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The linear bias of radio loud active galactic nuclei via cosmic microwave background lensing

Large areas of galaxy clusters, voids and filaments make up the cosmic web. An important realisation was that the distribution of galaxies does not exactly trace the total matter density field (dark matter plus baryonic matter) of the cosmic web. The linear bias (overdensity of baryonic matter to all matter) of galaxy populations informs us about their environmental properties, which can be a key driver of galaxy evolution and overall cosmological context. Radio-loud AGNs exist within the most massive galaxies and are therefore expected to be highly biased tracers of the matter field. Traditionally, measurements of bias have relied on galaxy n-point auto or cross-correlations. A promising alternative technique is that of measuring the cross-power spectrum of galaxy density fields with weak lensing maps of the cosmic microwave background (CMB), offering a very clean measurement using the CMB as a z = 1100 backlight. Light from the CMB has been travelling for 13.6 billion years and its path has been bent by the gravitational effect of all intervening matter that lenses the light.

We measure the cross-power spectrum of 12,820 AGNs at z<0.7, from the Best and Heckman selection of the FIRST radio galaxy catalogue, with the projected mass density from the Planck CMB lensing potential map. The amplitude of the cross-correlation signal is used to directly measure the linear bias using a spherical cut-sky approach. Here we report a 5.6 detection of the CMB-AGN cross-power spectrum. Using a spherical collapse formalism it is possible to estimate the halo mass from the linear bias. The results imply that radio-loud AGN typically inhabit halos of masses comparable to that of a large group of galaxies, in agreement with estimates of radio-loud AGN environments from optical and X-ray work.

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