

Non-Hermitian NRG: Solution of the non-Hermitian Kondo model

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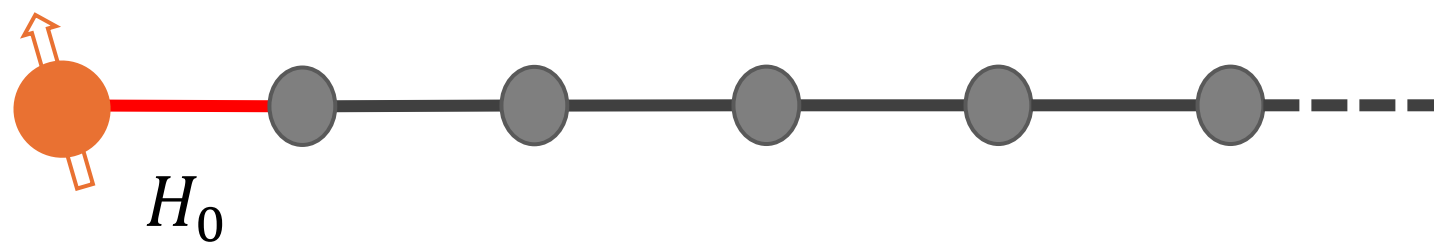
Motivation

- Non-Hermitian Hamiltonians → effective description of open quantum systems
- Need non-perturbative tools for strongly correlated NH many-body systems
- Introduce **NH-NRG** for solving NH quantum impurity models

NH Numerical Renormalization Group

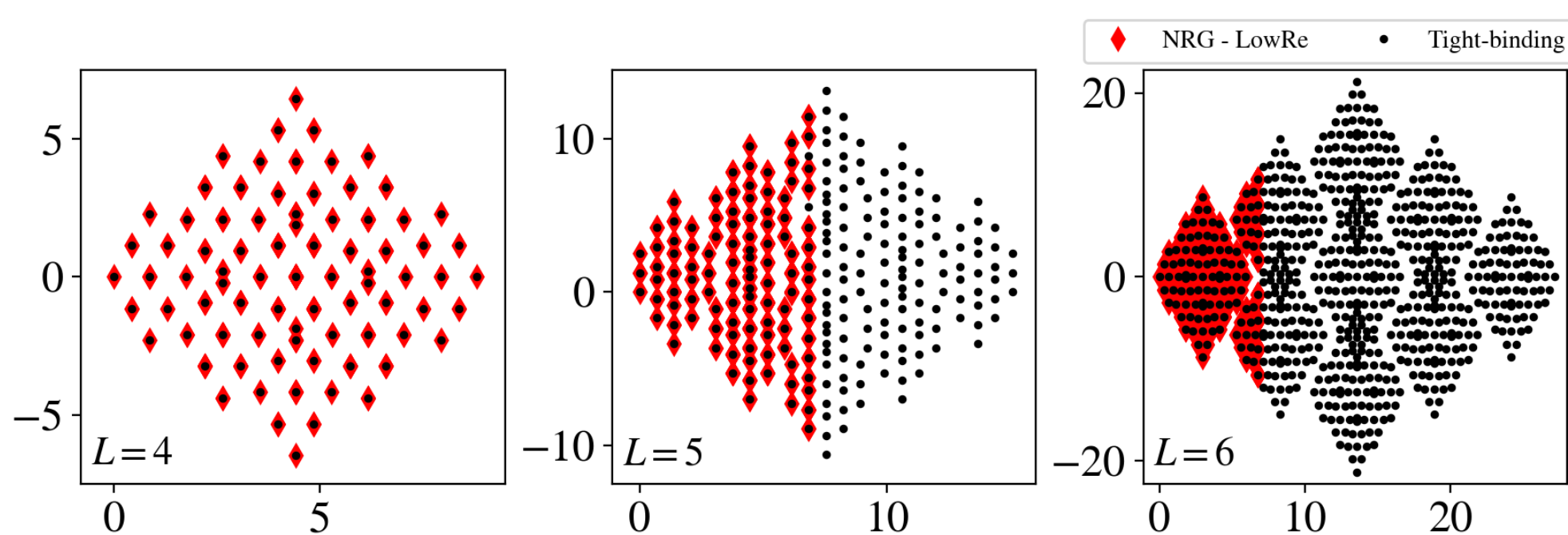
Numerical Renormalization Group¹ (NRG):

1. Logarithmically discretize infinite bath
2. Map to *Wilson chain*
3. Iteratively construct & diagonalize Hamiltonian
4. Truncate to lowest lying energy levels



Non-Hermitian NRG:

- **Iteratively construct with left and right eigenstates²**
- NH implies complex spectrum → Choice of truncation
- Lowest real truncation is natural, and stable⁴



Non-Hermitian Kondo Model

$$H = H_{bath} + J S_{imp} \cdot S_0, \quad J = J_R - i J_I$$

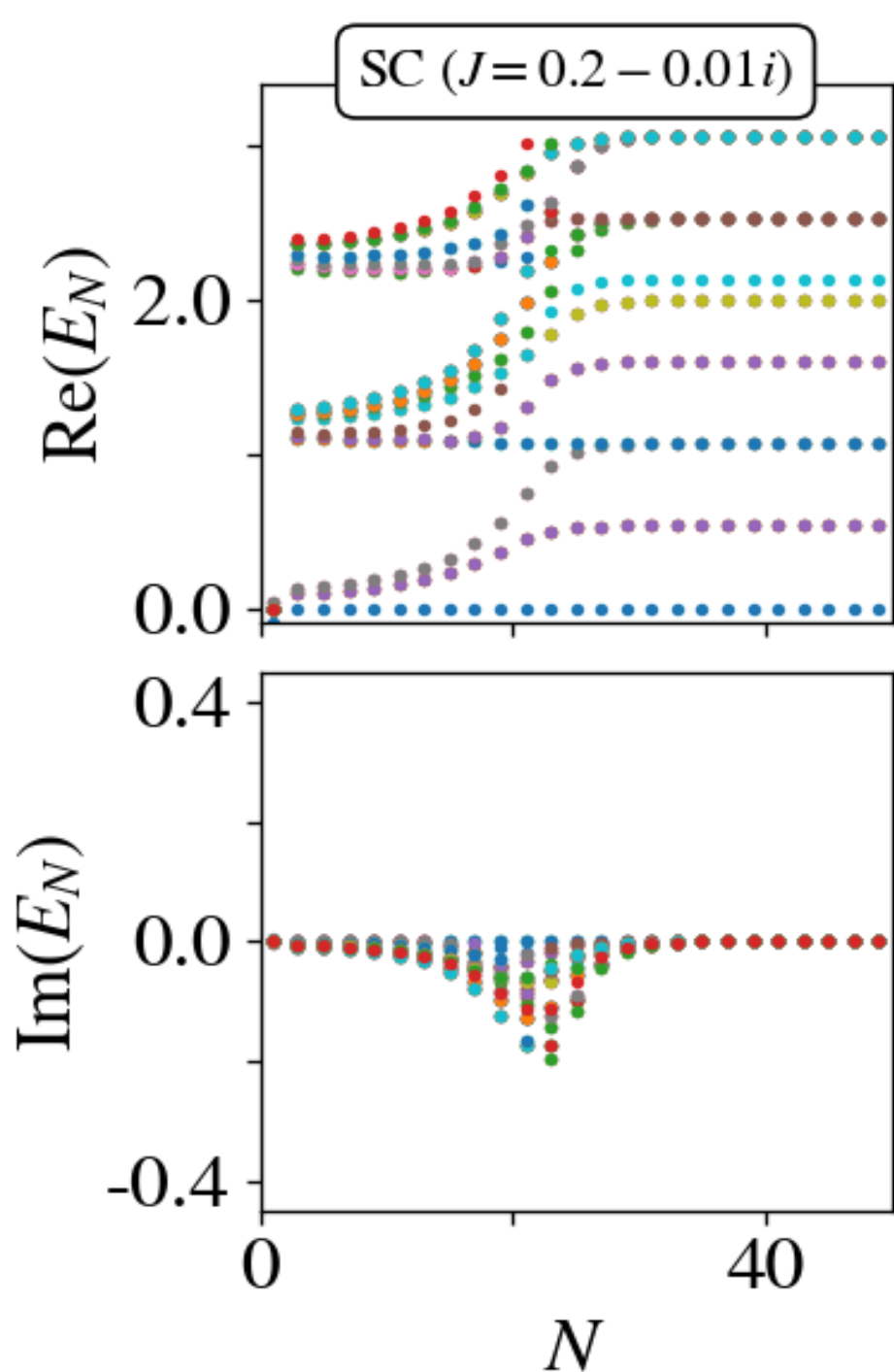
- Dissipative coupling to impurity → two-body loss³

- **Emergent Real Fixed points despite NH**

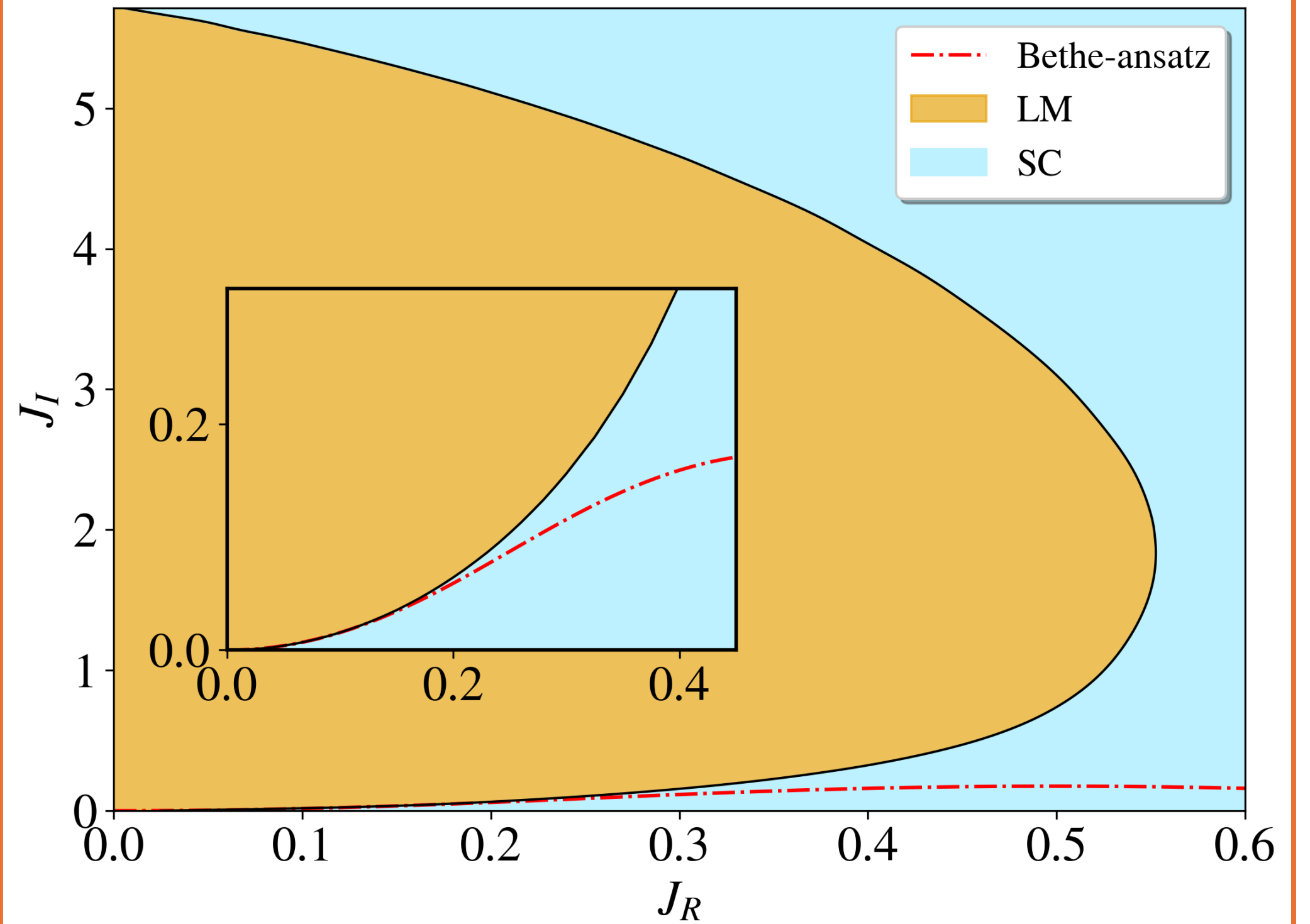
- Imaginary components flow to zero

- Strong coupling and Local Moment FPs from Hermitian model

- Uncover full phase diagram beyond perturbative regime



Dissipative phase diagram

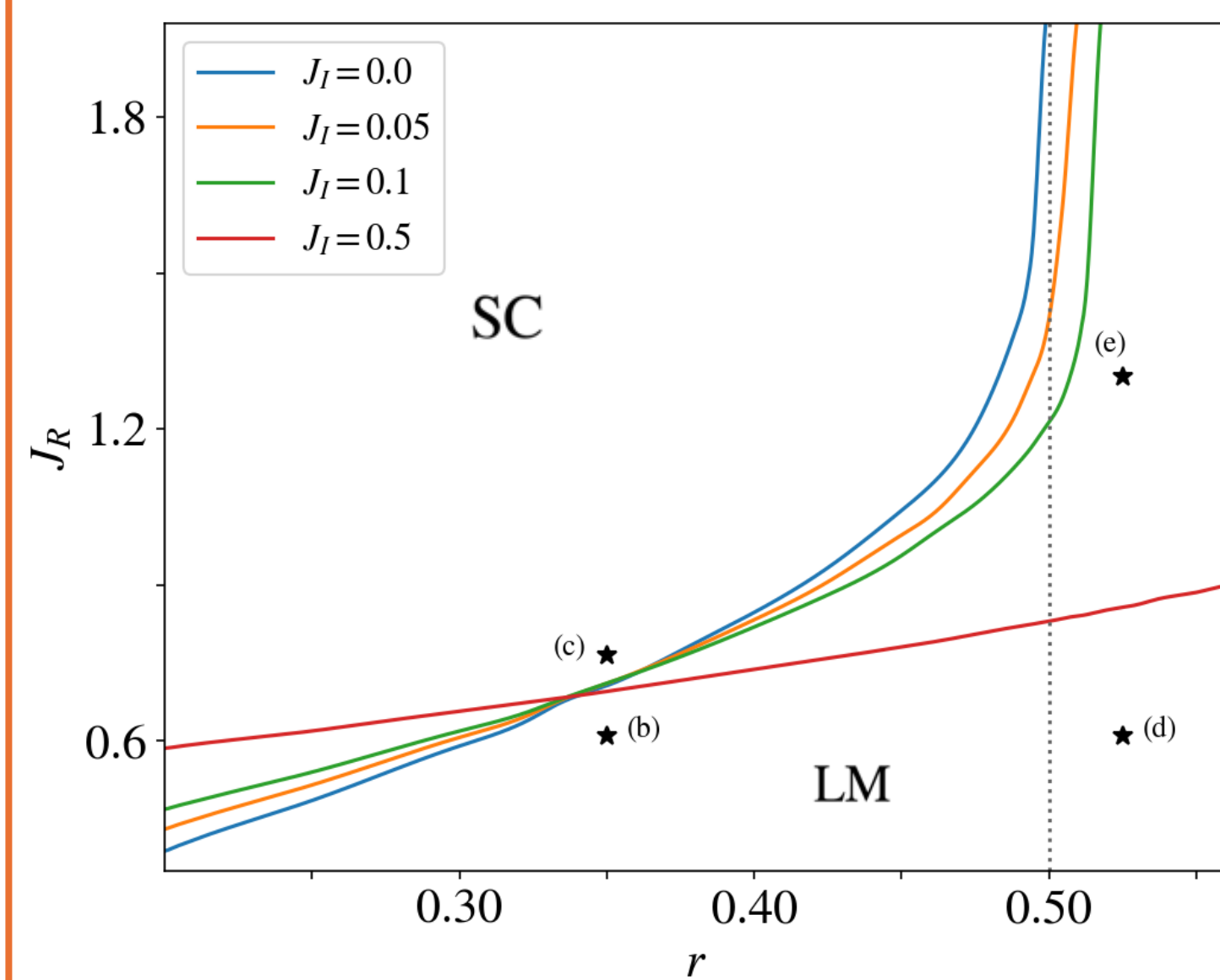


- **Observe interplay of dissipation and correlations**
- Match perturbative results in corresponding regimes
- Re-entrant SC → dissipation induced localization

Non-Integrable Application

- NH-NRG works for non-integrable systems
→ Non-linear density of states

Pseudogap non-Hermitian Kondo model



NH-Kondo
with
 $\rho(\omega) \propto |\omega|^r$

- Construct phase diagram in $J_R - r$ plane for various J_I
- **Uncover novel complex fixed point in dissipative case, for $r > 1/2$**

1. K. G. Wilson, The renormalization group: Critical phenomena and the Kondo problem, Rev. Mod. Phys. 47, 773 (1975)
2. D. C. Brody, Biorthogonal quantum mechanics, J. Phys. A 47, 035305 (2013)
3. M. Nakagawa, N. Kawakami, and M. Ueda, Non-Hermitian Kondo effect in ultracold alkaline-earth atoms, Phys. Rev. Lett. 121, 203001 (2018)

4. NonHermitianNRG - GitHub:

