Two Dimensional Electron Gas

Why in News

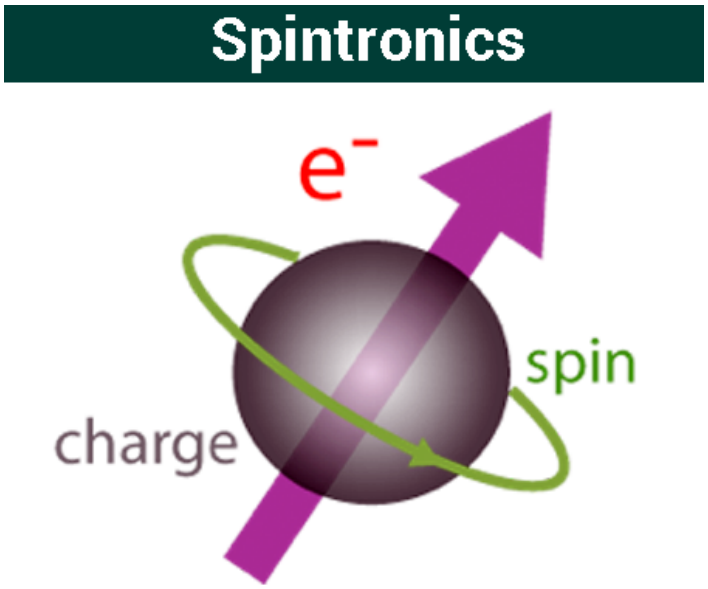
Scientists at **Institute of Nano Science and Technology (INST),** Mohali, Punjab have produced an **ultra-high mobility Two dimensional (2D)-electron gas** (2DEG).

Key Points

- **Two Dimensional Electron Gas (2DEG):**
  - It is an electron gas that is free to move in **two dimensions,** but tightly **confined in the third.** This tight confinement leads to **quantized energy levels for motion in the third direction.** Thus the electrons appear to be a **2D sheet embedded in a 3D world.**
  - One of the most important recent developments in **semiconductors,** has been the achievement of structures in which the electronic behavior is essentially **two-dimensional** (2D).
  - Most 2DEGs are found in **transistor-like structures** made from **semiconductors.**
  - 2DEG is a valuable system for exploring the physics of **superconductivity magnetism and their coexistence.**
    - Superconductivity is a phenomenon whereby a **charge moves through a material without resistance.** In theory this **allows electrical energy to be transferred between two points** with perfect efficiency, losing **nothing to heat.**

- **Cause for Development of 2DEG:**
  - The need for attaining new functionalities in modern electronic devices has led to the **manipulation of property of an electron** called **spin degree of freedom along with its charge.** This has given rise to an altogether new field of spin-electronics or **'spintronics'.**
  - The manipulation of **electron spin** offers **new dimensions for basic and applied research,** and the potential for **new capabilities for electronics technology.** This motivates studies of spin polarized electrons in a **high mobility two dimensional electron gas** (2DEG).

    Spintronics is the study of the **intrinsic spin of the electron** and its associated **magnetic moment,** in addition to its fundamental electric charge, in solid-state devices.



  - It has been realized that a phenomenon called the **'Rashba effect',** which consists of splitting of spin-bands in an electronic system, might play a key role in spintronic devices.

    Rashba Effect: Also called **Bychkov–Rashba effect,** it is a **momentum-dependent splitting of spin bands** in bulk crystals and low-dimensional condensed matter systems.
- **Mechanism and Importance:**
  - Due to the **high mobility of the electron gas,** electrons **do not collide** inside the medium for a **long distance** and hence **do not lose the memory and information.**

    Hence, it can speed up transfer of quantum information and signal from one part of a device to another and increase data storage and memory.
  - Since they collide **less during their flow, their resistance is very low, and hence they don't dissipate energy as heat.**

    So, such devices **do not heat up easily and need less input energy** to operate.

Source:PIB