CHAPTER I

INTRODUCTION

In studying quantum mechanics of a many-particle system with fixed number of particles, the reduced density matrices (1) are defined. A main feature of quantum mechanics is that the state vectors of two or more states can be linearly superposed to form a combined state, and the absolute square of the combined state depends on the difference in the phase of the components states. In very large examples the difference in the phases will most average out due to the chaotic thermal motion, thus lead to no observable effect. But the very interesting exceptions occur and these exceptions seem to be related to a very strong excitation of a single mode of motion, in this case their phases then show the correlation over macroscopic regions. The existence of phase correlation coincides with the existence of off-diagonal long-range order (1) in the reduced density matrices. Then the appearance of off-diagonal long-range order indicates the new thermodynamic phase of the system.

It is reasonable to assume that systems to be characterized by the existence of such an order are superconductors and superfluid helium. If off - diagonal long-range order is the characteristic of the new phase of superconductors and superfluid helium, then it is possible to calculate their properties in the realm of

off - diagonal long - range order in order to build into the physical picture.

This thesis will be focused on the use of the concept of off-diagonal long-range order with the equation of motion for reduced density matrices for the systems of fermions, such as the superconductors. After some remarks in the case of theory of superconductivity in Chapter II, we will give in Chapter III a brief review of some concepts of reduced density matrices and off-diagonal long-range order. Subsequent chapter will be dealt with the theory of the two-fluid model of superconductivity. In Chapter V we give some applications in conjunction with these theories to find the thermo-hydrodynamic equations of the Fermi superfluid. Finally the conclusion and discussion will be given in Chapter VI.