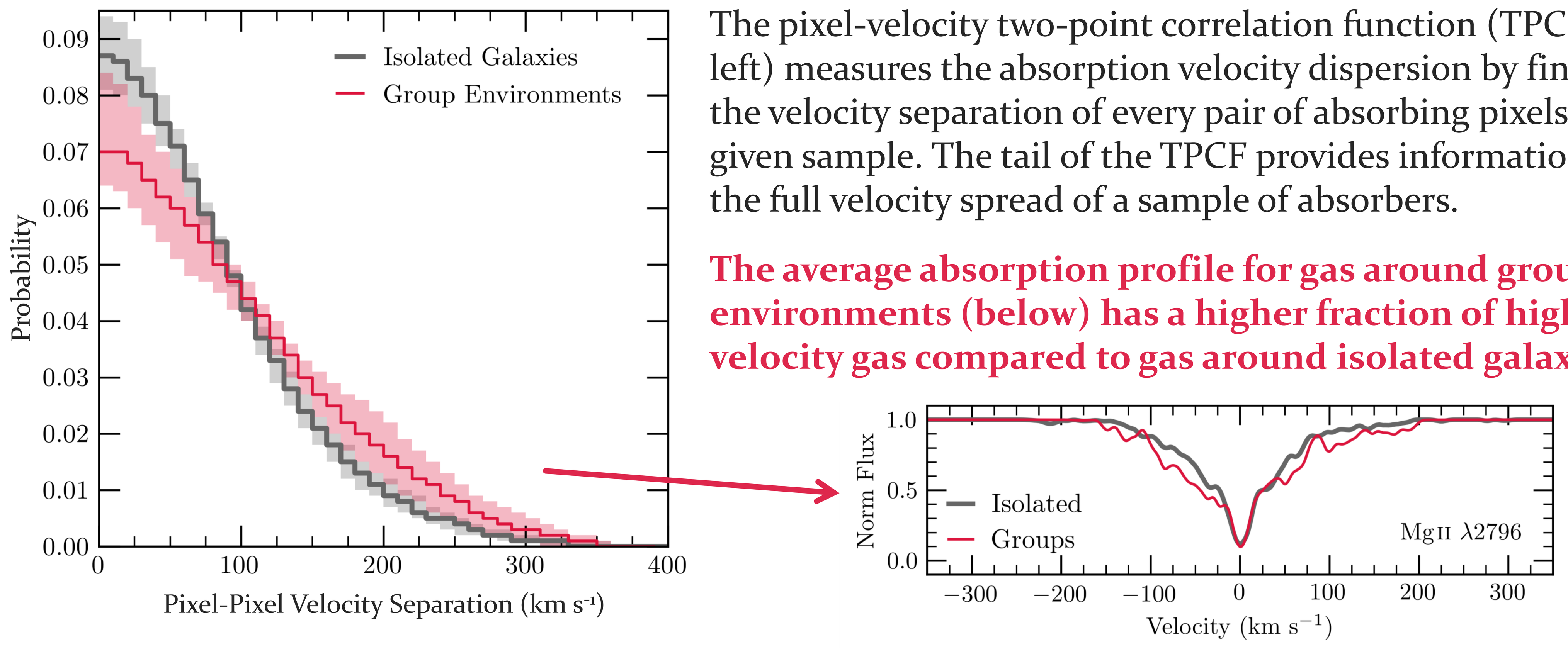


The CGM of isolated galaxies has a strong anti-correlation between MgII absorption strength and radius from the galaxy (Nielsen et al. 2013, ApJ, 776, 115). **Group galaxies also show decreasing absorption strength with galaxy radius, though multiple galaxies may give rise to the absorption.**

Assuming the most luminous galaxy in a group hosts the majority of absorption, **group galaxies appear to host a larger CGM than isolated galaxies – the intragroup medium.**

Gas Kinematics

The absorption profile line-of-sight velocity structure provides information on whether the gas is accreting onto or outflowing from galaxies (Nielsen et al. 2015, ApJ, 812, 83), where outflows have large velocity spreads. Comparing the absorption velocity dispersions, we find that **gas in group environments may be more kinematically complex compared to the isolated CGM due to tidal interactions between galaxies or "intergalactic transfer" of outflowing gas from one galaxy to another.**

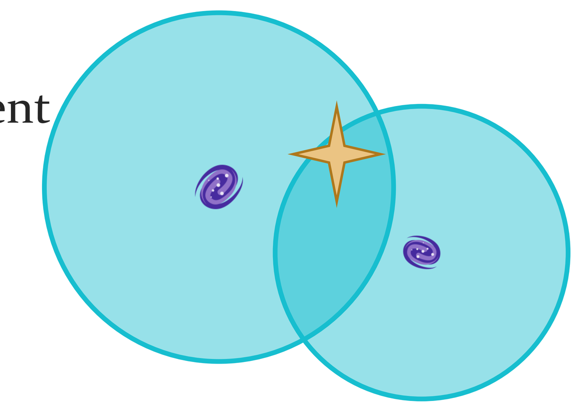


The pixel-velocity two-point correlation function (TPCF; left) measures the absorption velocity dispersion by finding the velocity separation of every pair of absorbing pixels for a given sample. The tail of the TPCF provides information on the full velocity spread of a sample of absorbers.

The average absorption profile for gas around group environments (below) has a higher fraction of high velocity gas compared to gas around isolated galaxies.

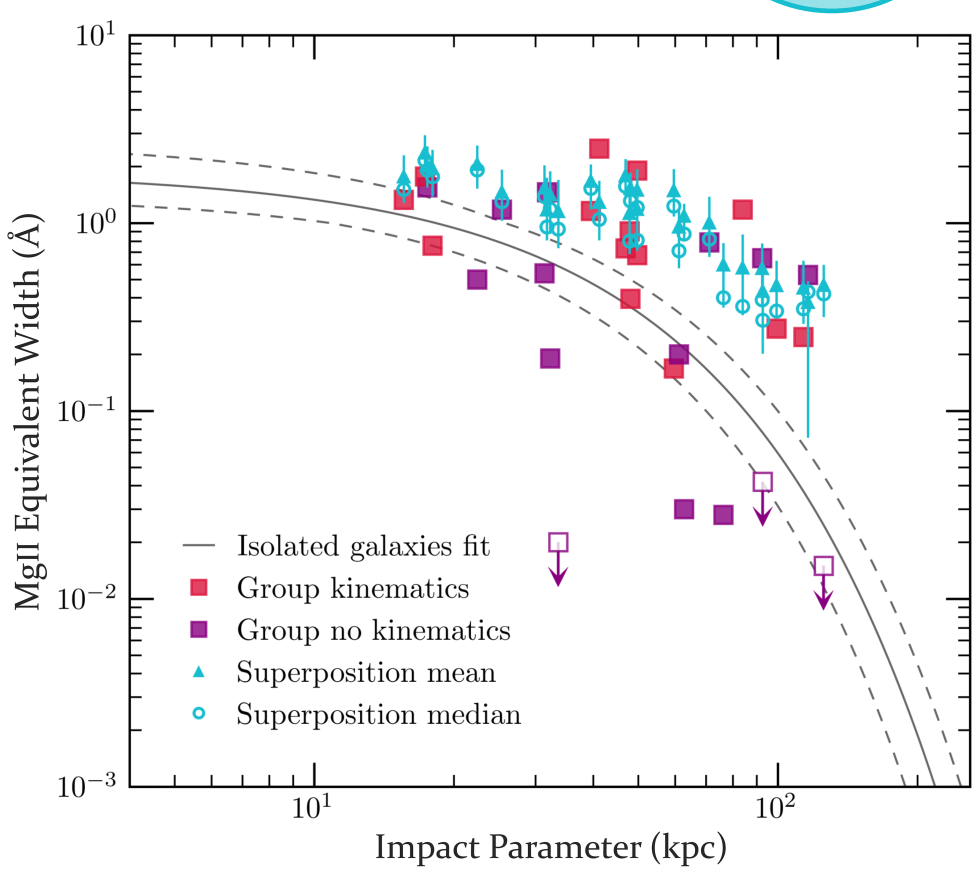
Superposition of Galaxy Halos Model

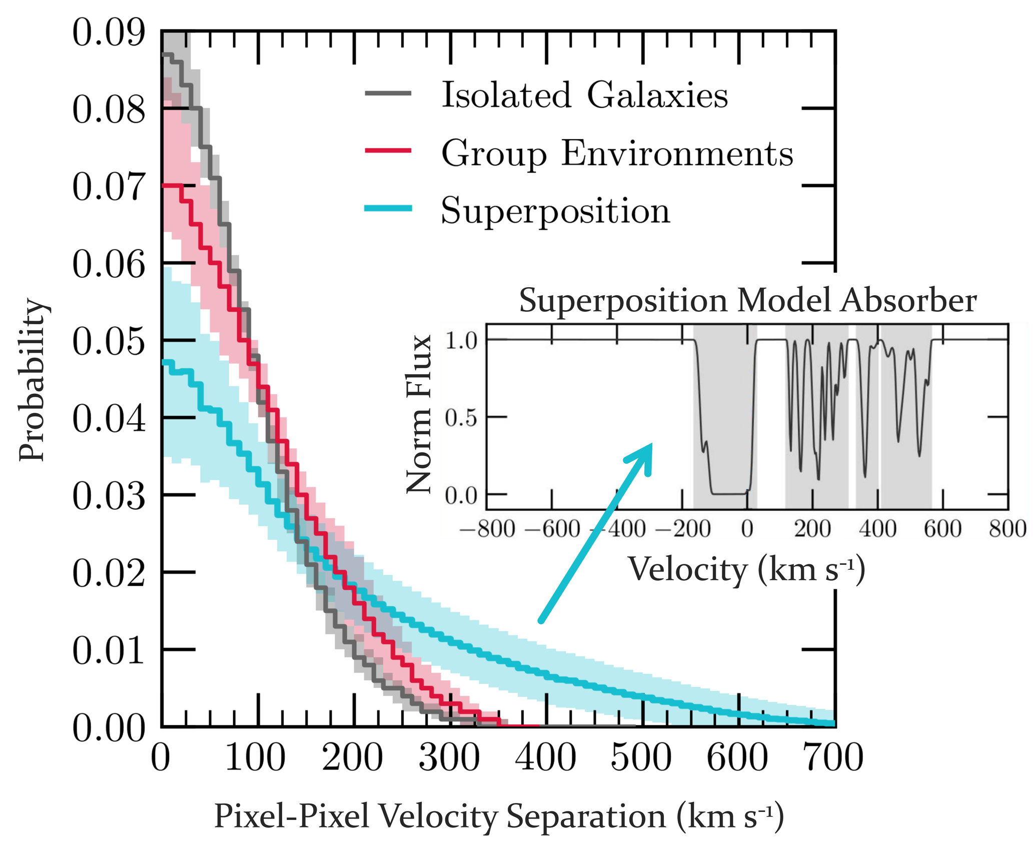
A previous study of the CGM in group environments also found an enhancement of the absorption equivalent width for a sample of stacked absorption profiles (Bordoloi et al. 2011, ApJ, 743, 10). They suggested that this result could be explained if the CGM of individual galaxies overlapped, where the quasar sightline simply passed through multiple halos. We tested this model.



For every group in the sample, isolated galaxies with similar impact parameter distributions as the observed groups were randomly selected to create mock groups. The equivalent widths associated with each randomly-selected isolated galaxy were then summed to obtain a group equivalent width. This model assumes that the mock group galaxies are not interacting in any way.

The superposition model equivalent widths are plotted (right) on top of the observed group values, assuming the galaxy nearest to the quasar hosts the absorption. **The superposition model equivalent widths match roughly half of the group galaxy sample.**





To test the kinematics expected in a superposition scenario, we created mock absorption profiles accounting for galaxy–galaxy velocity separations (z_{gal}) and absorber–galaxy velocity separations. The TPCF created from these mock profiles is shown in the left panel. **The superposition model significantly overestimates the velocity dispersion of gas in group environments.**

Gas in group environments is thus coupled to the group rather than individual galaxies, creating an intragroup medium.