Zwanzig-Mori formalism [nln28]

Beginnings:

Two phenomenological approaches for the dynamics of systems close to or at thermal equilibrium:

- ▷ Phenomenological equations of motion for probability distributions (e.g. master equation, Fokker-Planck equation).
- ▷ Phenomenological equations of motion for dynamical variables (e.g. Langevin equation)

In these approaches, the focus is on selected degrees of freedom. All other degrees of freedom are taken into account summarily in the form of ad-hoc randomness.

Completions:

Microscopic foundations for these phenomenological approaches.

- ▷ Zwanzig (1960): Rigorous derivation of a *generalized master equation* from first principles, i.e. from the Liouville equation.
- ▷ Mori (1965): Rigorous derivation of a *generalized Langevin equation* from first principles, i.e. from the (quantum) Heisenberg equation or the (classical) canonical equations.

The focus is again on selected degrees of freedom but here the effects of the other degrees of freedom are taken into account on a basis that is exact and amenable to systematic approximation.

Variants:

- ▷ Zwanzig's approach leads to a *kinetic equation* of a particular kind. There exist alternative ways to derive kinetic equations from the Liouville equations via systematic approximations (e.g. via BBGKY hierarchy).
- ▷ Mori's approach has been formulated in more than one rendition. The version named *projection operator formalism* is most illuminating regarding the physical meaning of systematic approximations. The version named *recursion method* is most readily amenable to computational applications.