

1. Graphene is neither relativistic nor non-relativistic: thermodynamics aspects

2. Wiedemann-Franz law violation domain for graphene and nonrelativistic systems

Graphene is a material made of a single layer of carbon atoms, arranged like a honeycomb, known for being extremely light and an excellent conductor of electricity and heat. Dr. Sabyasachi Ghosh (Associate Professor, Physics Department, IIT Bhilai) and his collaborators- Ms. Thandar Zaw Win and Mr. Cho Win Aung, international PhD students from Myanmar, and Mr. Gaurav Khandal, M. Sc student- have made notable theoretical progress in understanding how electrons inside graphene exhibit fluid-like behavior, challenging conventional transport theory. The first paper focuses on understanding the thermodynamic properties of electrons in graphene, focusing particularly on how the electronic specific heat has increased in the low-doping regime. This enhancement in specific heat leads to increased thermal conductivity, resulting in the violation of the classical Wiedemann-Franz (WF) law. From that finding, they have rooted in kinetic theory based Boltzmann Transport Equation (BTE), revealing how this unusual behavior leads to the violation of the classical WF law, which typically links electrical and thermal conductivities in ordinary metals. By formulating a non-fluid to fluid transition framework, the team identified distinct transport regimes in graphene- Ohmic, non-Ohmic, mixed, and fluid- and demonstrated how the Lorenz ratio evolves across them. Their theoretical model not only aligns with recent experimental findings but also connects with concepts from high-energy physics. This work contributes to the growing field of electron hydrodynamics in two-dimensional systems, and two articles have recently been published (January 30 and April 30, 2025) these works in Pramana and the International Journal of Modern Physics B.

1. DOI: <https://doi.org/10.1007/s12043-024-02888-y>

Home > Pramana > Article

Graphene is neither relativistic nor non-relativistic: thermodynamics aspects

Published: 30 January 2025

Volume 99, article number 28, (2025) [Cite this article](#)

Download PDF

Access provided by Indian Institute of Technology Bhilai



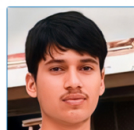
Pramana

[Aims and scope](#)

[Submit manuscript](#)

Thandar Zaw Win, Cho Win Aung, Gaurav Khandal & Sabyasachi Ghosh

[Use our pre-submission checklist](#)



2. DOI: [10.1142/S0217979225501826](https://doi.org/10.1142/S0217979225501826)

DETAILS

RELATIONS

International Journal of Modern Physics B
Volume 39, Issue 20
10 August 2025

ARTICLE

Wiedemann-Franz law violation domain for graphene and nonrelativistic systems

[View article page](#)

Thandar Zaw Win, Cho Win Aung, Gaurav Khandal and Sabyasachi Ghosh

CITE

2025 World Scientific Publishing Company
<https://doi.org/10.1142/S0217979225501826>

<<

1

⋮

⌂

🔗

International Journal of Modern Physics B
Vol. 39, No. 20 (2025) 2550182 (27 pages)
© World Scientific Publishing Company
DOI: [10.1142/S0217979225501826](https://doi.org/10.1142/S0217979225501826)

World Scientific
www.worldscientific.com

Wiedemann-Franz law violation domain for graphene and nonrelativistic systems

Thandar Zaw Win, Cho Win Aung, Gaurav Khandal and Sabyasachi Ghosh*

Department of Physics, Indian Institute of Technology Bhilai
Kutalabhata, Durg 491002, Chhattisgarh, India
*sabyaphy@gmail.com