Perturbation theory in “non-perturbative” regimes

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Main results:

- Determinantal diagrammatic Monte Carlo for the self-energy allows to compute diagram orders as high as $\sim 10$ in strongly correlated regimes numerically exactly with arbitrary $k$-resolution.

2D Hubbard model $T=0.2t$, $U=7t$, $n=0.935(1)$:

$$\Sigma(k, \omega) = \sum_n a_n U^n$$

but the series is typically divergent!

- Access to high orders reveals the analytic structure of the self-energy and allows to reconstruct it reliably from its series by resummation techniques.

Šimkovic, Kozik, arXiv:1712.10001
Conclusions/Outlook:

- Self-energy can be systematically reconstructed from divergent series in principle all the way to the nearest critical point.
  - Pushing the technique to higher orders brings its applicability range closer to the critical point ➞ further analysis of the series structure may enable this.

- The approach already gives controlled results immediately in the TD limit in truly correlated regimes currently inaccessible by other methods.
  - Lots of exciting physics is within reach: accurate equations of state (e.g. for current cold-atom experiments), pseudo-gap physics, phase separation, etc.

- Diagram orders ~10 are sufficient for detecting phase transitions as singularities of the series solution (extremely difficult for fine-size methods!).
  - We may have a powerful tool for studies of critical phenomena.