MP 4: Dynamics and Chaotic Behaviour

Time: Wednesday 11:00–12:30 Location: ZHG001

Invited Talk MP 4.1 Wed 11:00 ZHG001

Focusing dynamics for 2d Bose gases in the instability regime — •Lea Bossmann — FAU Erlangen-Nürnberg

We consider the dynamics of a 2d Bose gas with singular attractive interactions in the instability regime, where the corresponding focusing nonlinear Schrödinger equation (NLS) has a blow-up. We show that the evolution of the condensate is effectively described by this NLS for all times before the blow-up. Moreover, we prove the validity of the Bogoliubov approximation for the fluctuation dynamics, resulting in a norm approximation of the many-body dynamics. This is joint work with Charlotte Dietze and Phan Thành Nam.

MP 4.2 Wed 11:30 ZHG001

Chaotic Quantum Scattering and Supersymmetry: Exact Distributions in the Symplectic Case — •Nils Gluth and Thomas Guhr — Universität Duisburg-Essen, Duisburg, Deutschland

Scattering theory is a powerful tool with applications to a large variety of different systems in quantum physics and in the physics of classical waves. Often, such systems are complex or in a broad sense chaotic, calling for statistical approaches, in particular Random Matrix Theory. A few years ago, we put forward a variant of the Supersymmetry method to exactly calculate full distributions of scattering matrix elements and cross sections. Here, we focus on the previously not considered symplectic symmetry class which is relevant for certain spin systems. We exploit similarities in superspace to the unitary as well as to the orthogonal class. We extend and reformulate previous work on the corresponding supermanifolds.

MP 4.3 Wed 11:50 ZHG001

Complex symmetric, self-dual, and Ginibre random matrices: Analytical results for three classes of bulk and edge statistics — •Noah Ayguen — Bielefeld University, Bielefeld, Germany

The energy eigenvalues of chaotic quantum systems are expected to follow random matrix statistics, where closed systems relate to Hermitian random matrices while open systems with complex eigenvalues relate to non-Hermitian matrices. The random matrix model depends on the corresponding symmetry class of the physical systems under consideration. Recently, based on numerics, it has been conjectured that among such classes of non-Hermitian random matrices only three different local bulk statistics of complex eigenvalues exist. Motivated by these new insights, we find new analytic results for expectation values of characteristic polynomials, using the technique of Grassmann variables. The simplest representatives of these 3 bulk statistics are the Gaussian ensembles of well-known complex Ginibre matrices, complex symmetric, and complex self-dual random matrices. In the Cartan classification scheme of non-Hermitian random matrices they are labelled as class A, $\mathrm{AI}^{\dagger}$ and $\mathrm{AII}^{\dagger}$, respectively. (Based on joint work with G. Akemann, M. Kieburg, P. Päßler arXiv:2410.21032)

MP 4.4 Wed 12:10 ZHG001

Quantum chaos and complexity from string scattering amplitudes — •Aranya Bhattacharya[1] and Aneek Jana[2] — [1]Institute of Physics, Jagiellonian University, Lojasiewicza 11, 30-348 Krakow, Poland — [2]Centre for High Energy Physics, Indian Institute of Science, C.V. Raman Avenue, Bangalore 560012, India

We introduce Krylov spread complexity in the context of black hole scattering by studying highly excited string states (HESS). Krylov complexity characterizes chaos by quantifying the spread of a state or operator under a known Hamiltonian. In contrast, quantum field theory often relies on S-matrices, where the Hamiltonian density becomes non-trivially time-dependent rendering the computations of complexity in Krylov basis exponentially hard. We define Krylov spread complexity for scattering amplitudes by analyzing the distribution of extrema, treating these as eigenvalues of a fictional Hamiltonian that evolves a thermo-field double state non-trivially. Our analysis of black hole scattering, through highly excited string states scattering into two or three tachyons, reveals that the Krylov complexity of these amplitudes mirrors the behavior of chaotic Hamiltonian evolution, with a pre-saturation peak indicating chaos. This formalism bridges the concepts of chaos in scattering and state evolution, offering a framework to distinguish different scattering processes.