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Extracting equation of state from neutron star observation using machine learning

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First-principles evaluation of the dense matter equation of state is one of the longstanding problems in QCD. Owing to the advances in neutron star observations in last decade, it is now possible to evaluate the equation of state from the observational data. As it circumvent the problems that are inherent in the theory, it may put significant constraint on the theory. Here we discuss a novel method of machine learning to deduce the equation of state from a set of mass-radius observational data, which is alternative to the Bayesian analysis based on different principle. Using test data (mock observational data) we confirm that the equation of state is correctly reconstructed and this method works well. We use state of the art observational data of mass-radius measured from neutron star X-ray radiations as an input, and estimate the equation of state. We confirm that the speed of sound calculated from the equation of state is surpassing the conformal limit (1/3 of speed of light) as expected earlier. Our results are consistent with extrapolation from the conventional nuclear models and the experimental bound on the tidal deformability inferred from gravitational wave observation.

[1] Y. Fujimoto, K. Fukushima, K. Murase, Phys. Rev. D 98, 023019 (2018).

[2] Y. Fujimoto, K. Fukushima, K. Murase, arXiv:1903.03400 [nucl-th].

Primary author: Mr FUJIMOTO, Yuki (The University of Tokyo)

Presenter: Mr FUJIMOTO, Yuki (The University of Tokyo)

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