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Enabling hydrogen intensity mapping

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Neutral hydrogen 21-cm emission traces the Universe's large-scale structure. In par- ticular, if we relax the requirement of galaxy detection and integrate all radiation, we efficiently probe extensive areas, preserving the accurate distance information from the 21-cm line. This strategy is called Intensity Mapping (IM). IM is an emerging science field; many new or planned instruments can perform such surveys, such as the MeerKAT telescope, a precursor to SKAO. However, IM measurements face formidable challenges, and no direct detection has yet been per- formed. The main reason is that the foregrounds are orders of magnitude more intense than the signal, translating any possible tiny leakage due to the instruments'imperfections and calibration uncertainties into catastrophic contamination. I will discuss ways forward. On the one hand, we can use algorithms borrowed from signal processing to separate the cosmological signal effi- ciently. For example, within the MeerKLASS collaboration –which is conducting an IM survey at redshift less than 1.5 with MeerKAT, we started an effort to test and optimize the available foreground removal methods directly on data (e.g., PCA, FastICA, mixGMCA, GPR). I will show preliminary results. On the other hand, theoretical insights and adapted statistical methods can also help us retrieve the signal. In this respect, I'll present results showing how 2- and 3-point correlations of the signal alone or in cross-correlation with other probes can pin down the IM field. In perspective, these ongoing efforts are crucial for making IM experiments competitive for cosmology.

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