



SPINTRONICS – SCIENCE & TECHNOLOGY

News: Researchers have made a significant breakthrough in spintronics, achieving the generation of spin currents in just 2 femtoseconds (fs) using a new method called optical intersite spin transfer (OISTR).

What's in the news?

About Spintronics

- Spintronics stands for spin transport electronics
- It is a cutting-edge field that harnesses the intrinsic spin of electrons.
 - Unlike traditional electronics that rely solely on charge (electrons' movement), spintronics exploits both charge and spin properties.

Applications

- **Magnetic Hard Drives:** Spintronics has transformed hard drive technology.
 - Giant magnetoresistive heads (GMR heads) enable higher data densities and faster read/write speeds.
 - A laptop's hard drive owes its efficiency to spintronics.
- **MRAM (Magnetoresistive Random-Access Memory):** MRAM combines the best of both worlds: non-volatility (like flash memory) and speed (like RAM).
 - It stores data using electron spins, making it a promising candidate for future memory devices.
 - It's increasingly being adopted in consumer electronics, servers, and automotive applications.
- **Quantum Computing :** Spin qubits—quantum bits based on electron spins—could revolutionize quantum computers.
 - They offer longer coherence times and scalability compared to other qubit technologies.

Recent Developments

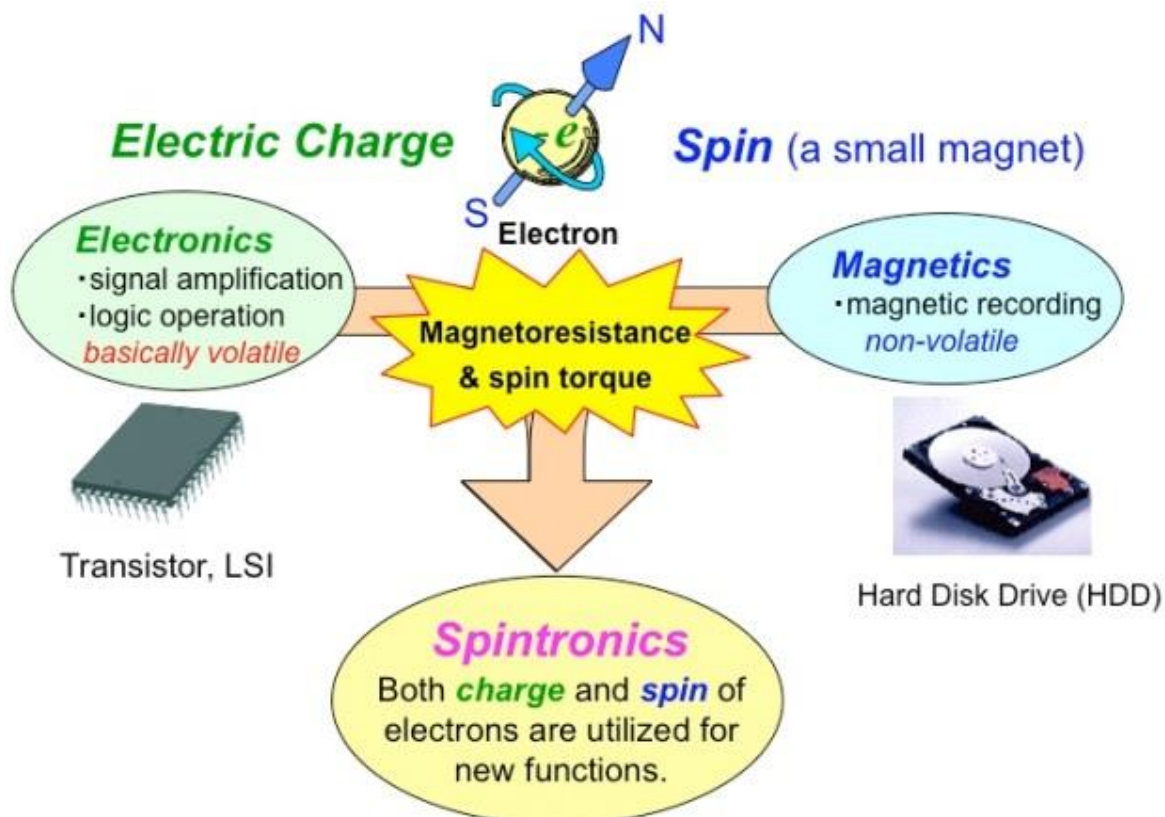
- Current spintronic devices already utilize electrons' magnetic properties, but improvements have stalled due to limitations in read/write speeds.
- The researchers engineered a **layered material composed of cobalt and platinum**, applying two laser pulses: a 4 fs pulse of linearly polarized light to excite the electrons, followed by a pulse of circularly polarized light to assess the resultant spin ordering.
- They observed a **slight decrease in spin order** in cobalt layers and an increase in platinum layers, indicating a spin current transfer.



- This proof of concept demonstrates that ultrafast lasers can **directly induce spin** currents within femtosecond timescales, paving the way for the development of next-generation spintronic devices capable of operating at even faster rates, potentially in the attosecond range.

Benefits

- **Speed:** Spintronic devices can operate at higher speeds than conventional electronic components, enabling faster data processing and transfer.
- **Power saving:** Spintronic devices can achieve non-volatile memory, meaning they retain information even when power is turned off.
 - This characteristic can lead to significant energy savings in data storage and computing.
- **Data:** Spintronic technology has the potential to store more data in smaller spaces
- **Enhanced Functionality:** Spintronics allows for the development of novel devices that combine logic and memory functions, leading to faster and more efficient computing architectures.



Challenges

- Many spintronic effects are **highly sensitive to temperature fluctuations**.



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- **Efficiently injecting spin-polarized electrons** into a nonmagnetic material is challenging.
- Achieving high spin injection efficiency without causing excessive resistance or **energy losses** is an ongoing research area.
- Spin **currents tend to decay** over relatively short distances.
- External magnetic fields, **impurities, and defects** can introduce noise and interfere with spintronic devices.

Conclusion and Way Forward

- Spintronics represents a paradigm shift in understanding and utilizing electronic materials.
- By harnessing the power of electron spin, this innovative technology offers a pathway to faster, more efficient, and more versatile devices. As we move further into the digital age, spintronics could play a crucial role in shaping the future of electronics, paving the way for new applications that will enhance daily lives and drive technological progress.
- The field is rapidly advancing, with ongoing research and development in both academic and industrial settings.
 - As scientists and engineers continue to explore the intricacies of electron spin, spintronics is poised to revolutionize the landscape of electronics.

Source: <https://www.thehindu.com/sci-tech/science/superfast-lasers-open-a-shortcut-to-hard-drives-of-the-future/article68637177.ece>