

**A NEURAL NET VIEW ON INTEGRABILITY: ON MATCHING
DYNAMICAL SYSTEMS THROUGH KOOPMAN OPERATOR
EIGENFUNCTIONS**

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Matching dynamical systems, through different forms of conjugacies and equivalences, has long been a fundamental concept, and a powerful tool, in the study and classification of non-linear dynamic behavior (e.g. through normal forms). In this presentation we will argue that the use of the Koopman operator and its spectrum are particularly well suited for this endeavor, both in theory, but also especially in view of recent data-driven machine learning algorithmic developments. Recall that the Koopman operator describes the dynamics of observation functions along a flow or map, and it is formally the adjoint of the Frobenius-Perron operator that describes evolution of densities of ensembles of initial conditions. The Koopman operator has a long theoretical tradition but it has recently become extremely popular through numerical methods such as dynamic mode decomposition (DMD) and variants, for applied problems such as coherence and also in control theory. We demonstrate through illustrative examples that we can nontrivially extend the applicability of the Koopman spectral theoretical and computational machinery beyond modeling and prediction, towards a systematic discovery of rectifying integrability coordinate transformations.