U04a Simulation and Separation for Signals in Low-Frequency Radio Sky

Jingying Wang, Haiguang Xu

We simulate the $50-200$ MHz radio sky that is constrained in the field of view of the 21 Centimeter Array (21CMA), by carrying out Monte-Carlo simulations to model the strong contaminating foreground of the redshifted cosmological reionization signals, including emissions from our Galaxy, galaxy clusters, and extragalactic discrete sources (i.e., star-forming galaxies, radio-quiet AGNs, and radio-loud AGNs). By introducing a new approach designed on the basis of independent component analysis (ICA) and wavelet detection algorithm, we prove that, with a cumulative observation of one month with the 21CMA array, about 80% of bright galaxy clusters can be safely identified and separated from the overwhelmingly bright foreground. By examining the brightness temperature images and spectra extracted from these identified clusters, we find that the morphological and spectroscopic distortions are extremely small as compared to the input simulated clusters, even for the clusters that are fainter than the confusion limit. Furthermore, aiming to correctly restore the redshifted 21 cm signals emitted by the neutral hydrogen during the cosmic reionization processes, we re-examine the separation approaches based on the quadratic polynomial fitting technique in frequency space. At $z=8$ and the noise level of 60 mK we find that a significant part of Mpc-scale components of the 21 cm signals is lost because it tends to be mis-identified as part of the foreground when single-narrow-segment separation approach is applied. The best restoration of the 21 cm signals can be obtained with the three-narrow-segment fitting technique as proposed in this paper. Similar results can be obtained at other redshifts.