Chapter 7

Summary

To summarize, in this thesis we have obtained some interesting results for the dilute Bose gas in different regimes.

In the first part, we studied the weak interaction regime. Here we discussed the working of an atom laser and also proposed an all optical method for continuously loading the thermal component (reservoir) of a cw- atom laser. We showed that despite the presence of spontaneously emitted photons, it is possible to configure the trapped system such that the probability of photon re-absorption is small and hence negligible heating of the atomic cloud.

Another essential component is the continuous evaporative cooling mechanism. This would have the effect of pumping thermal atoms into the condensate mode to compensate for the loss due to output coupling as well to compensate for other intrinsic loss mechanisms. Therefore, a proper understanding of a cw- atom laser would require a model satisfying all three basic requirements– loading, evaporative cooling and output coupling. Such a model will then allow us to calculate the phase diffusion properties of the cw- atom laser. Our discussion of the quantum kinetic regime in the second chapter would be very crucial to understanding the collisional contribution to the phase diffusion and hence the line width of the cw- atom laser.

In the second part of this thesis, we showed that under certain conditions a dilute Bose gas can enter the strongly correlated regime. In fact in this regime the Bose sys-

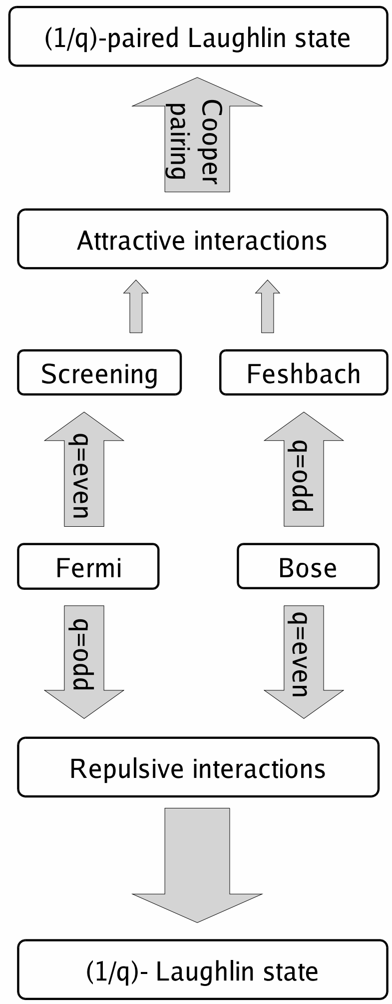

Figure 7.1: Origin of different possible fractions in the fermionic- and bosonic- fractional quantum Hall effect. The tuning of interactions via Feshbach resonance may result in generation of fractions, the underlying mechanism could be compared to that of the even FQHE.

tem showed fractional quantization quite analogous to that in the FQHE. The relevant fraction was found to be $\frac{1}{2}$ with the corresponding ground state given by the bosonic Laughlin wavefunction. Field theory method based on the Chern-Simons gauge was found to be extremely useful in treating the Feshbach mechanism for tuning the inter-atomic interactions in this regime. While controlling interactions is virtually impossible in the condensed matter fractional quantum Hall systems, our study of the dilute Bose gas in this regime has opened a whole new set of possibilities for investigating many body effects previously inaccessible in condensed matter systems. The most interesting example would be the existence of even fractions in electronic FQHE. In fact the only observed fraction is $\frac{5}{2}$ and its origin is still an active area of research. From this perspective, a rotating Bose gas with tunable interactions would be very useful. As depicted in the flow chart of Fig. 7.1, an identical mechanism in the Bose case would result in odd bosonic FQHE. Therefore, observing such strongly correlated phases with odd fractional statistics may help enhance our understanding of the even FQHE.