Muhammad Imran(PhD Condensed Matter Physics- Theory)

CONTACT INFORMATION

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RESEARCH PROJECTS

Condensed Matter Physics Projects

- Exploring the energy bands of the Moire superlattice system, twisted bilayer graphene, and twisted trilayer graphene. I have studied the ferromagnetic ordering in the Hofstadter energy bands of twisted bilayer, and trialyer energy bands.
- Boltzmann equation approach to study the anomalous charge transport in the topological Dirac and Weyl semimetals. I have derived these equations by using the Wigner and Moyal coordinates approximation and by expanding the wave function comprising of the Bloch wave packets.
- Kubo Linear response theory of the charge magnetotransport in the Dirac and Weyl semimetals, Feynmann diagrammatic techniques, and ladder diagram approximation. To derive the formulas of viscous magnetotransport, I have utilized the technique of straining the Hamiltonian of the electron gas.
- Random phase approximation for studying plasmonic modes of the spin orbit coupled Fermi liquid systems. Later we have also derived the same results by using the Landau technique of including interactions between quasiparticles.
- The Keldysh Greens function approach to study the electron transport through quantum dots and molecules in the presence of electron phonon and electron photon interactions. The technique has potential advantage over scattering matrix techniques, since it allows to include an arbitrary strength of the leads-dot coupling.
- Machine learning statistical tools for studying phase transitions in the magnetic and non magnetic systems. The statistical packages of machine learning are correlated with the Monte carlo algorithms. This speeds up the numerical work.

POSTDOC PUBLICATIONS

[1] Quantizing viscous transport in bilayer graphene, Muhammad Imran, Journal of Physics: Condensed Matter 33 (4), 045603,(2020).

PHD PUBLICATIONS

[2] Exploiting the violation of Lorentz symmetry for the planar Hall effect,
Muhammad Imran and Selman Hershfield, Phys. Rev. B(R) 100, 041201 (2019).

[3] Berry curvature force and Lorentz force comparison in the magnetotransport of Weyl semimetals,
M. Imran, and S. Hershfield, Phys. Rev. B 98, 205139 (2018).

[4] Angular dependence of negative magnetoresistance in the Weyl semimetals,
M. Imran, and S. Hershfield. APS March Meeting 2018.

[5] Electron spin resonance in a two-dimensional Fermi liquid with spin-orbit coupling,
S. Maiti, M. Imran, and D. L. Maslov, Phys. Rev. B 93, 045134 (2016).

M.PHIL PUBLICATIONS

[6] Electron transport through a diatomic molecule,
M.Imran, Physica B, 446 (2014).

[7] Electron transport through a quantum dot in the presence of electron-photon and electron-phonon coupling
M. Imran, Eur. Phys. J. B 86, 16 (2013).

[8] Electron transport through nano scale systems,
M.Imran, M.Phil Thesis, Summer(2011).

CONFERENCE TALKS

[9] Hofstadter Butterfly In Twisted Trilayer Graphene, M Imran, Y Barlas, Bulletin of the American Physical Society,(2022).

[10] Role of interactions on topological flat bands in twisted bilayer graphene at high magnetic field M. Imran., and Y. Barlas. American Physical Society March Meeting, 2021.

[11] Angular dependence of negative magnetoresistance in the Weyl semimetals,
M. Imran, and S. Hershfield. American Physical Society March Meeting 2018.

[12] International Scientific Spring 2011, National Center for Physics Islamabad, Pakistan on Mar 01-04, 2011.

[13] 12th National Symposium on Frontiers in Physics, 02-04 February 2011, GC University, Lahore.

[14] International Scientific Spring 2010, National Center for Physics Islamabad, Pakistan on Mar 01-06, 2010.

SCHOLARSHIPS AND FELLOWSHIPS

Awarded

[1] CLAS travel award, University of Florida 2020

[2] University of Florida Graduate school fellowship 2013-2017

[3] University of Florida Summer fellowship 2015

[4] Quaid-i-Azam University, Research assistantship 2010, 2013.

COMPUTATIONAL SKILLS

Matlab: 5-years of experience(2017-2022)
Python: 3-years of experience(2017-2020)
Mathematica: 5-years of experience (2015-2020)
C++ : 1-year of experience (2013)
Linux: 3-years of experience(2017-2020)
Latex : 10-years of experience (2010-2020)
Machine Learning Skills: 1-year of experience (2019).

AVAILABILITY

- Open to work.
- Open to relocation

EDUCATION

University of Florida, Gainesville, FL

Ph.D., Theoretical Condensed Matter Physics, May 2020 GPA: 3.6 (4.0 scale)

- Thesis Topic: *Theory of magnetotransport in the Dirac and Weyl semimetals*
- Advisor: Professor Selman Hershfield

M.S., Department of Physics, August 2017 GPA: 3.60 (4.0 scale)

- Major: *Computational and theoretical condensed matter physics*

M.Phill, Department of Physics, Quaid-i-Azam University, Islamabad, Pakistan,
August 2011 GPA: 4.00 (5.0 scale)

B.Sc, Department of Physics, Quaid-i-Azam University, Islamabad, Pakistan,
August 2009 GPA: 3.70 (5.0 scale)

PROFESSIONAL EXPERIENCE

Post-Doc, University of Nevada, Reno, Physics Department

August 2020 to Present

Teaching Assistant, University of Florida, Gainesville, Physics Department

August 2013 to 2020

Research Assistant, University of Florida, Gainesville, Physics Department

Theoretical Many Body Physics, 2014-2016

- Using Matlab to plot the Hofstadter energy bands of twisted trilayer graphene. I also wrote code to study the ferromagnetic ordering in Hofstadter energy bands of the square lattice, and twisted bilayer graphene. These code requires optimization and parallel programming skills.
- Using Mathematica to study the tensor products of many body spin spin correlation effects.
- Using Python to study the topological properties of the Dirac and Weyl semimetals.

EXPERTISE

Mathematics:

- Real and Complex Analysis, Ordinary Differential Equations, Mathematical Physics

Physics:

- Classical Mechanics, Quantum Mechanics, Statistical Mechanics, Electrodynamics, Quantum Field Theory, Gravitational Theory, Condensed Matter Physics.

PHYSICS ACTIVITIES

- Member of American Physical Society

REFERENCE

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