Time arrow and complex spectral analysis of Liouvillian and Hamiltonian dynamics in terms of non-Hermitian operators

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General overview review of recent results of the complex spectral analysis of the Liouvillian dynamics as well as the Hamiltonian dynamics developed by Austin-Osaka group is presented. From the microscopic fundamental laws of physics, time arrow with a broken-time-symmetry can be deduced through the resonance singularities in the so-called small-denominator for the open system. Due to the resonance singularities, the Hermitian generator of motion in the Hilbert space leads to non-Hermitian effective Liouvillian and/or Hamiltonian with complex eigenvalues in the extended function space. These operators share the same eigenvalue with the original Liouvillian and/or Hamiltonian. The imaginary parts of the eigenvalues give the transport coefficients in irreversible processes. In this talk the irreversible process associated to the Jordan block and the so-called exceptional points that have no counter part in Hermitian dynamics will be discussed. Some open problems in the mathematical formation will be also stated.