

Examples of exercises

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1. Many-body quantum mechanics

- Derive the representation of the kinetic energy operator in the position basis
- Write the wave function associated to a Slater determinant for $N=2$
- Prove that $P_{\sigma} = \frac{1}{2} (1 + \vec{\sigma}_1 \cdot \vec{\sigma}_2)$ is a projector and its action results in a spin exchange
- Prove that total antisymmetrisation of the two-nucleon wave function implies $(-1)^{L+S+T} = -1$ and explain what impact it has on the NN partial waves

2. Nucleon-nucleon interaction

- Show that the NN cross section can be parametrised in terms of a real function of k that acts as a shift in the phase of the incoming wave
- Show how only a superposition of 3S_1 and 3D_1 components can yield a magnetic dipole moment of the deuteron that is consistent with the experimental value



3. Second quantisation formalism

(E2)

- a) Prove that a Slater determinant provides an orthonormalised basis of F^F for $N=2$
- b) Prove the equivalence between the first- and second-quantised forms of a one-body operator
- c) Show that states of A_k are eigenstates of N with eigenvalue k