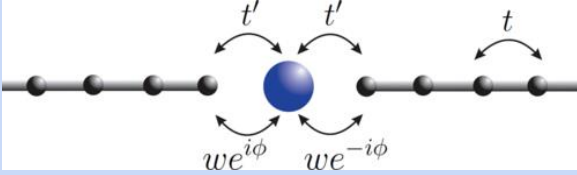# Kondo effect in a non-Hermitian, $\mathcal{PT}$-symmetric Anderson model with Rashba spin-orbit coupling
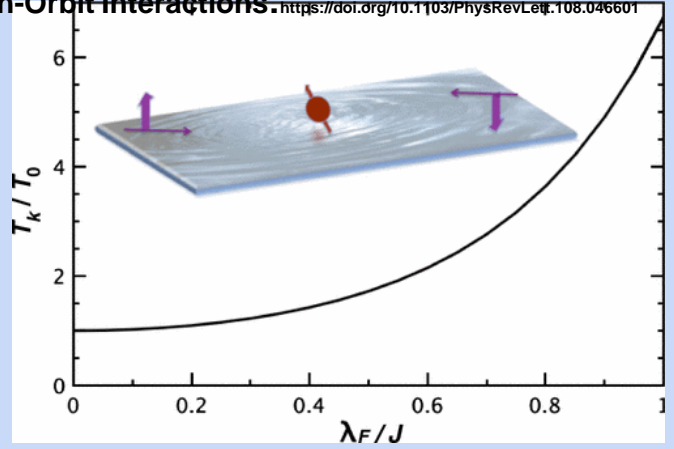
Vinayak M Kulkarni, Amit Gupta and Vidhyadhiraja N.S.   (Under review)
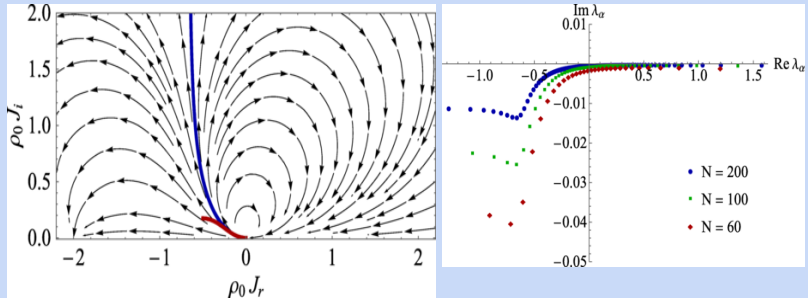
Motivation

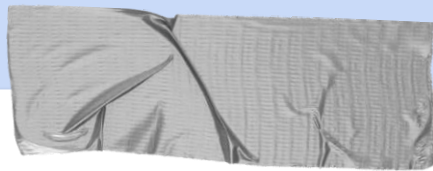**Kondo effect in a $\mathcal{PT}$-symmetric non-Hermitian Hamiltonian:** https://doi.org/10.1103/PhysRevB.98.085126

Enhancement of the Kondo Effect through Rashba Spin-Orbit Interactions: https://doi.org/10.1103/PhysRevLett.108.046601

Non-Hermitian Kondo Effect in Ultracold Alkaline-Earth Atoms; https://doi.org/10.1103/PhysRevLett.121.203001
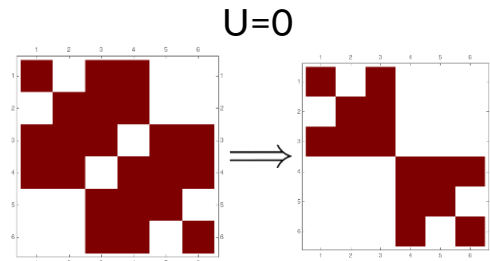
Model and Formalism

$$H = \sum_{\mathbf{k}\sigma} \epsilon_{\mathbf{k}} c_{\mathbf{k}\sigma}^{\dagger} c_{\mathbf{k}\sigma} + \sum_{\sigma} \epsilon_d d_{\sigma}^{\dagger} d_{\sigma} + U n_{d\uparrow} n_{d\downarrow} + \sum_{\mathbf{k}\sigma} V_{\mathbf{k}\sigma} (c_{\mathbf{k}\sigma}^{\dagger} d_{\sigma} + \mathrm{h.c.})$$

$$H_{RSO} = \lambda \sum_k k \left(e^{i\theta_k} c_{k\uparrow}^{\dagger} c_{k\downarrow} + \mathrm{h.c.} \right)$$

Rashba Term

$$c_{\mathbf{k}\sigma} = c_{k_x k_y \sigma} = \frac{1}{\sqrt{2\pi k}} \sum_{m=-\infty}^{\infty} c_{km\sigma} \exp(-im\theta_{\mathbf{k}})$$

Operators in AM basis

$$H_{bath} = \mathcal{U}^{\dagger} (\sum_{km\sigma} \epsilon_k c_{km\sigma}^{\dagger} c_{km\sigma} + H_{RSO}) \mathcal{U}$$

U=0

$$\eta \tilde{H} \eta^{-1} = \tilde{H}^{\dagger}$$

Slave - Boson Solution

$$\frac{\partial \tilde{E}_{tot}}{\partial \zeta} = \mathcal{A}(\tilde{\epsilon}_d, r^2, \theta) + 2r^2 \cos 2\theta - 1$$

$$\frac{\partial \tilde{E}_{tot}}{\partial r^2} = \frac{1}{r^2}\mathcal{B}(\tilde{\epsilon}_d, r^2, \theta) + 2\zeta \cos 2\theta$$

$$\frac{\partial \tilde{E}_{tot}}{\partial \theta} = -2\left[\tan(2(\phi+\theta))\mathcal{B}(\tilde{\epsilon}_d, r^2, \theta) + 2\zeta r^2 \sin 2\theta\right]$$
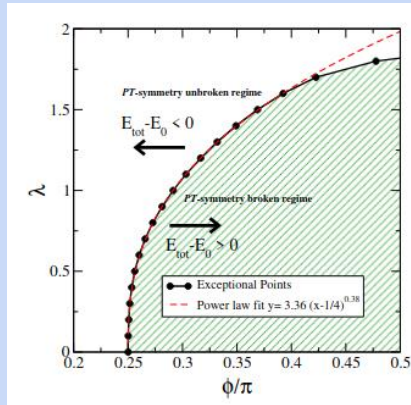
SB-rep and constraint

$$\langle b_L^\dagger \rangle = \langle b_L \rangle = re^{i\theta}$$
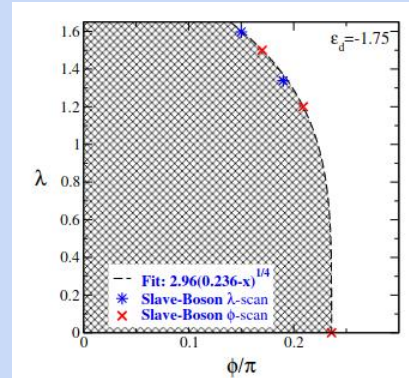$$\langle b_R^\dagger \rangle = \langle b_R \rangle = re^{-i\theta}$$

$$H_{MF} = H_0 + \sum_{k\eta h} \tilde{X}_{k\eta h}\left[c_{k\eta h}^\dagger d_h + \text{h.c.}\right]$$
$$+ \tilde{\epsilon}_d \sum_h n_{dh} + \zeta\left(2r^2 \cos(2\theta) - 1\right)$$
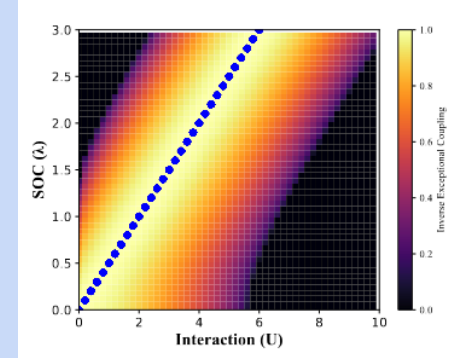
Results And conclusion

Non Interacting Finite D

Slave Boson Full model

Impurity?

That man in the cartoon survive along the line.(Local Moment)

Black region no chance to survive.(Sunk)

Yellow region the man will be in coma (partially screened)

Thank You For Attention