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Fast realistic, differentiable, mock halo generation for wide-field galaxy surveys

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Accurately describing the relation between the dark matter over-density and the observable galaxy field is one of the significant challenges to analyzing cosmic structures with next-generation galaxy surveys. Current galaxy bias models are either inaccurate or computationally too expensive to be used for efficient inference of small-scale information.

In this talk, I will present a hybrid machine learning approach called the Neural Physical Engine (NPE) that addresses this problem. The network architecture, first developed and tested by Charnock et al. (2020), exploits physical information of the galaxy bias problem and is suitable for zero-shot learning within field-level inference approaches.

Furthermore, the model can efficiently generate mock halo catalogues on the scales of wide-field surveys such as Euclid. Finally, I will also show that those generated mocks are consistent with full phase-space halo finders, including the 2-point correlation function.

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