Fermionic Molecular Dynamics

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Current research in heavy-ion dynamics focuses on phenomena like fusion, deeply inelastic reactions and multi fragmentation in collision experiments. In order to understand the underlying mechanisms dynamic quantum many-body models are needed. Within the framework of Fermionic Molecular Dynamics (FMD) [1, 2, 3] the time evolution of the nuclear system is described with a parameterized antisymmetric many-body state $\mid Q(t) \rangle$ composed of single-particle Gaussian wave packets

$$\langle \vec{x} \mid q(t) \rangle \quad = \quad \exp\left\{ -\frac{(\, \vec{x} - \vec{b}(t)\,)^2}{2\, a(t)} \right\} \otimes \mid \chi(t), \phi(t) \rangle \otimes \mid m_t \rangle \ , \qquad (1)$$

$$\vec{b}(t) = \vec{r}(t) + i\, a(t)\, \vec{p}(t) \ ,$$

which are localized in phase space at $\vec{r}(t)$ and $\vec{p}(t)$ with a complex width $a(t)$, spin angles $\chi(t), \phi(t)$ and isospin quantum number m_t. Given the Hamilton operator $\underset{\sim}{H}$ the equations of motion for all parameters are derived from the time–dependent variational principle

$$\delta \int_{t_1}^{t_2} dt \, \langle\, Q(t) \mid \ i \frac{d}{dt} - \underset{\sim}{H} \ \mid Q(t) \rangle \quad = \quad 0 \ . \qquad (2)$$

This variational principle is very general and allows to derive approximate quantum equations of motion also for other systems.

Together with the method of unitary correlation operators [4] FMD covers a wide range of nuclear phenomena both for ground states and dynamics.

References

[1] H. Feldmeier, Nucl. Phys. **A515** (1990) 147

[2] H. Feldmeier, J. Schnack, Prog. Part. Nucl. Phys. **39** (1997) 393

[3] http://www.gsi.de/∼fmd

[4] H. Feldmeier, T. Neff, R. Roth, J. Schnack, Nucl. Phys. **A632** (1998) 61