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Characterization of Transport in Quantum Regime Containing Mesoscopic Structures

[1]Rajani Kumari Suman* and [2]Ashok Kumar

Author's Affiliations: [1]Research Scholar, University Department of Physics, B.N. Mandal University, Madhepura, North Campus, Singheshwar, 852128, Bihar, India.
E-mail: rajanisuman8719@gmail.com
[2]University Department of Physics, B.N. Mandal University, Madhepura, North Campus, Singheshwar, 852128, Bihar, India.
E-mail: ashokabnu@yahoo.co.in

***Corresponding author:** **Rajani Kumari Suman**
Research Scholar, University Department of Physics, B.N. Mandal University, Madhepura, North Campus, Singheshwar, 852128, Bihar, India.
E-mail: rajanisuman8719@gmail.com

ABSTRACT

We have studied the characteristics of transport in quantum regime having mesoscopic structures. We have used a model which was interference dependent of voltage. The magnetic flux broke the symmetry of currents. The thermal phase slip occurred on the surface of the used sample. The thermal activation of phase slips produced transformation of cooper pairs within quasi particles. The applied magnetic field was not able to affect quasi particles. For the study of our research problem, we have used Ginzburg-Landau theory. The transport in mesoscopic is connected with structures and shapes of used rings. The characterization of transport was made by charge flow in the quantum regime. The charge carrier's interference was possible due to stored phase memory. In mesoscopic rings the interference was explained by applying two dimensional semiconductor Schrodinger equation. Resistance dependence due to magnetic flux generated spatial sensitivity. The transmission model determined magneto resistance. It was found that magneto resistance oscillation was responsible for interference of cooper pairs and did not affect the amplitude of produced currents.

KEYWORDS Transport, quantum regime, mesoscopic structure, symmetry, thermal phase slip, interference, magneto resistance.

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INTRODUCTION

Gobel and Siegner[1] studied the mesoscopic structures of rings in different shapes. It was followed by other investigators[2-3] to obtain positive result. Datta[4] studied the interference of charge carriers having phase memory. Fomin[5] studied the quantum interference effect and was explained oscillation of magnetic field function. Devreese et al.[6] studied the persistent current generation due to charge carriers and change of magnetic field. Wendler et al.[7] studied the phenomenon of quantum interference taking into account the two dimensional Schrodinger equation happened in the case of rings of mesoscopic case. Carillo et al.[8] presented magneto resistance oscillation by means by Little-Parks effect and generated sinussoidal conditions in parabolic shapes. Papari and Fomin[9] made measurement of Magneto resistance oscillation using dynamics of vortex. Papari et al.[10] presented activation of vortex motion in the presence of phase choherence and generated zero bias resistance due to residual density. Sharon et al.[11] studied the creation of flux quanta due to magnetic field for enhancing quasi particles for the production of damped oscillation of resistance. Sochnikov et al.[12] demonstrated the vortex flow modulation to obtain the velocity cooper pairs oscillations. Gurtovoi et al.[13] studied the quantum jumps atomic likesystems in nano rings of Aluminium to show the transport properties of mesoscopic rings. Sammon et al.[14] studied the transport lifetime to show the transport properties of two dimensional hole gas system. For this purpose Boltzmann transport theory was used. Eisenstein et al.[15] and Laroche et al.[16] obtained scattering for spin splitting threshold. Habib et al.[17] studied the transport and interaction in GaAs two dimensional holes. Qian et al.[18] studied the screening for reduction of scattering from charged impurities. Mi et al.[19] and Laroche et al.[20] studied the reduction of Dingle ratio for crossover from impurity scattering for generation of transport properties. Jing et al.[21] and Meng et al.[22] studied topological transitions for narrow band of semiconductors. Shi et al.[23] studied possibility of finding quantum states at filling factors at lower temperatures in the case of hole density. Xin Liu et al.[24] studied the transport in Ge/SiGe hetrostructure to obtain quantum scattering time at the hole density in the case of two dimensional hole gas and it was found that transport mobility was not greatly affected.

METHOD

We have used a model considering Ginzburg Landau theory having mesoscopic ring to obtain screening currents in one dimensional system for the description of quantum state, we have used the relation

$$\tilde{\psi}_{1D}\left(\Theta\right)=\sqrt{n_s}\exp\left\{i2\pi\frac{\Phi'\left(\Theta\right)}{\Phi_0}\right\}$$

Where $\Phi_0=\dfrac{h}{2e}$ is the magnetic flux quantum and Θ is the azimuthal angle. The screening currents were presented considering London vector potential and external flux were represented by vector potential. The transport properties were explained by using

$$J_s=\frac{e\hbar}{im}\left\{\tilde{\psi}'\nabla\tilde{\psi}\psi'\right\}-\frac{2e^2\left|\tilde{\psi}\right|^2}{m}A.$$

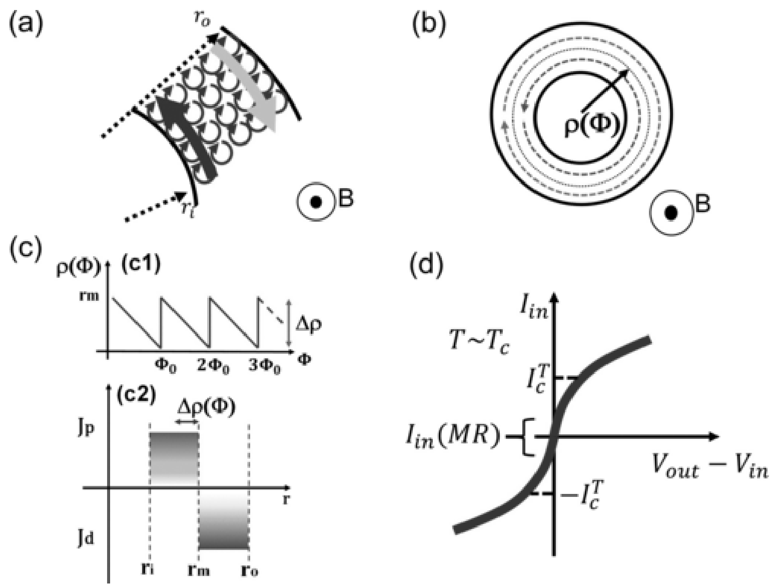
Where A is a vector potential and J_s is the supercurrent density, *m* is the mass of charge carrier. The transport measurements were found with the help of input currents at different voltages. The degree of freedom was obtained with the help of mesoscopic rings of different sizes depending on their thickness. The magnetic fields produced penetration depth and was useful or Pearl penetration depth. The different parameters involved in the study were obtained by screening currents. The transmission was demonstrated due to modulation of interference mechanism and was represented by

$$\tilde{\psi}_{out}=T\left(\phi\right)\tilde{\psi}_{in}$$

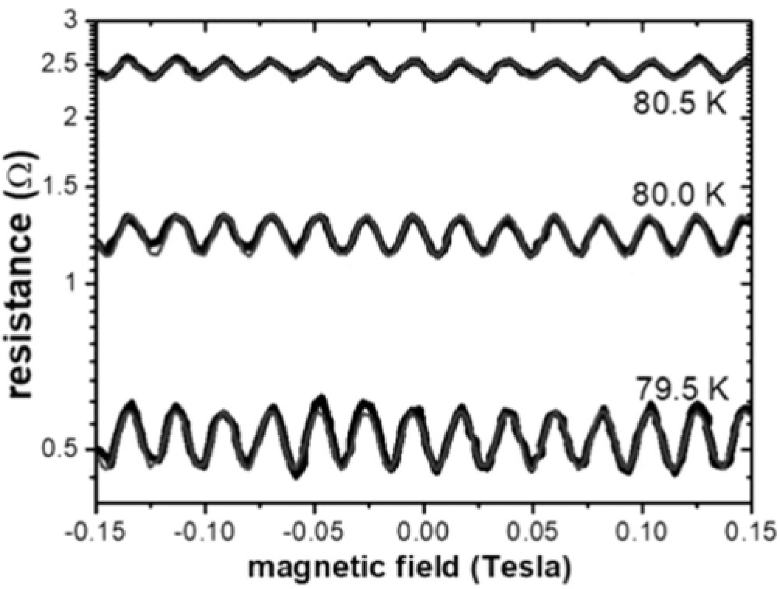
Where $T\left(\phi\right)$ is the function of magnetic flux.

RESULTS AND DISCUSSION

We have studied the characteristics of transport in quantum regime for mesoscopic structures. The study of effect of screening current on transport was made. The screening currents produced interference in the presence magnetic fields in the case of quasi particles. The dependence of screening currents in response to density of cooper pairs were presented in the case of mesoscopic rings. Graph (1) shows the plot of local screening currents versus different strengths of diamagnetic materials. It shows the distribution of local screening currents and different parameters used for the study of transport properties. This representation also present that in opposite directions the flow show is nearer to paramagnetic cases. This indicated the distribution of screening currents. The resulting currents pattern is shown in Graph (1) (b) and indicated the generation of zero super-currents at the circumference. Graph (2) shows the plot of magneto resistance versus different magnetic fields for finite size of mesoscopic rings. It shows that curves represents the magneto resistances for three different temperatures. It indicated that fluxoid quantuization was induced in the case of cooper pairs/ quasi particles cases and was due to voltages leading. The magnetization produced damped sawtoth behavior as a functionary for different magnetic fields. The obtained results were compared with previously obtained results and were found in good agreement.



Graph 1: Plot of local screening currents versus vs strength of diamagnetic materials.



Graph 2: Plot of magneto resistance versus magnetic fields.

CONCLUSION

We have studied the characterization of transport in quantum regime containing mesoscopic structures. For this purpose Ginzburg-Landau theory was used. it was found that transport was affected due to screening currents. The symmetry breaking was found in the presence of magnetic flux. The screening currents produced interference due to distribution of screening currents. The quasi particles density was improved in the presence of magnetic fields. The found results were found in good agreement with previously obtained results.

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