The development of methods of the theory of nonequilibrium processes for thermofield quantum systems is one of the most important trends in modern theoretical physics. Nowadays, methods of the quantum field theory, on the one hand, and of nonequilibrium statistical mechanics, on the other hand, are powerful instruments in the study of interacting quantum fields and particles. Unification of these methods can be useful and effective for solving numerous problems of nonequilibrium thermofield quantum systems. Methods of the quantum field theory (such as the Green function and renormalization group methods) turned out to be fruitful and promising in statistical mechanics. A considerable success in describing thermofield quantum systems was reached by Umezawa and Takahashi and co-authors based on the thermofield dynamics (TFD). This theory is a synthesis of the usual quantum field theory and equilibrium statistical mechanics by Gibbs. It is based on a dual structure of quantum field theory i.e., a dynamical reflection of the description in terms of Heisenberg fields into some description using "physical" fields which correspond to the observables, namely to the spontaneous symmetry breaking, Goldstone's bosons condensation, dynamical rebuilding of a symmetry etc.

The generalization of thermofield dynamics on nonequilibrium states of quantum field systems in papers by Arimitsu and Umezawa, and Suzuki was an important step in this direction. The new theory has been called the nonequilibrium thermofield dynamics (NETFD). It is formulated with the help of two conceptions: rough description of a nonequilibrium state (using the projection operators method, for example), and the conception of a thermal vacuum state. The thermal Liouville space is introduced in this case. Its definition and properties were well defined in the papers by Fano and Schmuz.

The papers of the first part of the present issue (p. 5–168) describe some applications of the nonequilibrium thermofield dynamics and other methods for the description of classical and quantum nonequilibrium properties of both non-relativistic and relativistic systems. In particular, problems of the description of nonequilibrium processes of open boson and fermion systems, classical relativistic system of point-like particles in an electromagnetic field, electron-phonon system and massive fermion in a hot medium are considered.

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