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High-precision numerical solution of the Fermi polaron problem and large-order behavior of its diagrammatic series (ONSITE presentation)

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The Fermi polaron is a quasiparticle that emerges when a mobile impurity is coupled through a short-range interaction to a single-component ideal Fermi gas. Its energy, mass, and quasiparticle residue are renormalized since the bare particle is dressed by particle-hole excitations of the Fermi sea. Experimental studies with cold atomic gases raise a considerable theoretical interest in this system. While exact analytical results can be obtained in one dimension, most works in higher dimensions rely on approximate treatments of the strongly correlated many-body problem.

We present a simple determinant diagrammatic Monte Carlo algorithm to compute the ground-state properties of this system [1]. The fermionic sign does not cause any fundamental problem when going to high diagram orders, and we reach order N=30. The data reveal that the diagrammatic series diverges exponentially as (−1/R)ˆN with a radius of convergence R<1. Furthermore, on the polaron side of the polaron-dimeron transition, the value of R is determined by a special class of three-body diagrams, corresponding to repeated scattering of the impurity between two particles of the Fermi sea. A power-counting argument explains why finite R is possible for zero-range interactions in three dimensions. Resumming the divergent series through a conformal mapping yields the polaron energy with record accuracy.

[1] K. Van Houcke, F. Werner and R. Rossi, Phys. Rev. B 101, 045134 (2020).

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