File ID	104493
Filename	Summary

SOURCE (OR PART OF THE FOLLOWING SOURCE):

Type	Dissertation
Title	One-dimensional Bose gas on an atom chip
Author	A.H. van Amerongen
Faculty	Faculty of Science
Year	2008
Pages	viii, 116
ISBN	9789090228419

FULL BIBLIOGRAPHIC DETAILS:
http://dare.uva.nl/record/270822

Summary

This thesis describes the study of an ultracold gas of bosonic atoms that is magnetically confined to a one-dimensional (1D) geometry. The confining field is generated with a micro-electronic circuit. This microtrap for atoms or 'atom chip' is particularly suited to generate a tight waveguide for atoms close to the chip surface.

Systems of ultracold bosons are interesting because in 3D a phase transition occurs to a Bose-Einstein condensate (BEC) when the sample is cooled to the point where the de Broglie wavelengths are comparable to the average interparticle separation. The quantum-mechanical ground state becomes macroscopically occupied and a BEC is formed that is characterized by long-range phase coherence. This long-range order is the origin of macroscopic phenomena in many-body quantum systems like superconductivity and superfluidity. In 2D and 1D systems, at finite temperature, long-range order is destroyed due to a large population of excited states.

In this thesis we investigate the (coherence) properties of a finite-temperature 1D Bose gas with repulsive interactions. This system is of particular interest because it forms the textbook example for the many-body quantum-mechanical systems that can be exactly solved using the Bethe Ansatz. Moreover, using a method developed by Yang and Yang, exact expressions for the thermodynamics of this system of repulsive bosons in 1D can be given. The method by Yang and Yang is of wide relevance because it is the simplest example for obtaining the thermodynamics of the complete class of exactly solvable models for many-body quantum mechanical systems in 1D, e.g. the Heisenberg spin chain and the Hubbard model.

In experiments described in this thesis we cool a gas of ^{87}Rb that is trapped in a waveguide to a temperature below 160 nK corresponding to the level splitting of the confining potential in the radial direction. Then, the gas of a few thousand atoms is confined to one dimension because radial motion is frozen. We find excellent agreement between measurements of the equation of state of a trapped gas of ^{87}Rb atoms and numerical solutions to the exact Yang-Yang thermodynamics.

In our 1D-gas samples thermally-driven fluctuations of the phase result in a reduced coherence length. The axial momentum distribution is the Fourier transform of the spatial correlation function and can therefore be used as a probe for the coherence in the gas. We use the technique of Bose gas focusing, that is equivalent to the action of a lens in optics, to measure the momentum distribution of the gas in the Fourier plane. This method allows us to probe correlations that go beyond the Yang-Yang description. At the time of writing the first theoretical calculations of the correlations are being performed that can be compared with our experimental observations.

Part of this thesis describes how we have constructed the microtrap for the

realization of BEC and the attainment of the 1D regime. Design considerations and analysis of the thermal properties of the microtrap, when a relatively high current is sent through tiny wires, are presented.