Contribution ID: **3** Type: **not specified**

Physics-Informed Neural Networks for Holographic Minimal Surfaces: Instanton Effects and Topology Change in Gluon Scattering

We describe two related developments at the intersection of string theory, holography, and scientific machine learning. First, we develop a flexible physics-informed neural network (PINN) framework to solve boundary value problems for minimal surfaces in curved spacetimes, with a particular emphasis on handling singular geometries and moving boundaries. The method encodes the governing equations and boundary conditions directly into the loss, enabling accurate solutions for challenging setups relevant to AdS/CFT. Second, we analyze instanton effects on gluon scattering amplitudes in N=4 supersymmetric Yang–Mills theory at strong coupling and large N. Using the holographic Wilson-loop minimal surface description of these amplitudes, we find that in the presence of instantons the relevant worldsheets can undergo nontrivial topology change. We outline how the PINN framework can be adapted to capture such topology-changing configurations and boundary dynamics, providing a practical computational tool for exploring instanton-corrected holographic observables. This joint perspective demonstrates the promise of data-driven approaches for reconstructing minimal surfaces in singular spacetimes and for quantifying nonperturbative effects in gauge/string duality, with applications to precision studies of scattering amplitudes and related observables.

Authors: OGIWARA, Gakuto (Saitama Institute of Technology); Mr KYO, Koichi (Kyoto University); HASHIMOTO, Koji (Kyoto University); MURATA, Masaki (Saitama Institute of Technology); Dr TANAHASHI, Norihiro (Kyoto University)

Presenter: OGIWARA, Gakuto (Saitama Institute of Technology)