



Moiré Materials and Superconductivity

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Why in News?

A recent **Nature study** found that **moiré materials** made from [semiconductors](#) can also be [superconducting](#), a property **previously** thought to be exclusive to [graphene](#).

What are the Key Facts About Moiré Materials?

- **About:** Moiré materials are materials having **unique properties** due to the **interference pattern** formed when **two repetitive structures are overlaid at a slight angle**.
- **Creation of Moiré Materials:** Moiré materials are created by **stacking two layers of a two-dimensional (2-D) material**, such as [tungsten diselenide](#), and **twisting one layer** at a small angle (3.65°).
 - The **twist** between the layers creates a **unique moire pattern** that gives rise to **new electronic behaviors** not present in individual layers.
- **Electronic Properties:** The twist in layers creates **flat bands** in the electronic structure, where **electrons** move slowly with nearly **constant energy**.
 - This slow movement boosts **electron-electron interactions**, crucial for superconductivity.
- **Research on Tungsten Diselenide (tWSe₂):** tWSe₂, a semiconductor moiré material, demonstrated **superconductivity** at a transition temperature of approximately **-272.93° C**, comparable to that of **high-temperature superconductors**.
 - The superconducting state in tWSe₂ was found to be **more stable** than in other moiré materials.
- **Comparison with Graphene Superconductors:** Graphene-based moiré materials achieve superconductivity through **electron-lattice interactions** and **flat band formation**, while tWSe₂ relies on **electron-electron interactions**, making it more stable and potentially more robust.
 - Electron-lattice interactions are the interactions between **electrons and the atomic lattice** (the arrangement of atoms) in a material's crystal structure.
- **Significance of Findings:** **Stable superconductivity** at low temperatures enables practical applications in [quantum computing](#) and **electronics**.
 - It can aid in **designing new materials** for future technologies.

Note: Superconductivity is the property of certain materials to conduct **direct current (DC) electricity without energy loss** when they are **cooled below a critical temperature (T_c)**.

- These materials also **expel magnetic fields** as they transition to the superconducting state.
- Superconductivity was discovered in **1911 by Heike Kamerlingh-Onnes**. For this discovery, he won the **1913 Nobel Prize in Physics**.
- E.g., **MRI machines** use an alloy of **niobium and titanium**.

Read more: [Allotropes of Carbon](#)

UPSC Civil Services Examination Previous Year Question (PYQ)

Prelims

Q. Which one of the following is the context in which the term "qubit" is mentioned?

- (a)** Cloud Services
- (b)** Quantum Computing
- (c)** Visible Light Communication Technologies
- (d)** Wireless Communication Technologies

Ans: (b)

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