LK-99: The Quest for a Room-Temperature Superconductor

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Why in News?

A group of South Korean scientists have recently claimed the **discovery of a material they named LK-99**. According to their reports, **LK-99 is a** superconductor **at room temperature and pressure.**

- This groundbreaking claim has piqued the interest of the scientific community and could potentially **revolutionize the world of** electrical conductivity **and technology.**

What does the Claim on Discovery of LK-99 Suggest?

- **Exploring Apatite Materials:** The South Korean group's discovery involved a rather unexpected material called **apatite.**
  - Apatites are minerals with a phosphate scaffold in a tetrahedral or pyramidal motif(one phosphorus atom is surrounded by four oxygen atoms).
  - The scientists started with lead apatite and substituted some of the lead atoms with copper, **resulting in copper-substituted lead apatite, which they named LK-99.**
- **Evidence of Superconductivity:** The group reported that at **10% copper substitution, LK-99 exhibited the characteristics of a superconductor.**
  - The material also maintained superconductivity in the presence of an external magnetic field, up to a certain critical threshold, a behavior consistent with known superconductors.
- **The Implications of LK-99**: If the claims of LK-99 being a room-temperature superconductor are confirmed, it could usher in a new era for electrical conductivity and technology.
  - The widespread application of superconductors in everyday devices could lead to increased **energy efficiency, reduced power losses, and the development of revolutionary technologies.**

What are Superconductors?

- **About:**
  - Superconductors are **materials that exhibit zero electrical resistance** when cooled to extremely low temperatures. This property allows them to **conduct electricity with no loss of energy.**
    - **Example:** Lanthanum-Barium-Copper Oxide, Yttrium-Barium-Copper Oxide, Niobium-Tin etc.
- **Discovery:**
  - In **1911 Kamerlingh Onnes** discovered that the electrical resistance of **mercury completely disappeared at temperatures a few degrees above absolute zero.**
    - The phenomenon became known as **superconductivity.**
- **Applications of Superconductors:**
  - **Energy Transmission:** Superconducting cables can transmit electricity without losses, making them ideal for long-distance power transmission.
  - **Magnetic Resonance Imaging (MRI):** Superconducting magnets are used in MRI machines **to create strong and stable magnetic fields**, enabling detailed medical imaging.

- **Particle Accelerators:** Superconducting magnets are crucial components in particle accelerators like the **Large Hadron Collider (LHC)**, allowing particles to reach high velocities.
- **Electric Motors and Generators:** Superconducting materials can enhance the efficiency and power density of electric motors and generators.
- **Maglev Trains:** Superconducting magnets enable **magnetic levitation (maglev) trains to float above tracks,** reducing friction and enabling high-speed travel.
- **Quantum Computing:** Some superconducting materials are being explored for their **potential in** quantum computing due to their ability to exhibit quantum states.