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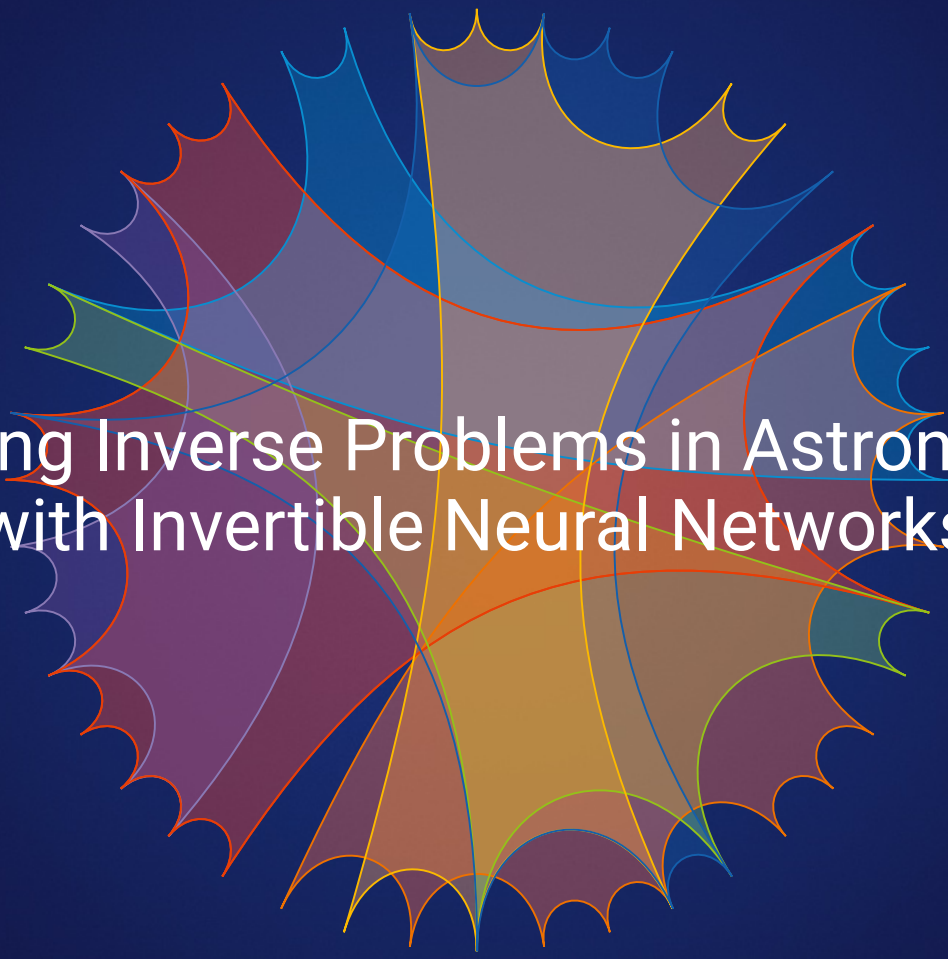

Solving Inverse Problems in Astronomy with Invertible Neural Networks

January 16, 2026, 1:30 PM, Phil 12 GHs

COFFEE & SNACKS IN ROOM 106

ZOOM: Meeting ID: 935 6549 3662, Code: 928036

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ABSTRACT

Astronomy hosts many inverse problems, that is the inference of not-directly measurable physical properties of a system given secondary observables. In many cases, the forward process, which links the physical parameters to the observables, is fairly well understood through sophisticated simulations, whereas the inverse problem tends to be challenging. Due to inherent information loss in the forward mapping, the inverse problem often includes degeneracy, such that different sets of physical parameters may return similar observations, rendering the inference step ambiguous. Classical Bayesian solutions for inverse problems rely usually on the Markov Chain Monte Carlo (MCMC) formalism to compute full posterior distributions of the physical properties. However, depending on the complexity of the inverse problem, they can quickly become prohibitively computationally expensive. The Invertible Neural Network (INN), a deep learning method tailored towards solving inverse problems, offers a computationally efficient alternative. Using a latent space approach to capture the information loss of the forward process, INNs can estimate the full posterior distribution of the physical parameters given an observation, capturing and highlighting potential degeneracies in a given inverse problem. Astronomy has already seen a variety of successful applications of INNs, including the recovery of physical parameters of stars from photometry, the characterisation of exoplanets from atmospheric observations, the analysis of MUSE stellar spectra, or the 3D reconstruction of interstellar dust in star-forming cores from dust emission maps. In this talk, I will introduce INNs for inverse problems, give an overview of the astronomical subjects that we have successfully applied INNs to, and outline our ongoing development.

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