

Bayesian Inference of Initial Conditions from Non-Linear Cosmic Structures using Field-Level Emulators

Ludvig Doeser, Drew Jamieson, Stephen Stopyra, Guilhem Lavaux, Jens Jasche
(Stockholm University)

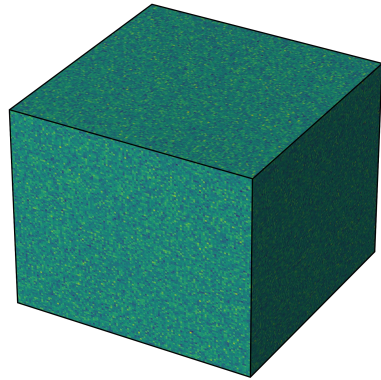
Institut Astrophysique de Paris – ML-IAP/CCA-2023 (Nov 28)



Field-level inference for Full Information Extraction

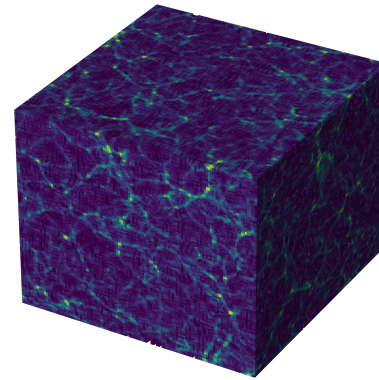


Gaussian initial conditions
at $z \sim 1000$



physics model
→

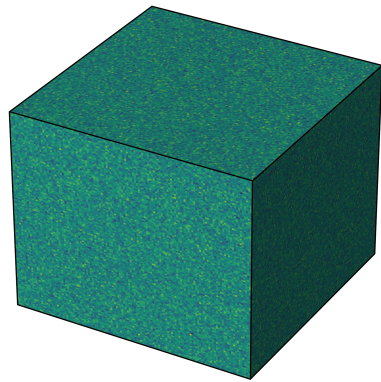
Non-linear cosmic structures
at $z=0$



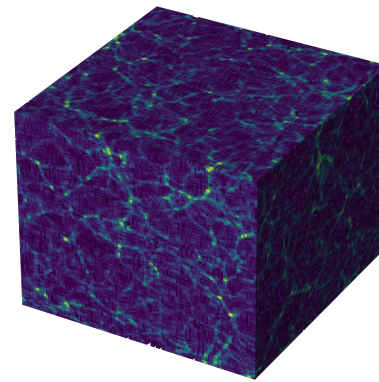
Field-level inference for Full Information Extraction



Gaussian initial conditions
at $z \sim 1000$



Non-linear cosmic structures
at $z=0$



inference*

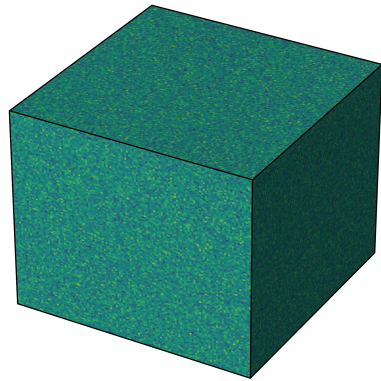


*BORG (Jasche & Wandelt, [1203.3639](#),
Jasche, Leclercq & Wandelt, [1409.6308](#),
Lavaux & Jasche [1509.05040](#))

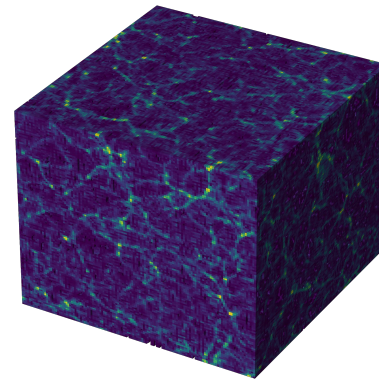
Field-level inference for Full Information Extraction



Gaussian initial conditions
at $z \sim 1000$



Non-linear cosmic structures
at $z=0$



inference*

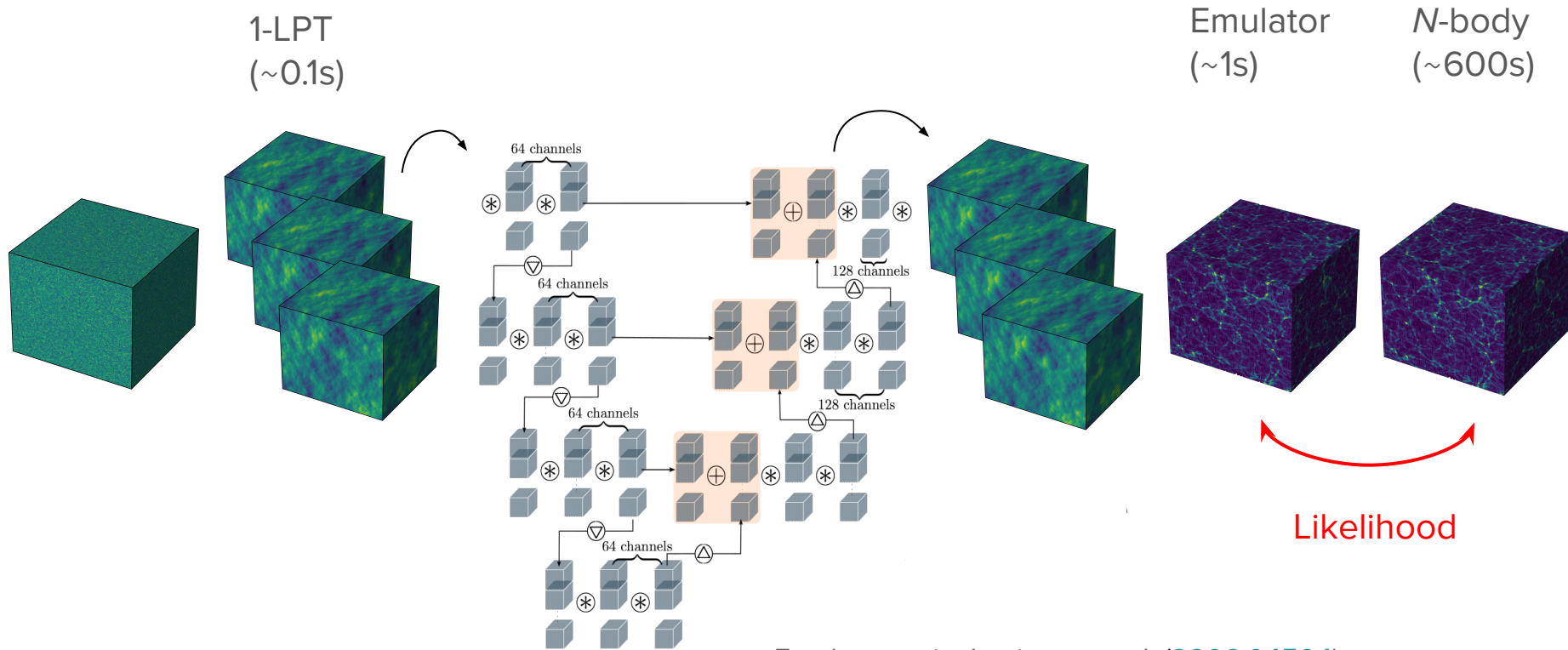


Fast and accurate
physics model

Resolution: $1.95h^{-1}$ Mpc

*BORG (Jasche & Wandelt, [1203.3639](#),
Jasche, Leclercq & Wandelt, [1409.6308](#),
Lavaux & Jasche [1509.05040](#))

V-Net Emulator at Field Level ($250h^{-1}$ Mpc, 128^3 particles)

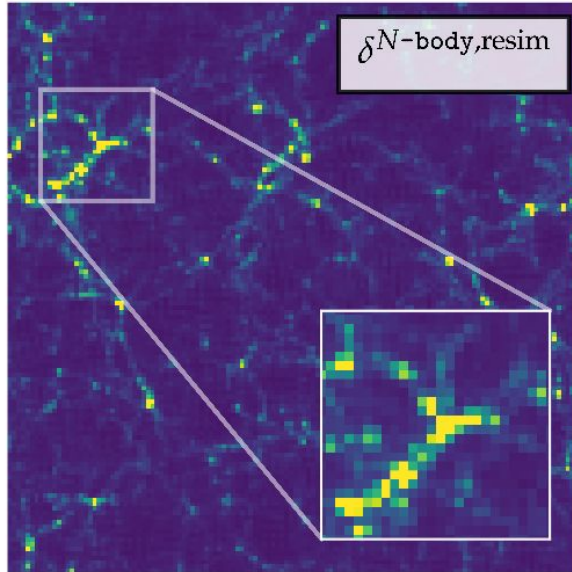


Emulator as in Jamieson et al. ([2206.04594](#))

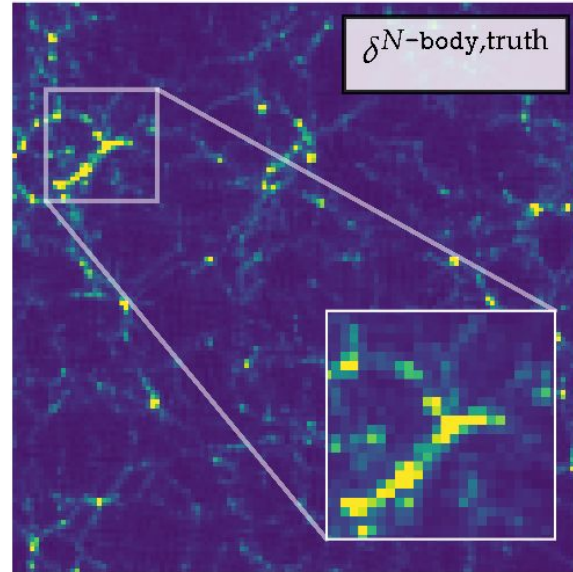
Inferred Initial Conditions in N -body simulations



Posterior Resimulation



Ground truth



Inferred Fields: Percent-level Accuracies with ground truth

