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Modeling the 21-cm signal from the Cosmic Dawn

The birth of the first stars, black holes and galaxies heralded the end of the cosmic Dark Ages and the beginning of the Cosmic Dawn. The light from these objects heated and ionized almost every atom in existence, culminating in the Epoch of Reionization: the final major phase change of the Universe. This final frontier of astrophysical cosmology is undergoing a transition from an observationally-starved epoch to a "Big Data" field. This process is set to culminate with upcoming Square Kilometre Array interferometric observations of the redshifted 21-cm line: providing a 3D map of the first billion years of our Universe. With the SKA, we will be able to actually study the UV and X-ray properties of the first galaxies, as well as physical cosmology, which are encoded in the large-scale structure of the 21-cm signal.
I will review the current status of observations of the EoR and Cosmic Dawn, before discussing the main challenges in modeling the 21-cm signal: a huge range of relevant scales and a large parameter space of astrophysical uncertainties. I will review how simulations have adapted to address these challenges. Finally, I will introduce a Bayesian forward-modeling framework capable of on-the-fly sampling of 3D simulations, allowing us to simultaneously infer the properties of the unseen first galaxies and physical cosmology encoded in the 21-cm signal.

Presenter: Prof. MESINGER, Andrei (Scuola Normale Superiore)