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From few to many: thermodynamics with up to seventh-order virial coefficients[1] YAQI HOU, JOAQUIN DRUT, University of North Carolina at Chapel Hill — The thermodynamics of dilute quantum systems is captured at high temperatures by the virial expansion (VE). In the VE, order by order, the few-body dynamics enters into the many-body dynamics. The 2nd-order virial coefficient is calculated by analyzing the 2-body problem, which results in the celebrated Beth-Uhlenbeck formula. For the n-th order coefficient, one analyzes the n-body problem and sums over energy eigenstates. For those reasons, it was only in the 21st century that precise 3rd-order calculations first appeared. To tackle this problem, we developed a new non-perturbative, non-stochastic computational method and applied it to spin-1/2 Fermi gases with short range attractive interactions. Our answers reproduce previous results for the 3rd-order coefficient from weak coupling to the unitary limit and resolve a long-standing tension between theory and experiment for the 4th-order coefficient. In this contribution we present new estimates up to 7th order for the first time, which allow us to use resummation techniques and calculate the density and magnetization equations of state, Tan's contact, and static response, all of them at zero and finite polarization. Our method can be generalized to harmonically trapped systems, studies of quench dynamics, and neutron matter.

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