Strong-coupling renormalization group in the hierarchical Kondo model

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Kondo model

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

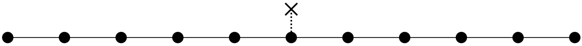
$$H = H_0 + V \quad \text{on } \mathcal{H} = \mathcal{F}_L \otimes \mathbb{C}^2$$

  - H_0: kinetic term of the *electrons*

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

  - V: interaction with the *impurity*

$$V = -\lambda_0 \sum_{j=1,2,3} \sum_{\alpha_1,\alpha_2} c_{\alpha_1}^\dagger(0) \sigma^j_{\alpha_1,\alpha_2} c_{\alpha_2}(0) \otimes \tau^j$$



Kondo effect: magnetic susceptibility

- Non-interacting magnetic susceptibility
  - Isolated impurity: $\chi^{(0)}(0,\beta) \underset{\beta\to\infty}{\longrightarrow} \infty$
  - Chain of electrons: $\lim_{\beta\to\infty} \lim_{L\to\infty} \frac{1}{L}\chi_e(0,\beta) < \infty.$
- Anti-ferromagnetic interaction: $\lambda_0 < 0$:

$$\lim_{\beta\to\infty} \chi^{(\lambda_0)}(0,\beta) < \infty.$$

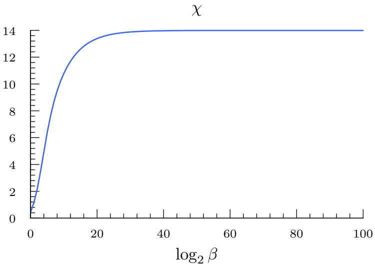
- *Strong-coupling* effect: the qualitative behavior changes as soon as $\lambda_0 \neq 0$.

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?