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Atomic Theory: Drilling Down to New Physics (I)

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The helium atom with its nucleus and two electrons provides a prime example of the quantum mechanical three-body problem. It is often used in text books to provide an example of simple approximation methods for atomic structure calculations. However, variational solutions to the three-body Schrodinger equation that are essentially exact for all practical purposes are possible, and they provide a systematic connection with less accurate approximation methods such as configuration interaction and the Hartree-Fock approximation. In addition, the variational solutions provide a firm foundation on which to build higher-order relativistic and quantum electrodynamic corrections. The results provide a valuable teaching tool for the physical phenomena that must be taken into account to reach spectroscopic accuracy, and to search for new physics of fundamental importance.

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