Detecting Bose-Einstein Condensation in Liquid Helium-4

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Purpose

- To search for Bose-Einstein characteristics in Liquid Helium-4

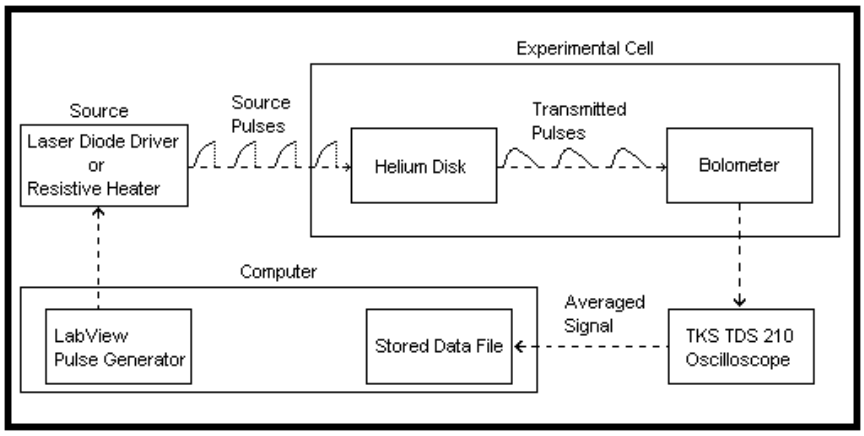
Background

- Theory has predicted that Helium will form a Bose-Einstein condensate when cooled to a low temperature, but experimental evidence is fragmentary.
- There is an ongoing experiment, directed by Prof. J. Woods Halley of the Physics Department, seeking to witness Bose-Einstein characteristics by analyzing the transmission of particles through a disk of liquid Helium-4.
- During 2008 I wrote a LabView program to create the beam of pulses sent at the disk of Helium by evaporation of superfluid on the tip of an optical fiber or heater, and record the bolometer response to the transmitted particles.

Methods

- The LabView program is controlled by the user's input selections of pulse type, width, period, amplitude, delay, and number of pulses.
- These inputs are used to reconstruct a period of the pulse in the form of a 2D array of amplitude and time.
- This array is then output the selected number of times using an analog output waveform generator function.
- The pulses are used to control a source, which converts the signal into a laser pulse or a heat pulse. These source pulses are sent through the disk of Helium.
- Transmitted pulses are detected by a bolometer. This reaction is monitored on a TKS TDS 210 Oscilloscope. Using an averaging function on the TDS 210, 128 pulses are averaged.
- The averaged pulses are stored to a new data file at set intervals of time selected by the user.
- These data files will undergo more averaging and analysis in search of Bose-Einstein characteristics.

Experimental Data Flow



Results

- The result of the LabView program is a versatile set of pulses. The shape of the pulses can vary from square waves to power waves which increase in amplitude over time (by a power, x, chosen by the user). The shape we are most interested in is the power of .7 as theory predicts it will give the best response.
- The wave can be used to control a laser diode driver which allows us to send laser pulses at the disk of helium.
- The wave can also be used to control a resistive heater, a source that has been studied previously by Prof. J. W. Halley.
- An accurate pulse can be created down to a pulse period/width on the order of microseconds (the normal experimental settings are a pulse width of 10 us and period 1ms).

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Discussion

- Due to problems related to cooling the cell to the low temperature necessary to run the experiment, we have not been able to collect data for analysis yet.
- Throughout 2008 modifications were made to the experimental apparatus. Now that these changes are completed, the problems with cooling seem to be solved and we are looking to run the experiment this spring.
- When the experiment is run we will be testing the laser pulse source and comparing the results to that of the resistive source.

References

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