**Can exact KS potential reproduce HOMO-LUMO gap?:**

**analytically solvable two-electron system**

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Clear understanding of one-particle Green’s function (GFs) for interacting electronic systems is important for material science since photoemission spectra are the GFs under some assumptions[1-3]. To capture the essential physics encoded in GFs, we study the one-particle GF of an interacting two-electron model system confined to a harmonic potential[4]. Since the calculation of GF requires the energy eigenstates of the corresponding three-electron system, we solve the Schroedinger equation analytically to obtain the exact solutions, from which we construct explicitly the simultaneous eigenstates of the energy and total spin for the first time. The solutions for the three-electron system allow us to derive analytic expressions for the exact one-particle GF for the two-electron system. We calculate the GF in frequency domain to examine systematically its behavior depending on the electronic interactions. We also compare the pole structure of non-interacting GF using the exact Kohn-Sham (KS) potential with that of the exact GF to find that the discrepancy of the energy gap between the KS system and the original system is larger for a stronger interaction. We perform numerical examination on the behavior of GFs in real space to demonstrate that the exact and KS GFs can have shapes quite different from each other. Our simple model will help to understand generic characteristics of interacting GFs.

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