

Planck intermediate results: XL. the Sunyaev-Zeldovich signal from the Virgo cluster

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Abstract

© ESO, 2016. The Virgo cluster is the largest Sunyaev-Zeldovich (SZ) source in the sky, both in terms of angular size and total integrated flux. Planck's wide angular scale and frequency coverage, together with its high sensitivity, enable a detailed study of this big object through the SZ effect. Virgo is well resolved by Planck, showing an elongated structure that correlates well with the morphology observed from X-rays, but extends beyond the observed X-ray signal. We find good agreement between the SZ signal (or Compton parameter, y_c) observed by Planck and the expected signal inferred from X-ray observations and simple analytical models. Owing to its proximity to us, the gas beyond the virial radius in Virgo can be studied with unprecedented sensitivity by integrating the SZ signal over tens of square degrees. We study the signal in the outskirts of Virgo and compare it with analytical models and a constrained simulation of the environment of Virgo. Planck data suggest that significant amounts of low-density plasma surround Virgo, out to twice the virial radius. We find the SZ signal in the outskirts of Virgo to be consistent with a simple model that extrapolates the inferred pressure at lower radii, while assuming that the temperature stays in the keV range beyond the virial radius. The observed signal is also consistent with simulations and points to a shallow pressure profile in the outskirts of the cluster. This reservoir of gas at large radii can be linked with the hottest phase of the elusive warm/hot intergalactic medium. Taking the lack of symmetry of Virgo into account, we find that a prolate model is favoured by the combination of SZ and X-ray data, in agreement with predictions. Finally, based on the combination of the same SZ and X-ray data, we constrain the total amount of gas in Virgo. Under the hypothesis that the abundance of baryons in Virgo is representative of the cosmic average, we also infer a distance for Virgo of approximately 18 Mpc, in good agreement with previous estimates.

<http://dx.doi.org/10.1051/0004-6361/201527743>

Keywords

Cosmic background radiation, Galaxies: clusters: individual: Virgo, Galaxies: clusters:

intracluster medium, ISM: general, Large-scale structure of Universe