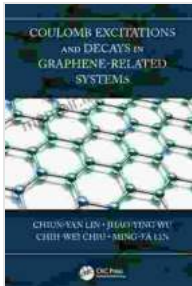


# Coulomb Excitations and Decays in Graphene-Related Systems: Unveiling the Quantum Realm of 2D Materials



## Coulomb Excitations and Decays in Graphene-Related Systems by Peter J. A. Bollen

★★★★☆ 4 out of 5

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Graphene, a two-dimensional (2D) material composed of a single layer of carbon atoms arranged in a hexagonal lattice, has captured the attention of scientists and engineers worldwide due to its remarkable properties. Its unique electronic structure, exceptional mechanical strength, and high thermal conductivity make it a promising candidate for a wide range of applications, including nanoelectronics, optoelectronics, and energy storage.

One of the key aspects of graphene's behavior is its response to external stimuli, such as light or electric fields. These interactions can lead to the excitation of various collective modes, known as Coulomb excitations, which play a crucial role in determining graphene's optical, electronic, and thermal properties.

## Coulomb Excitations in Graphene

Coulomb excitations are collective oscillations of the electron charge density in graphene. They arise from the interaction between electrons and can be classified into three main types:

- **Plasmons:** Plasmons are quanta of electromagnetic waves that propagate through graphene. They are analogous to photons in free space and exhibit a unique dispersion relation that depends on the electron density and Fermi energy of graphene.
- **Phonons:** Phonons are quanta of lattice vibrations. In graphene, phonons have a unique dispersion relation that reflects the two-dimensional nature of the material.
- **Excitons:** Excitons are bound states of electrons and holes in graphene. They have a finite lifetime and can decay into photons or other excitations.

## Decays of Coulomb Excitations

Coulomb excitations in graphene can decay through various mechanisms, including:

- **Radiative decay:** Coulomb excitations can decay by emitting photons. This process is responsible for the optical properties of graphene, such as its absorption and emission of light.
- **Non-radiative decay:** Coulomb excitations can also decay through non-radiative processes, such as electron-phonon coupling or defect scattering. These processes limit the lifetime of Coulomb excitations and affect their transport properties.

## Applications of Coulomb Excitations and Decays

Understanding the behavior of Coulomb excitations and decays in graphene is essential for designing and optimizing graphene-based devices. These phenomena play a role in a wide range of applications, including:

- **Nanoelectronics:** Coulomb excitations can be used to control the electrical conductivity of graphene-based transistors and other electronic devices.
- **Optoelectronics:** Coulomb excitations can be used to enhance the optical properties of graphene, making it a promising material for light-emitting diodes (LEDs), photodetectors, and solar cells.
- **Energy storage:** Coulomb excitations can affect the charging and discharging behavior of graphene-based batteries and supercapacitors.

Coulomb excitations and decays are fundamental phenomena that shape the behavior of graphene and other 2D materials. Understanding these phenomena is crucial for unlocking the full potential of these materials and developing innovative applications in nanoelectronics, optoelectronics, and beyond. As research in this field continues to advance, we can expect to gain even deeper insights into the quantum realm of 2D materials and their potential to revolutionize modern technology.

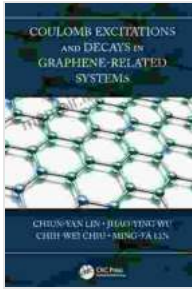
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