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# kSZ Tomography with Foregrounds and Systematics

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Much of what we know of the early universe comes from observations of the cosmic microwave background (CMB): a 13 billion-year-old field of microwave radiation that permeates the entire universe. Recent technological advances have made real the possibility of combining CMB measurements with other large data sets to extract hitherto inaccessible cosmological information. One such example is the novel technique of kinetic Sunyaev Zel'dovich (kSZ) tomography in which one combines a CMB temperature map with the positions and distances of galaxies across the sky, using statistical correlations between high-fidelity maps to reconstruct the velocity of those galaxies at the largest angular scales and over an appreciable fraction of the volume of the universe. At these scales and distances the motion of large-scale structure owes its statistical properties to the conditions of the early universe; measuring this velocity map would therefore provide an independent probe into the physics of that era.

The primary challenge in extracting a velocity map using kSZ tomography is characterizing the dominant sources of uncertainty introduced by non-idealities such as redshift measurement error, incomplete sky coverage, galactic and extragalactic contaminants, and confusion with other physical effects in the CMB. To this end we have designed a pipeline to perform the reconstruction using next-generation CMB and galaxy survey data that incorporates these contaminants into its design. We account for redshift errors and demonstrate that masking and other cut sky effects do not influence the reconstruction fidelity. We show that galactic processes do not contribute to the reconstruction noise, and estimate the impact of extragalactic sources that mimic the kSZ signal. We demonstrate that reconstruction is possible with data from next generation surveys and forecast how well the pipeline will perform with realistic contaminants. We estimate a strong signal-to-noise of the velocity map on large scales, making it a new data product on the cutting edge of cosmological research, as the field turns its attention to upcoming high-resolution datasets.

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