Precision Simulations of Cosmic Dawn Experiments

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Redshifted 21 cm emissions offer a faint view into an otherwise dark period of the universe's history – the so-called *Cosmic Dawn*, when the first ionizing sources formed and began heating and reionizing the intergalactic medium. A successful measurement of the 21 cm power spectrum from this time would provide a three-dimensional picture of large-scale structure formation and an insight into the astrophysics behind early star and galaxy formation. The expected signal is unfortunately overwhelmed by foregrounds, like synchrotron emission from the galaxy and extragalactic point sources, that can be over 10^5 times brighter. Successfully removing these foregrounds requires a high level of sensitivity and a detailed knowledge of the data processing pipeline. Communication among the various pipelines for different EoR experiments is an important step toward checking consistency among their results.

FHD (Fast Holographic Deconvolution) is a purpose-built software framework for calibration, imaging, and foreground subtraction. It has been developed to work on data from the Murchison Widefield Array (MWA), but can be readily applied to other instruments. The FHD imaging algorithm, a variant of A-projection and forward modeling, uses the primary beam of the antenna to both grid data and simulate foregrounds. Beginning with a catalog of known bright sources and a set of data, FHD generates a set of model visibilities by convolving the antenna response with a sky model in the uv plane. The data are then gridded with the primary beam, and the model visibilities subtracted from the data.

The forward-modeling feature of FHD may be used as a standalone instrument simulation tool. By setting up the parameters of a particular observation session and providing a catalog of sources and an antenna model, FHD will generate a set of visibilities resembling data from existing or future instruments. These visibilities may then be passed along to different power spectrum estimators. I will discuss FHD simulations of the new MWA Hex configuration, PAPER-128, and HERA-19 as they compare to the latest data from these experiments. I will also discuss simulations of the upcoming HERA-37 and HERA-250 arrays to demonstrate their capabilities with different reionization models.