The Hartree-Fock equations

The total energy is given by

\[ E = \int \left[ H_0(r) + V(r) \right] \, d^3r \]

where

\[ H_0(r) = \sum_i \frac{p_i^2}{2m_i} + V_{\text{HF}}(r) + V_{\text{C}}(r) + V_{\text{P}}(r) \]

and

\[ V_{\text{HF}}(r) = \sum_{i<j} V_{ij}(r) \]

The Hartree-Fock approximation is used to determine the values of the Skyrme parameters by searching the space of Skyrme parameters for the best fit. The parameters are then used to calculate the binding energy and spin-orbit splitting for a set of nuclei.

The simulated annealing method (SAM)

The SAM is a method for optimization problems of large scale, in particular, where a desired global extremum is hidden among many local extrema. The SAM is designed to overcome the limitations of the HF approximation, which can get stuck in local minima.

The total energy is then given by

\[ \Phi = \int \left[ H_0(r) + V_{\text{HF}}(r) + V_{\text{C}}(r) + V_{\text{P}}(r) \right] \, d^3r \]

where

\[ V_{\text{HF}}(r) = \sum_{i<j} V_{ij}(r) \]

and

\[ V_{\text{C}}(r) = \sum_{i} W_i(r) \]

and

\[ V_{\text{P}}(r) = \sum_{i} P_i(r) \]

The Skyrme interaction

To model the nuclear force \[ V_{\text{HF}}(r) \], the Skyrme effective nucleon-nucleon interaction is used:

\[ V_{\text{HF}}(r) = V_{\text{NN}}(r) + V_{\text{C}}(r) + V_{\text{P}}(r) \]

where

\[ V_{\text{NN}}(r) = \sum_{i<j} V_{ij}(r) \]

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