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Artificial Neural Networks in Foreground Removal from Low Frequency Cosmological Observations

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The cosmological 21cm signal is an excellent probe and could be a powerful diagnostic to test cosmological theories. The 21 cm line of neutral hydrogen presents a unique probe of the evolution of the neutral intergalactic medium (IGM), and cosmic reionization. There are many advantages of using the HI line for this purpose. The HI line provides rich information of the evolution of cosmic structure. The interplay between the CMB temperature, the kinetic temperature and the spin temperature, along with radiative transfer, lead to very interesting physics of the 21cm signal. The HI 21cm observations can be used to study evolution of cosmic structure from the linear regime at high redshift (i.e., density-only evolution), through the non-linear regime associated with luminous source formation (Barkana 2005).

The hyperfine transition line of atomic hydrogen (in the ground state) arises due to the interaction between the electron and proton spins. The spin temperature primarily determines the intensity of the 21cm radiation. The differential brightness temperature of the spin temperature with respect to the CMB background is an estimate of the global 'all sky-averaged' redshifted 21cm signal from Cosmic Dawn and Epoch of Reionization (Mirocha et al. 2015).

There are two major challenges faced while trying to detect the global signal. One involves foregrounds and the other involves calibration. Radio emission from our galaxy as well as terrestrial radio emission dominates the feeble signal we are trying to detect. This foreground includes galactic and extragalactic sources. The expected signal is about 10^4 times weaker than the foreground emission.

Here, we have used ANN (artificial neural network) to extract faint 21cm global signal in presence of significantly dominant foreground. The training process for an ANN is an iterative procedure that begins by collecting the data and preprocessing it to make training more efficient. In this type of network, the information flow is unidirectional that takes place with the help of an activation function between each layer. First, we create a set of models for 21cm global signal using *ARES* (Mirocha et al. 2015) within frequency range of 20-160 MHz or redshift range of ~ 8 to 68. The foreground model is created and added to the signal models. We have not included any instrumental white noise in the training datasets so that we can test the efficiency of the network by introducing increasing noise in the test dataset.

Our preliminary results show proper recovery of the global signal with required accuracy. We will also report some results from detailed instrumental modeling with respect to several ground based global signal observations.

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