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Inference of neutrino flavor evolution through data assimilation and neural differential equations ERMAL RRAPAJ, University of California, Berkeley, AMOL PATWARDHAN, SLAC National Accelerator Laboratory, EVE ARMSTRONG, Department of Physics, New York Institute of Technology, GEORGE FULLER, Department of Physics, University of California, San Diego — The evolution of neutrino flavor in dense environments such as core-collapse supernovae and binary compact object mergers constitutes an important and unsolved problem. Its solution has potential implications for the dynamics and heavy-element nucleosynthesis in these environments. In this paper, we build upon recent work to explore inference-based techniques for the estimation of model parameters and neutrino flavor evolution histories. We combine data assimilation, ordinary differential equation solvers, and neural networks to craft an inference approach tailored for non-linear dynamical systems. Using this architecture, and a simple two-neutrino-beam, two-flavor model, we compare the performances of nine different optimization algorithms and expand upon previous assessments of the efficacy of inference for tackling problems in flavor evolution. We find that employing this new architecture, together with evolutionary optimization algorithms, accurately captures flavor histories in the small-scale model and allows us to quickly explore both model parameters and initial flavor content. In future work we plan to extend these inference techniques to large numbers of neutrinos.

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