Chapter 4

Concluding Remarks

Throughout this thesis, we calculate the effective interaction in 2D liquid ^{3}He and study superfluidity.

We have applied the R-matrix theory to 2D ^{3}He on a flat substrate to calculate possible transition temperatures to a superfluid state. This theory is found to be valid in the dilute region, $\rho_{2D} \lesssim 0.020 \mathring{A}^{-2}$, where the selfenergy effect is ineffective. In this region, the effective interaction in the p-wave channel is the most attractive and the p-wave transition temperature is estimated to be of order of mK.

We also investigate the wave number dependence of the static spin susceptibility $\chi(q)$ and the effective interaction between quasiparticles mediated by spin fluctuations in the dilute 2D Hubbard model. The quantum Monte Carlo method (QMC) and the fluctuation exchange approximation (FLEX) are applied to this model. It is found that a maximum at wave number $q = 0$ emerges and develops in $\chi(q)$ as the interaction U gets strong. It is also found that the most attractive component of the effective interaction mediated by spin fluctuations is the p-wave component in the strong coupling region where a maximum at $q = 0$ develops in $\chi(q)$.

From a theoretical point of view, theoretical understanding of 2D liquid ^{3}He in the dense region is unsatisfactory. As this is a problem of a truly strongly correlated fermion system, it is not at all surprising that a reliable calculation has not been carried out; for example, the QMC method can, in principle, be directly applied to 2D liquid ^{3}He, too, but it is extremely difficult to obtain detailed and reliable information on possible superfluidity. Development of a more powerful and efficient method to deal with this strongly correlated system is highly desired. If it succeeds for this system, it would also be applied to strongly correlated electron systems.

On the other hand, experiments of 2D liquid ^{3}He on a substrate as flat as possible and as pure as possible are also highly desired. Once discovered, superfluidity of 2D liquid ^{3}He, which we surely believe is of p-wave symmetry, would open a new

window to a fascinating new aspect of Mother Nature.