Probing Edge States in Quantum Droplets on Two Dimensional Electron/Hole Gas

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Introduction

Microwave absorption spectroscopy of quantum droplet on two dimensional electron/hole gas is a powerful tool investigating the number and velocities of the charge modes. We have sample patterned with multiple circular dots on the order of several microns. It is directly placed onto the meander line superconducting waveguide positioned inside a resonance container. The whole setup is attached to the bottom of a top loaded Helium 3 cryostat with base temperature down to 300mK. This absence of quantum contact has the advantage over standard transport measurement with its high sensitivity and could be generalized to a common method probing edge states hosted in other new materials.

BACKGROUND

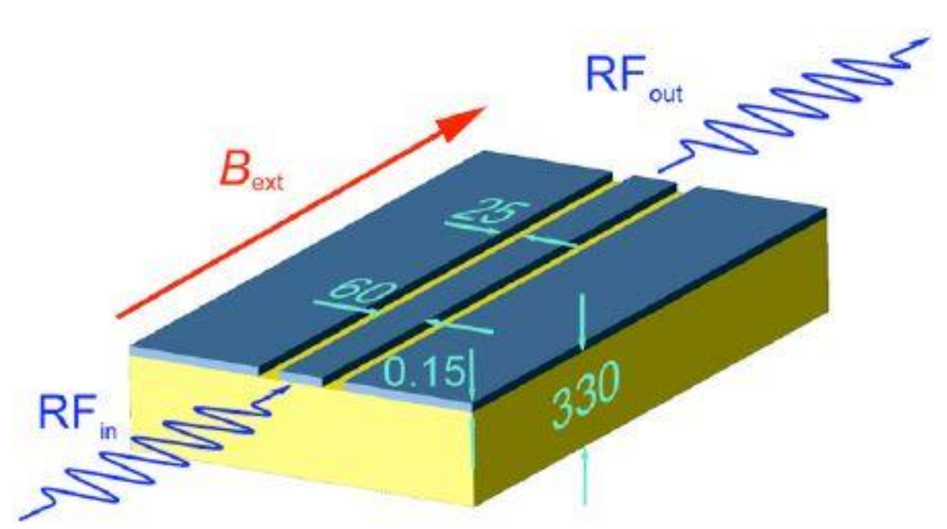
Microwave absorption spectroscopy

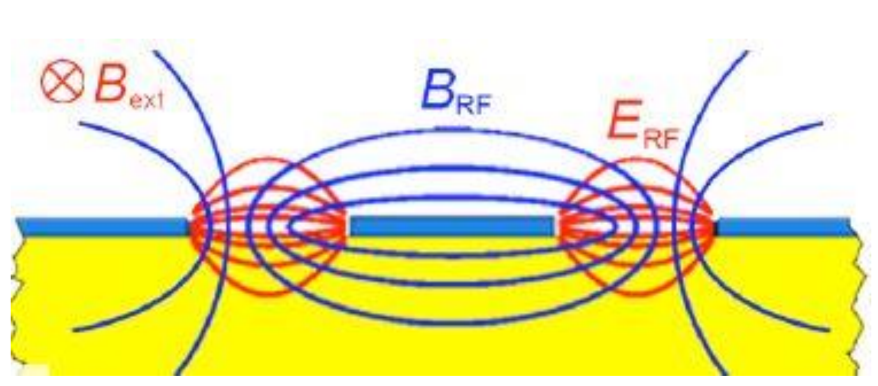
•Absorption signal can be detected when photon energy matches with the excitation of the edge of the quantum droplet which has a minimal energy of

$$2\pi\hbar v/L$$

where L is the circumstance of the droplet.

• Superconducting waveguide which is fabricated by Aluminum film has better transmission coefficient under critical temperature (1.2K for Aluminum)





CONSTRUCTION & METHODS

• He3 cryostat operates at base temperature of 300mK

Probe Schematics

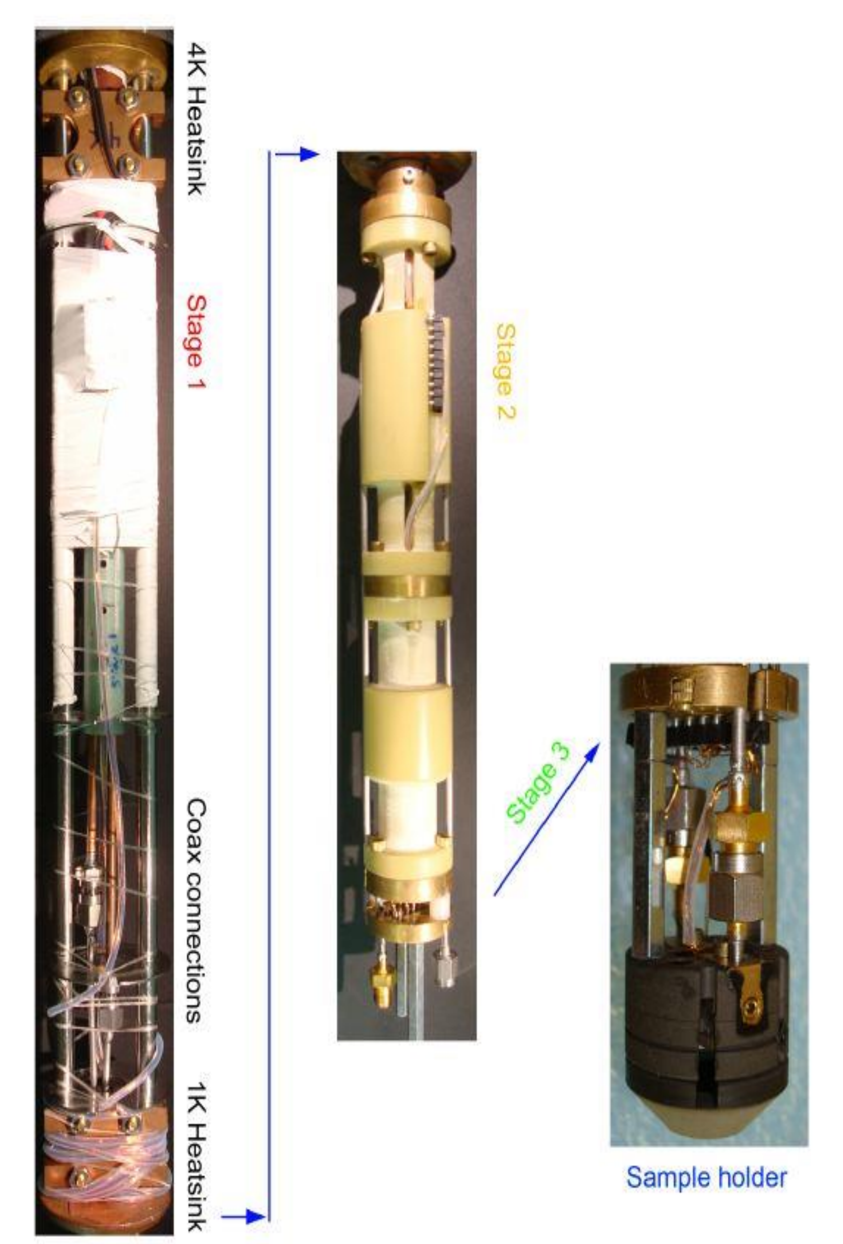
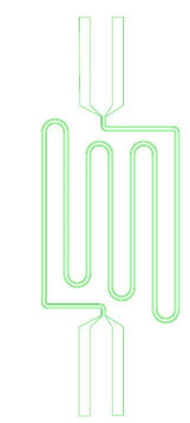


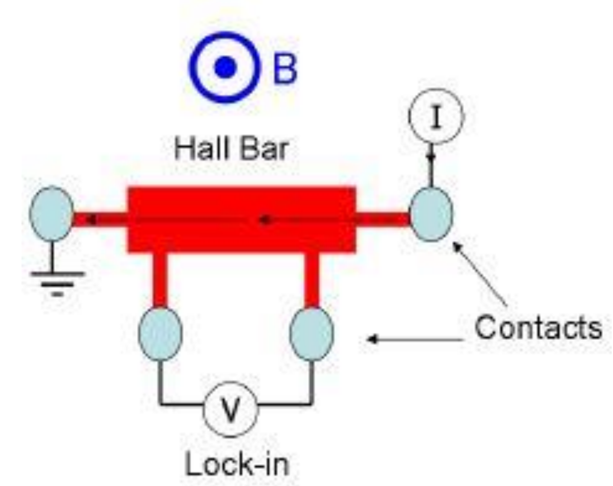
Figure D.1: Pictures of the probe stages: 4K, 1K, and the sample holder.

• Brass box plated with gold on the inner surface to increase reflectivity



• Meander line structure superconducting waveguide to enhance the interaction between the microwave and the sample

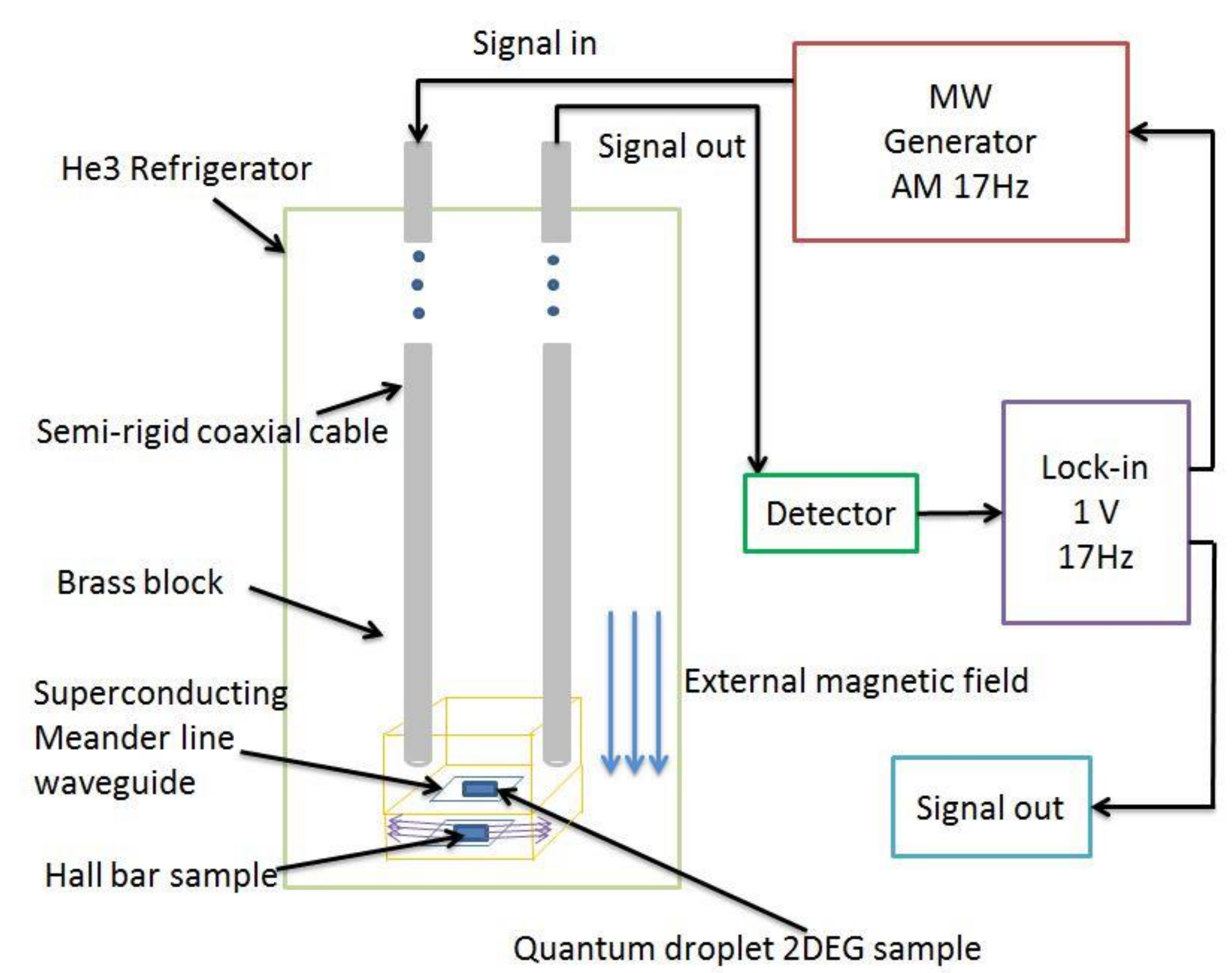
• Transport measurement



• Measurement Technique

--- Amplitude modulation

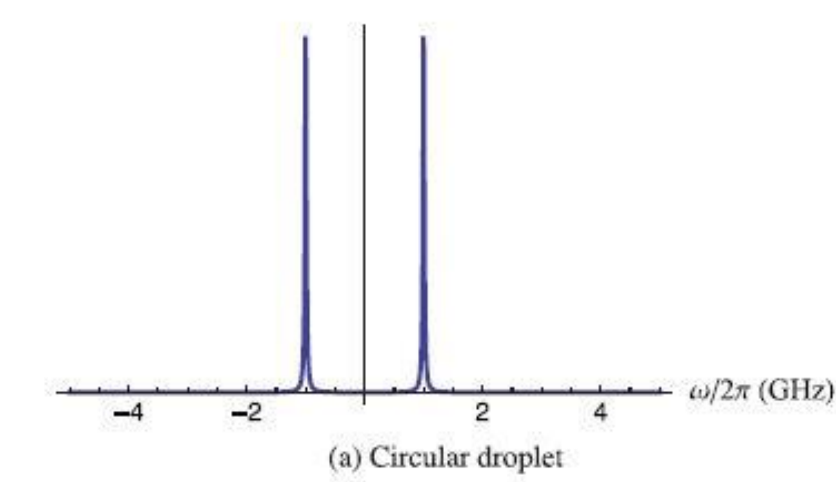
The returning microwave signal is measured by a zero-biased Schottky diode, the output of which is a negative voltage. Such a small signal is usually hard to be measured. However, if the input signal is amplitude modulated, the output signal will have the same frequency which can be detected by a lock in amplifier easily.



Expectation

• Lauphlin states and υ =1

$$R(\omega) = v\frac{E^2L^2}{32\pi}\delta(\omega \pm 2\pi v/L).$$



• Multiple peaks with arbitrary shape or with fractional filling factor

CONCLUSIONS

A microwave absorption spectroscopy is built to detect edge states of quantum droplets on 2DEG. This method could also be used to resolve ESR on different materials without requiring electrical contacts. It is promising for measuring fractional charged edge states.

REFERENCES

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