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Deep learning 21cm light-cones in 3D

Interferometric measurements of the 21cm signal with the Square Kilometre Array are a prime example of the data-driven era in astronomy and astrophysics we are entering with current and upcoming experiments. To optimally learn the Universe from low to high redshift I advocate for the use of multiple lines (multi-line intensity mapping) and complementary galaxy survey data, as well as the development of well-tailored modern machine learning techniques to increase information content inferred and its robustness. Tomography of 21cm intensity maps targeted by SKA-LOW will teach about source properties, IGM state and cosmology during the epoch of reionisation, while imaging with SKA-MID can tell about HI galaxy properties at lower redshifts. In this talk I firstly showcase the use of deep networks that are tailored for the structure of tomographic 21cm light-cones of reionisation and cosmic dawn to directly infer e.g. dark matter and astrophysical properties jointly without an underlying Gaussian assumption. I compare different architectures and highlight how a comparably simple 3D network architecture (the 3D-21cmPIE-Net) that mirrors the data structure as the best-performing model. I present well-interpretable gradient-based saliency maps and discuss robustness against foregrounds and systematics via transfer learning. I discuss first findings on reliable error calibration on the way to a 3D Bayesian network. I complement these findings with a discussion of lower redshift results for the recent SKA Science Data Challenge 2, where hydrogen 21cm sources where to be detected and characterised in a large (TB), again 3D, cube. I will highlight my team's lessons-learned on the use of machine learning methods for such data, where our networks performed especially well when asked to characterise flux and size of sources bright in 21cm.

Main Topic

Deep learning

Secondary Topic

Participation mode

In person

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