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Fourth- and Fifth-Order Virial Coefficients from Weak Coupling to Unitarity[1] YAQI HOU, JOAQUIN DRUT, University of North Carolina at Chapel Hill — Due to its simplicity, experimental accessibility, and universality across various fields, ranging from condensed matter to nuclear physics, the unitary Fermi gas has been one of the most intensively investigated systems of the last two decades. At finite temperature, one widely used tool to study the thermodynamics of such a system is the virial expansion, whose spirit is to encode the many-body physics into a series of n-body contributions, captured by the virial coefficients b_n. Implementing a new nonperturbative analytical method, featuring only systematic uncertainties, we have calculated the b_n of a Fermi gas from weak coupling to the unitary point. Our method reproduces the exact b_3 and supports a previous conjecture for b_4, thus resolving the long-standing disagreement between theory and experiment. Pushing on to b_5 for the first time, we use the Pade resummation and find agreement with experimental measurements of various thermodynamic properties. Applying our expansion to polarized matter, we find excellent agreement with Monte Carlo calculations. Preliminary results up to the ninth order coefficient are also presented. Connections to low-energy nuclear physics and generalizations to other systems and observables are also discussed.

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