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The Mallat Scattering Transform for Reduced Order Modelling of Partial Differential Equations. FRANCIS OGOKE, Carnegie Mellon University, MICHAEL GLINSKY, Sandia National Laboratories, AMIR BARATI FARIMANI, Carnegie Mellon University — The development of data-driven models to describe physical phenomenon requires frameworks that are physically principled and generalizable. We present a data-driven framework for reduced order modeling of continuum physics by harnessing the Mallat Scattering Transform (MST). The MST acts as an analogue to the traditional Convolutional Neural Network framework with predefined, physics-informed weights to aggregate information in a scale-dependent manner while preserving conservation properties. The transform provides a state based representation of the physics and time-independent rate coefficients describing their evolution, which can be determined using a modified version of the Generalized Master Equation. This framework reduces the amount of parameters that must be independently optimized compared to similar data-driven models, while enforcing the necessary conditions like diffeomorphic continuity. The framework also produces descriptors of the dynamics that are translatable to the underlying physical principles governing the behavior of the PDE. We demonstrate the efficacy of the framework by surrogating the behavior of one-dimensional linear and non-linear Partial Differential Equations, such as the Burgers' Equation. SNL is managed and operated by NTESS under DOE NNSA contract DE-NA0003525.

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