TAKING ARMS AGAINST A SEA OF TROUBLES

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Part 1: Susceptibility disordered XXZ chain

- Fidelity susceptibility:

$$\chi_n(\lambda) = \sum_{m \neq n} \frac{|\langle m|\partial_\lambda H|n\rangle|^2}{(E_m - E_n)^2}$$

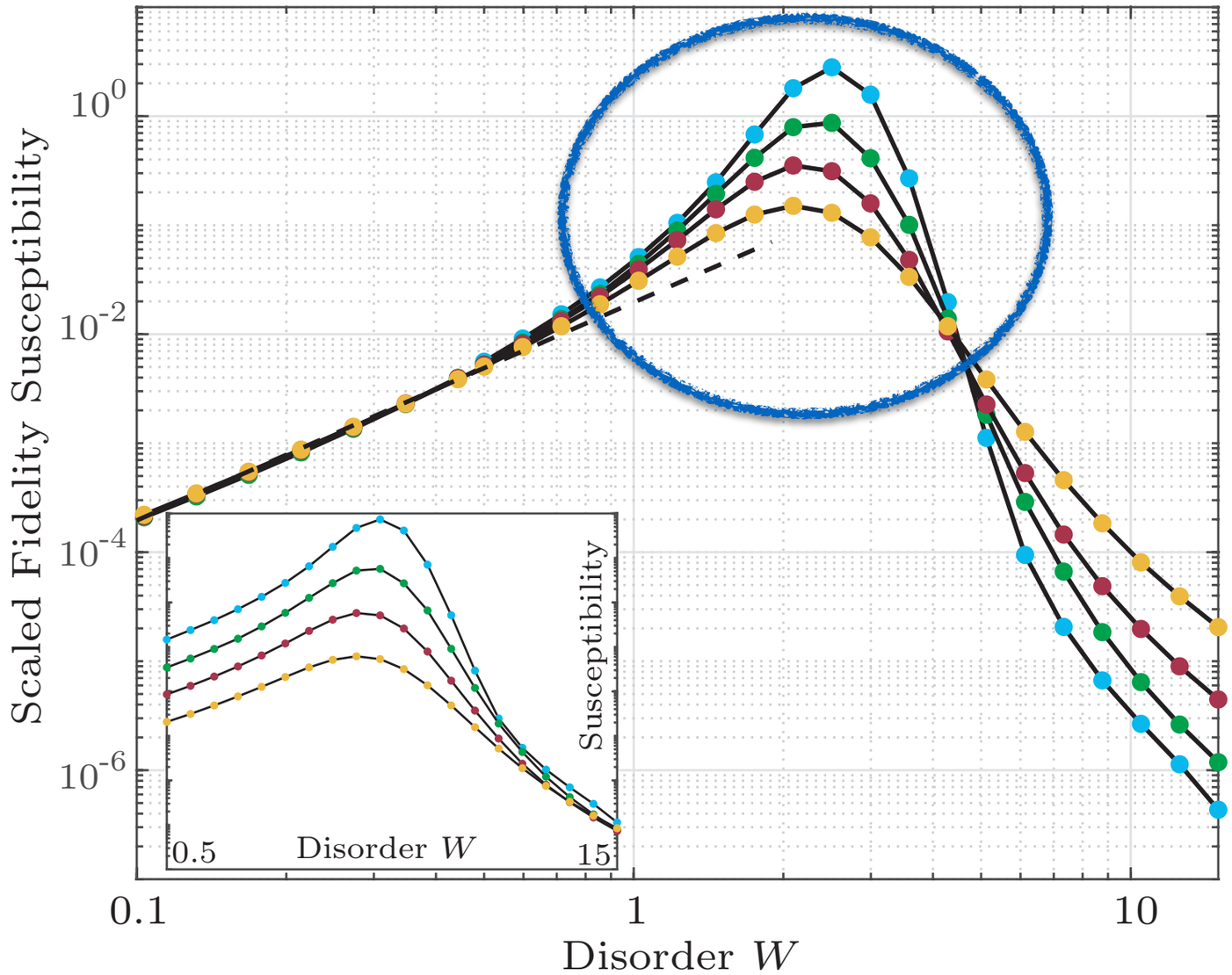
- Typical because of resonances

$$\bar{\chi} = \exp\left(\mathbb{E}\left[\log(\chi)\right]\right)$$

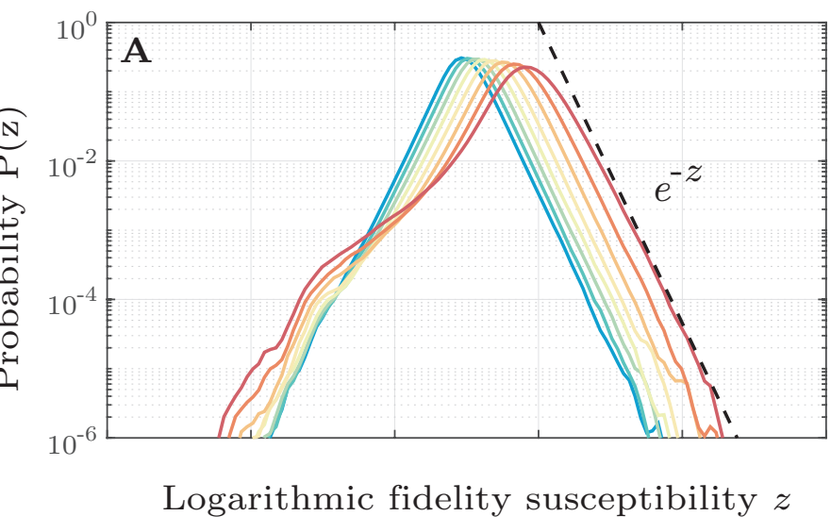
- Data scaled to ETH expectation
- W<0.5 perfect ETH
- W>>10 perturbative

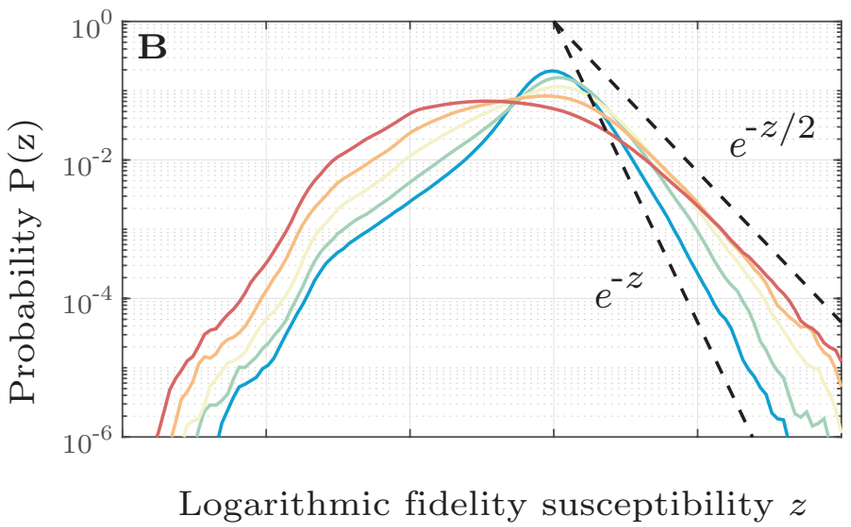
$$\bar{\chi} = W^{-8/3}$$

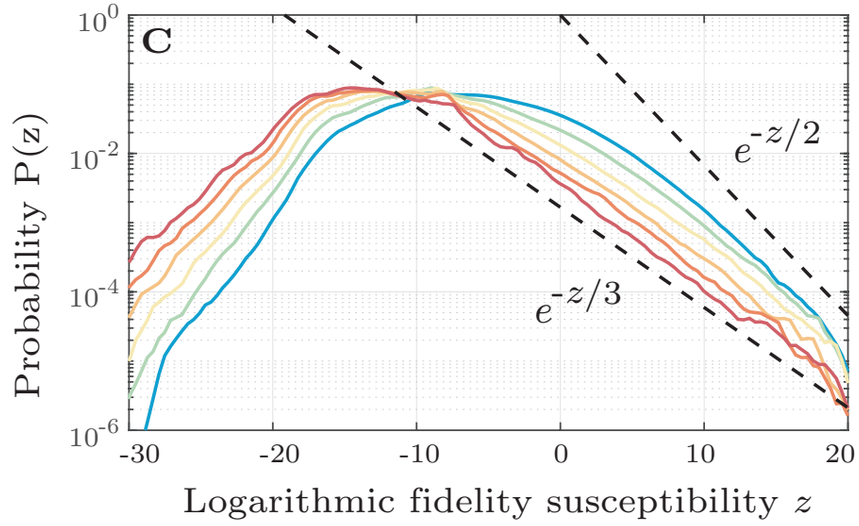
$\Delta = 1.1 \quad L = (12, 14, 16, 18)$



Susceptibility distribution







Distribution: $P(z) = \exp\left(-z\frac{1+\beta}{2+\alpha}\right)$,with: $z = \log[\chi]$

Level spacing: $P(s) = s^{\beta}$

Spectral function: $|f(\omega)|^2 = \frac{1}{\omega^{\alpha}}$

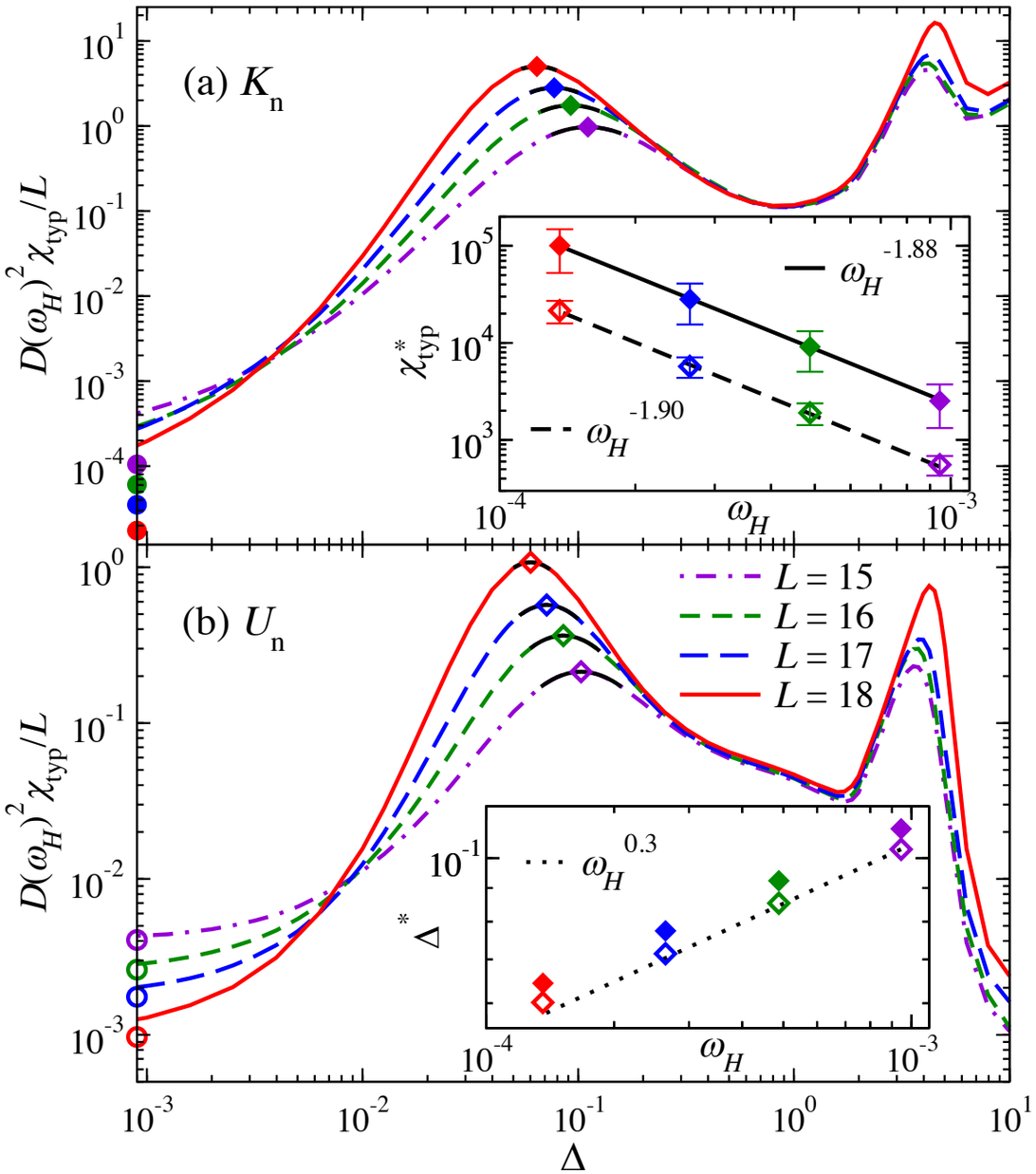
$$\chi_n(\lambda) = \sum_{m \neq n} \frac{|\langle m|\partial_\lambda H|n\rangle|^2}{(E_m - E_n)^2}$$

Anderson Insulator

- Hamiltonian

$$H = \sum_i \left(S_i^x S_{i+1}^x + S_i^y S_{i+1}^y + \Delta S_i^z S_{i+1}^z \right) + \sum_i h_i S_i^z$$

with $h_i \in [-W, W]$, W=0.6 and we change Δ



- Robust ETH regime
- Clear scaling

$$\bar{\chi} \sim \omega_H^{-2}$$

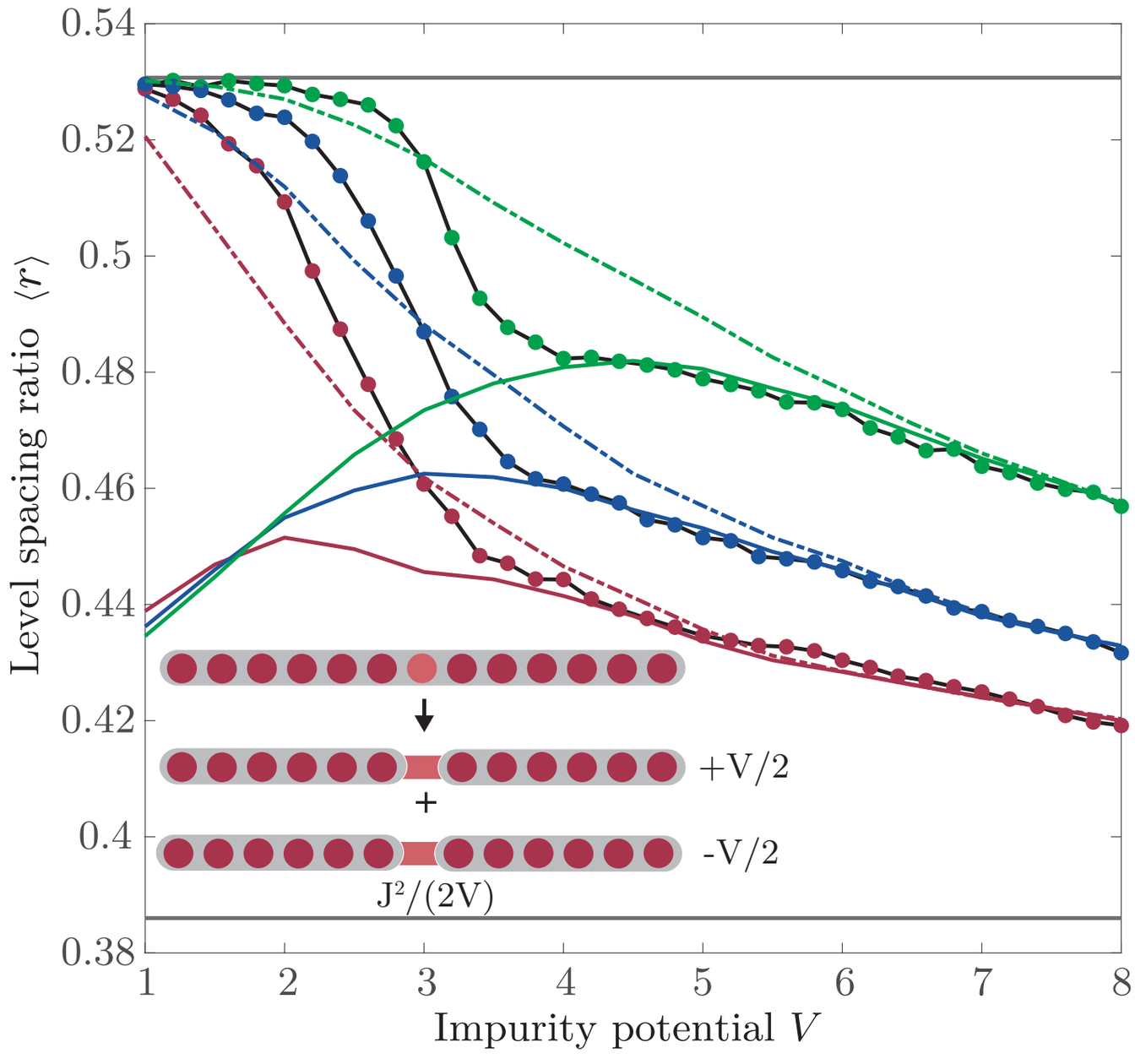
- Fast drift of the peak: consistent with exponential
- $1/\omega^2$ spectral function: consistent with Fermi's golden rule

Part 2: Impurity problem

- Just one impurity
- Onset of “ergodicity breaking” when impurity starts to freeze
  - FGR rate reaches level spacing

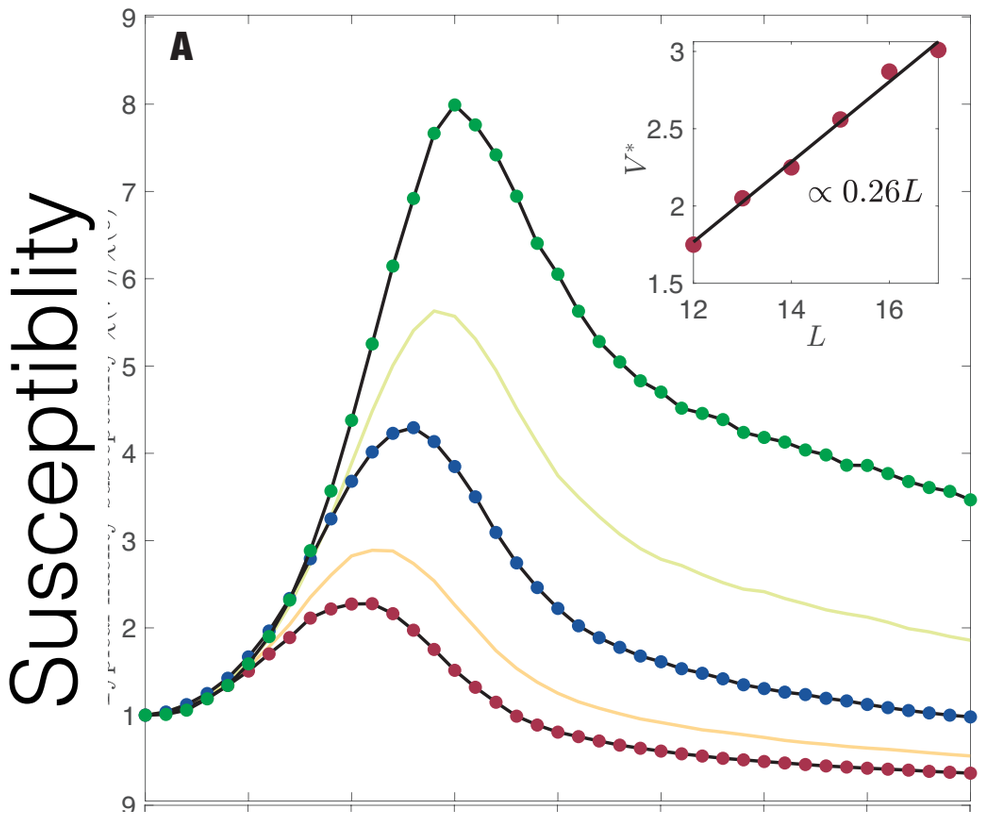
$$\Gamma_{FGR} \sim e^{-cV \log V}$$

- Define effective model by Schrieffer-Wolff out impurity
  - Ergodicity really gets broken when blocks decouple

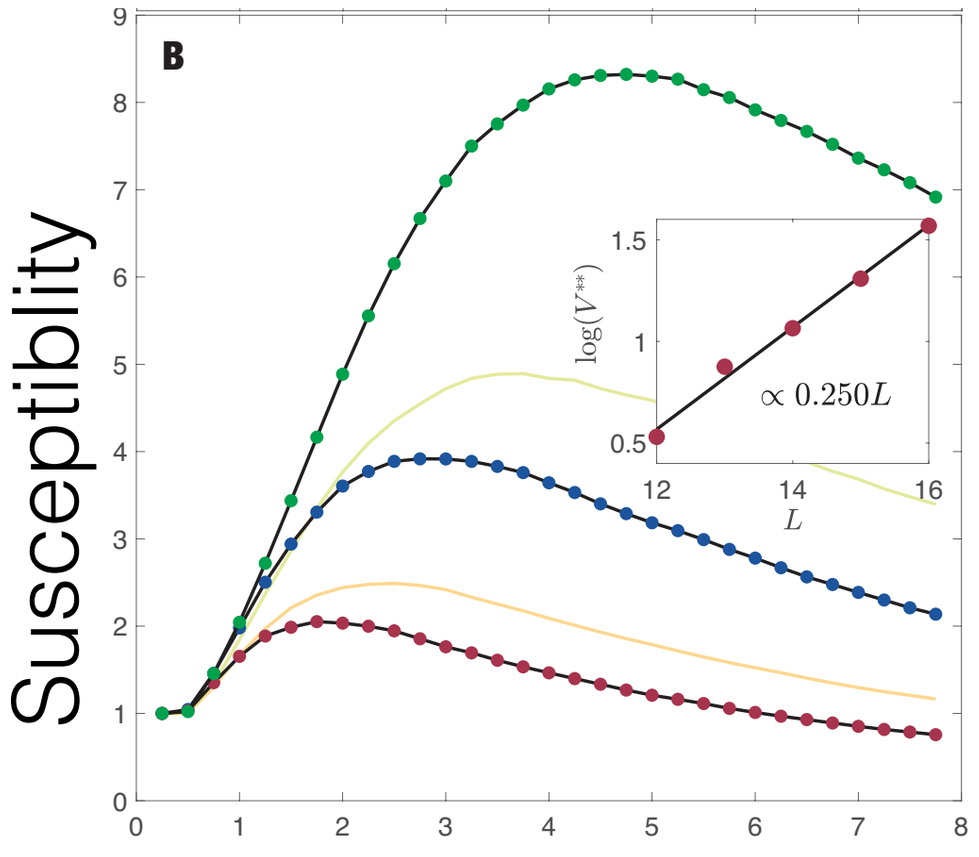


Susceptibility impurity

Full model

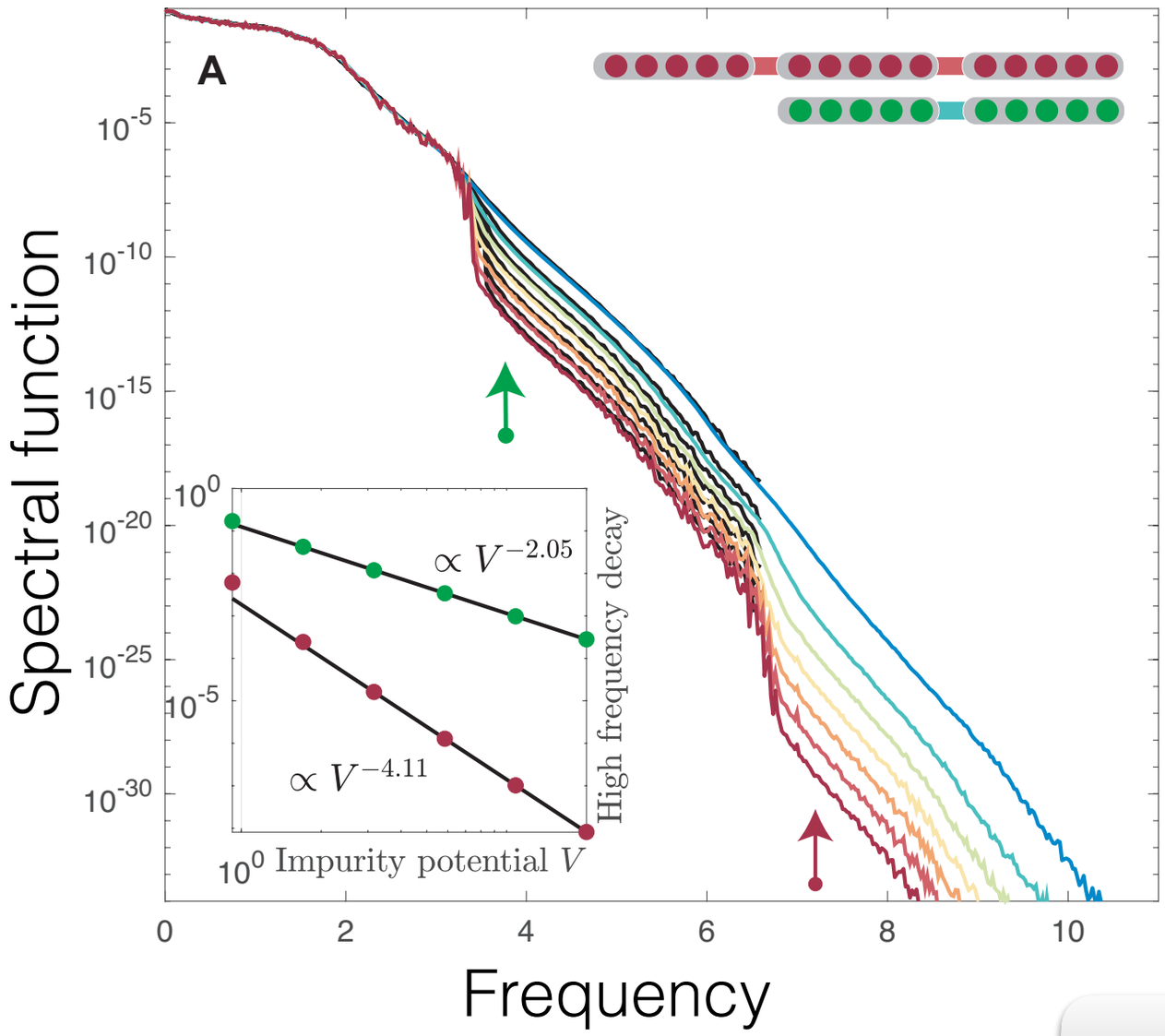


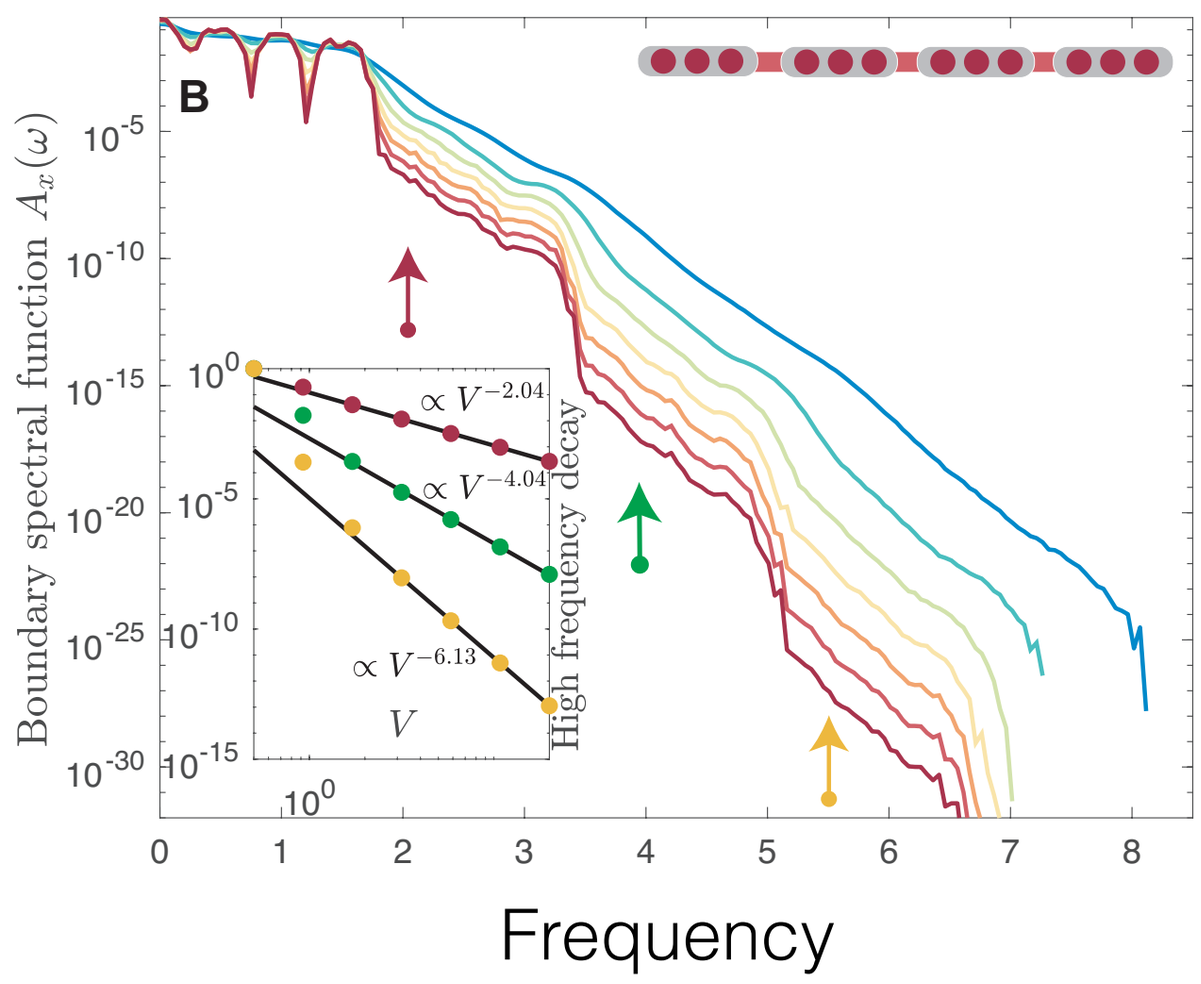
Effective model



High frequency spectral function

How do extra impurity affect the spectral function?

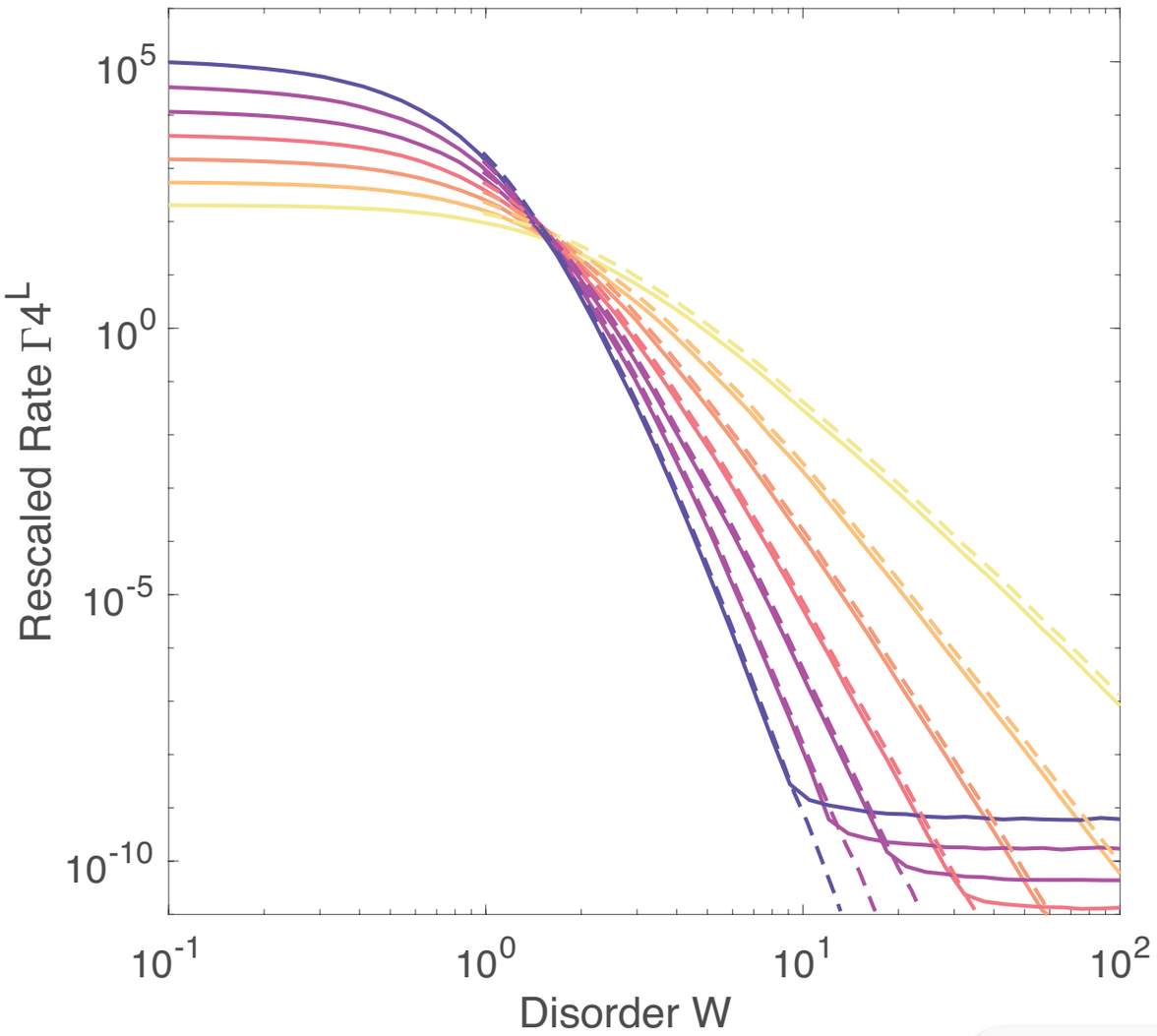


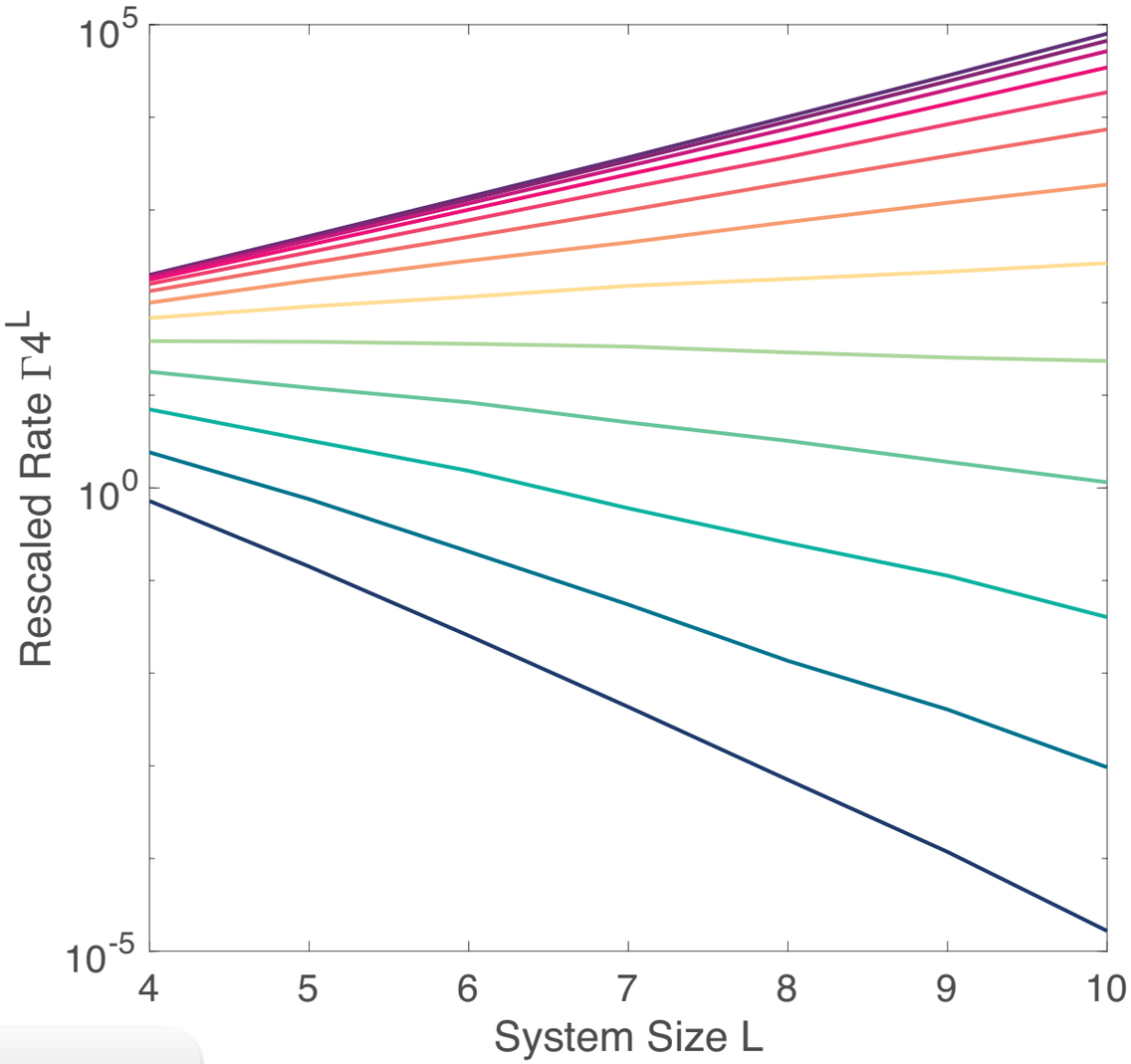


$$\Gamma \geq \Gamma_0^{1+1/\ell}$$

Part 3: Avalanches with infinity bath

Anderson Insulator

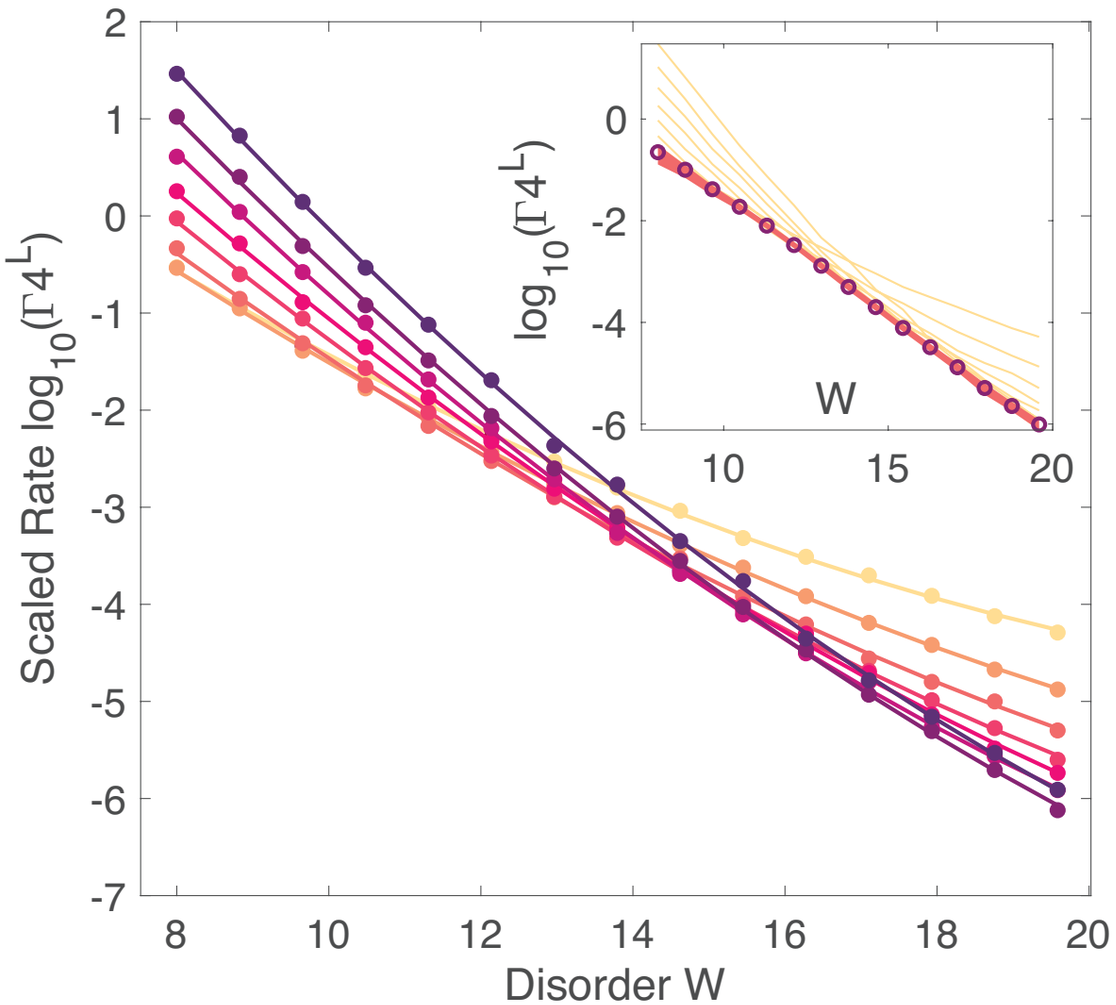


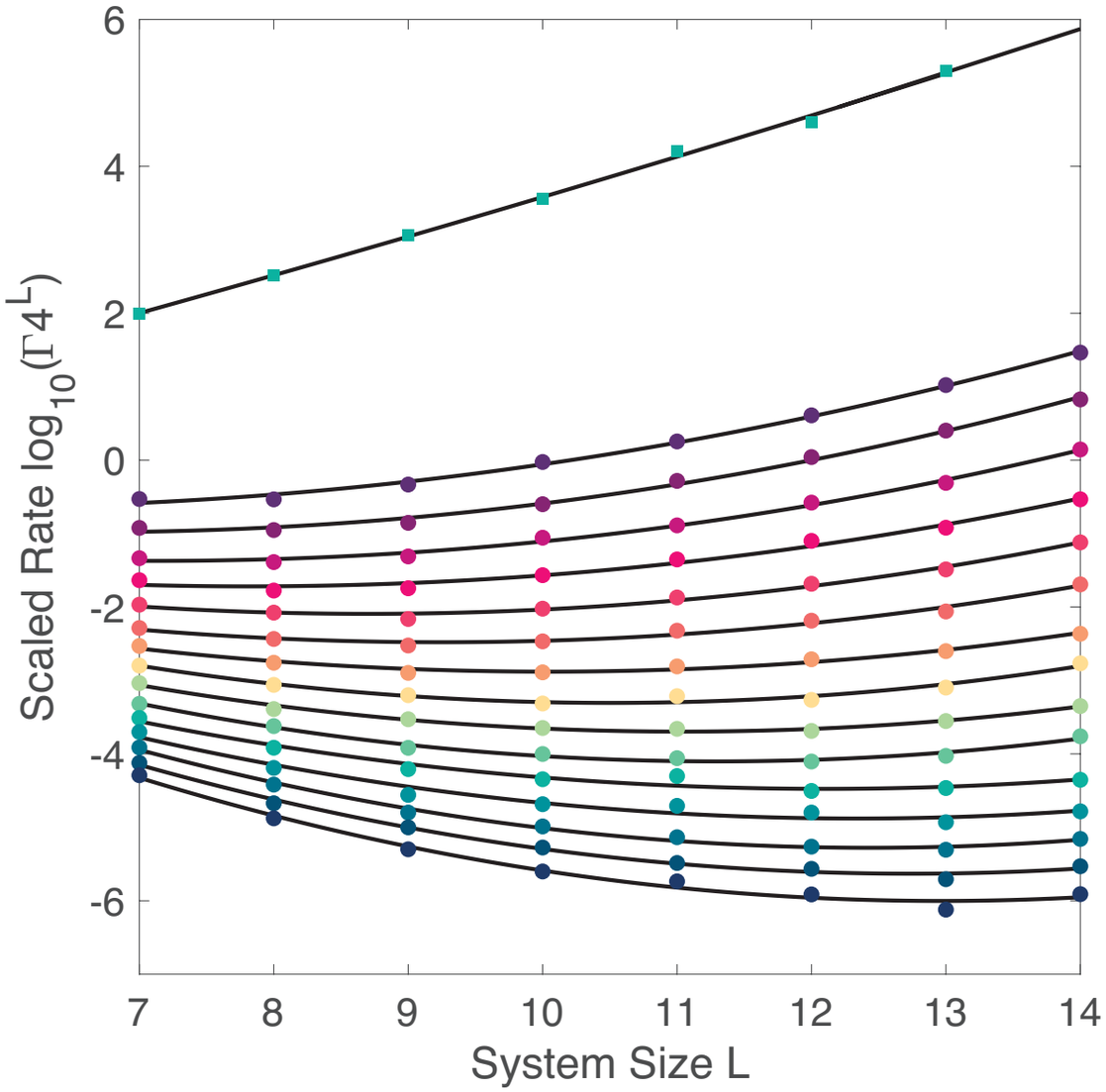


$$W^* \approx 1.4$$

Avalanches with infinity bath

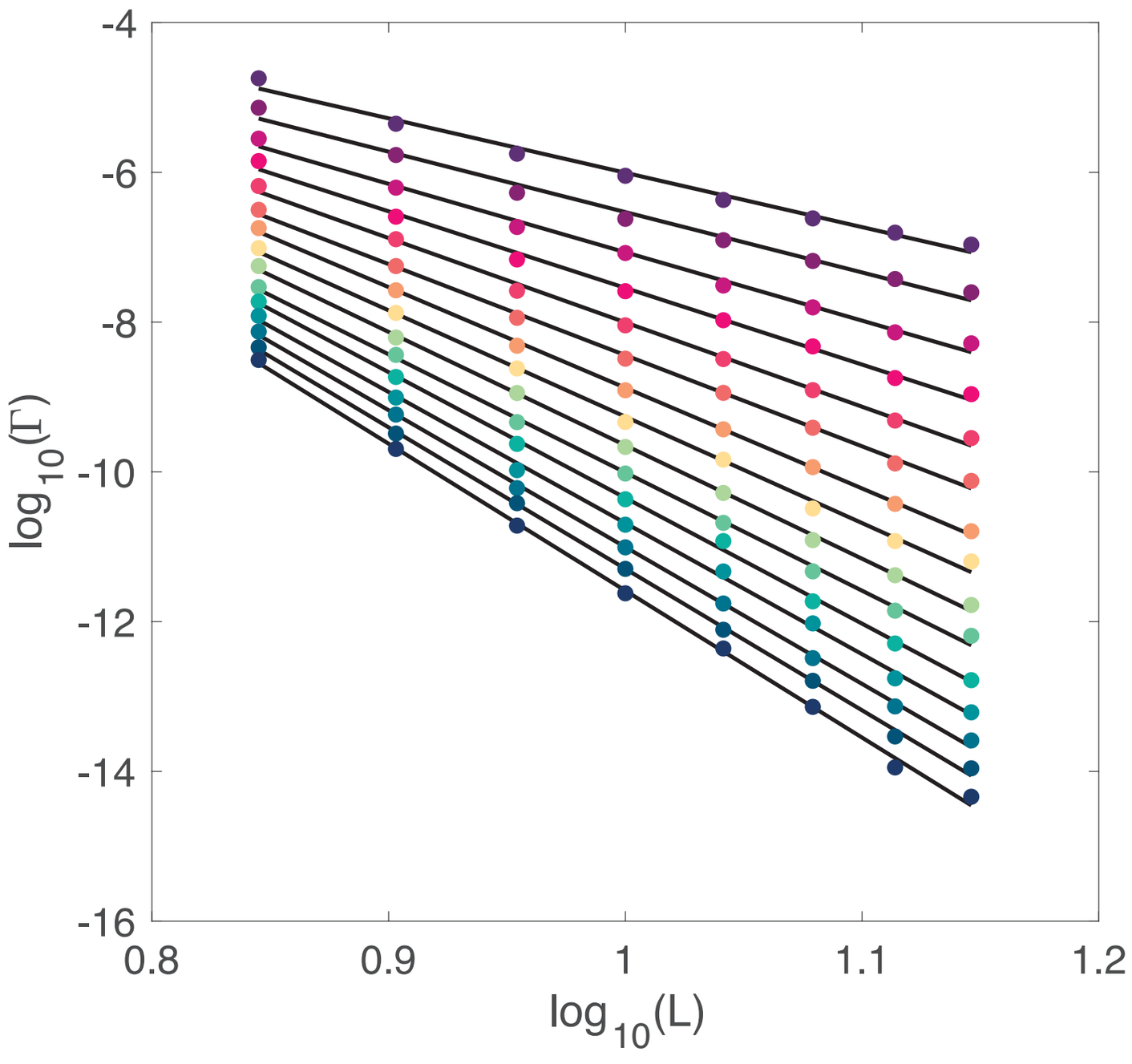
Disordered Heisenberg model



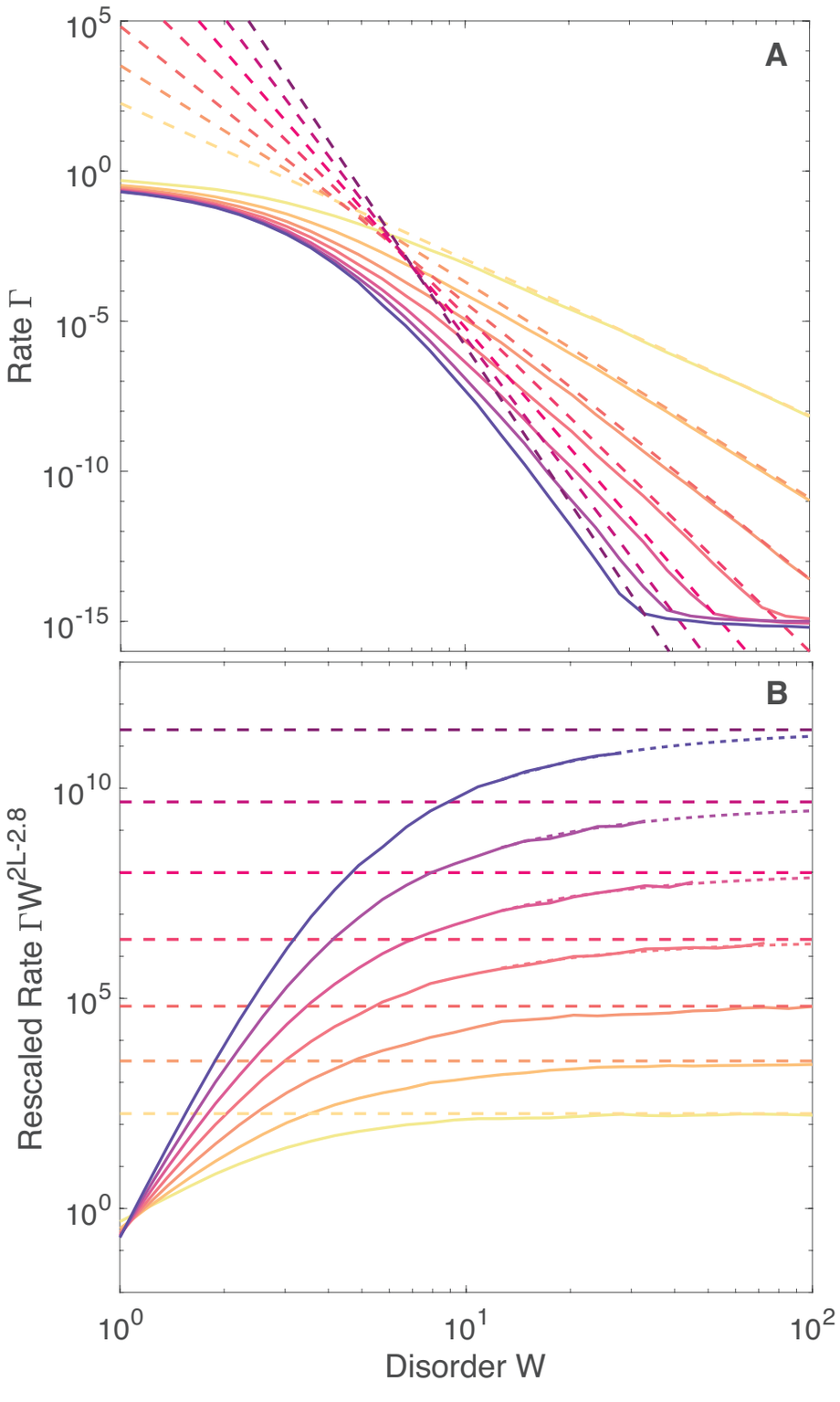


Avalanches with infinity bath

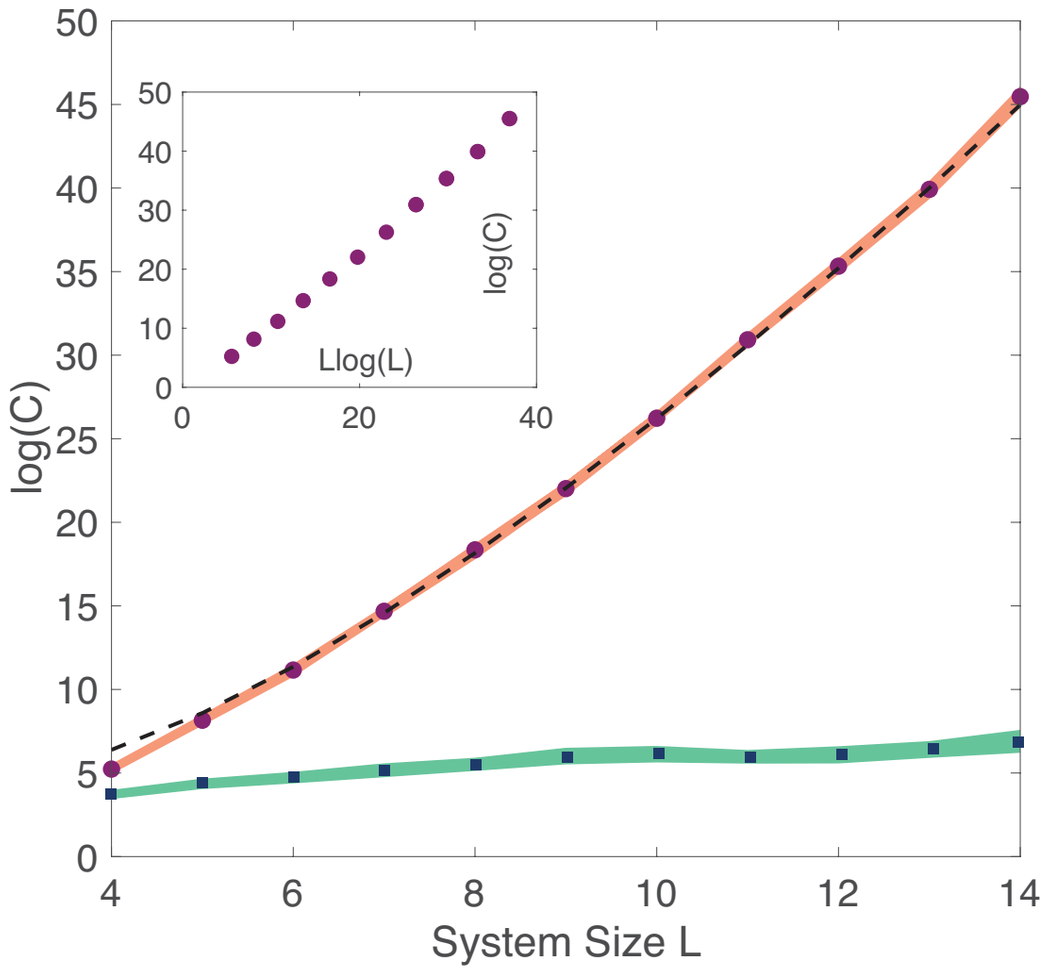
Power law?



Avalanches with infinity bath



Absence of l-bits



$$\Gamma \sim \frac{C_L}{W^{2(L-1)}}$$

Conclusion

- Enhanced susceptibility when system breaks ergodicity
  - Contraints transition scenarios
- Impurity model elucidates difference between ergodicity breaking and freezing of the impurity
  - Any finite density is ergodic in thermodynamic limit
- Previous deep MBL regime still has avalanches for disorder O(20) in small systems
  - We see indication for absence of l-bits