RydEx24_Abstract_poster_egenlauf

Application of machine learning to find exceptional points

P. Egenlauf[1,2,3,*], P. Rommel[4], J. Main[4]

[1]*Stuttgart Center for Simulation Science, SimTech Cluster of Excellence EXC 2075, University of Stuttgart, Pfaffenwaldring 5a, Stuttgart, Germany.*
[2]*Interchange Forum for Reflecting on Intelligent Systems, IRIS3D, University of Stuttgart, Universitätsstraße 32, Stuttgart, Germany.*
[3]*International Max Planck Research School for Intelligent Systems (IMPRS-IS), Hofgartenstraße 8, Munich, Germany.*
[4]*Institute for Theoretical Physics I, University of Stuttgart, Pfaffenwaldring 57, Stuttgart, Germany.*
**e-mail: patrick.egenlauf@simtech.uni-stuttgart.de*

At an exceptional point (EP), both the eigenvalues and eigenvectors in non-hermitian Hamiltonians degenerate. EPs can occur in Rydberg systems in external electric and magnetic fields for specific field strengths. For excitons in cuprous oxide they exist at experimentally accessible field strengths. In general, such systems depend on a parameter $\kappa \in \mathbb{C}$, which corresponds to the fields ($\mathrm{Re}(\kappa) \equiv B$and $\mathrm{Im}(\kappa) \equiv E$) in physical systems. The imaginary part of the complex eigenvalue describes the lifetime of the quasi-bound state (resonance).

Due to the very time consuming calculations of eigenvalues for a physical system, a machine learning method is presented, which aims to minimize the number of diagonalizations by estimating the EP [1]. This is achieved by training a Gaussian process regression model on an initial set of eigenvalues belonging to an EP and performing a root search on the prediction. By adding the exact eigenvalues of the prediction to the training set, an accurate estimate of the position of the EP in the parameter space can be achieved iteratively.

References

[1] Patrick Egenlauf, Patric Rommel and Jörg Main, "Gaussian-process-regression-based method for the localization of exceptional points in complex resonance spectra", *Mach. Learn.: Sci. Technol.* **5,** 015045 (2024).