Quasiparticle properties of three-dimensional soft-core fermions

Bilal Tanatar[1], Iran Seydi[2], and Saeed H. Abedinpour[2]

[1]*Bilkent University, Department of Physics, 06800, Ankara, Turkey*
[2]*Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan 45137-66731, Iran*

Rydberg-dressed ultracold atoms are characterized by their soft-core interactions. Using the G0W technique along with the random-phase approximation for the dynamically screened particle-particle interactions we study the effects of many-body exchange and correlation on the quasiparticle properties of a three-dimensional system of ultracold Rydberg-dressed fermions with repulsive interactions. In particular, we look at the effective mass and renormalization constant of this system. In the weak coupling regime, the Hartree-Fock (static) term is the dominant term in the self-energy where the renormalization constant remains close to one. Upon increasing the coupling constant and soft-core radius, enhancement of the correlation effects in the system causes the reduction of the renormalization constant. At strong coupling and large soft-core regime, a strong suppression is observed in the renormalization constant, but it never reaches zero. It indicates the validity of the Landau Fermi liquid picture in the Rydberg-dressed Fermi gases up to very strong couplings. Our numerical calculations predict a strong reduction in the many-body effective mass with increasing interaction strength and soft-core radius.