Strong-coupling renormalization group
in the hierarchical Kondo model

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1506.04381
Kondo model

- [P. Anderson, 1961], [J. Kondo, 1964]:

\[ H = H_0 + V \quad \text{on } \mathcal{H} = \mathcal{F}_L \otimes \mathbb{C}^2 \]

- **\( H_0 \): kinetic term of the electrons**

\[ H_0 := \sum_x \sum_{\alpha=\uparrow,\downarrow} c_{\alpha}^\dagger(x) \left( \left( -\frac{\Delta}{2} - 1 \right) c_{\alpha} \right)(x) \otimes 1 \]

- **\( V \): interaction with the impurity**

\[ V = -\lambda_0 \sum_{j=1,2,3} \sum_{\alpha_1,\alpha_2} c_{\alpha_1}^\dagger(0) \sigma_{\alpha_1,\alpha_2}^j c_{\alpha_2}(0) \otimes \tau^j \]
Kondo effect: magnetic susceptibility

- Non-interacting magnetic susceptibility
  
  - Isolated impurity: $\chi^{(0)}(0, \beta) \xrightarrow{\beta \to \infty} \infty$
  
  - Chain of electrons: $\lim_{\beta \to \infty} \lim_{L \to \infty} \frac{1}{L} \chi_e(0, \beta) < \infty$.

- Anti-ferromagnetic interaction: $\lambda_0 < 0$:
  
  $$\lim_{\beta \to \infty} \chi^{(\lambda_0)}(0, \beta) < \infty.$$  

- Strong-coupling effect: the qualitative behavior changes as soon as $\lambda_0 \neq 0$.  

Previous results

• [J. Kondo, 1964]: third order Born approximation.

• [P. Anderson, 1970], [K. Wilson, 1975]: renormalization group approach

• Remark: [N. Andrei, 1980]: the Kondo model (suitably linearized) is exactly solvable via Bethe Ansatz (which breaks down under any perturbation of the model).
Current results

- Hierarchical Kondo model: idealization of the Kondo model that has the same scaling properties.
- It is exactly solvable: reduces the system to a 2-dimensional discrete dynamical system.
- Kondo effect in the hierarchical model.
Open problem

• Usual approach to the Renormalization group: perturb around the uncoupled theory.

• Cannot access strongly-coupled effects.

• Idea: perturb around hierarchical models.

• How? Which hierarchical models?