Advancements in Magnetic Field Measurements

Source: PIB

Scientists at the **Raman Research Institute (RRI)** have developed a technique called **Raman-Driven Spin Noise Spectroscopy (RDSNS)** which can be incorporated into an **all-optical quantum magnetometer** to **improve magnetic field measurements.**

RDSNS (Raman-Driven Spin Noise Spectroscopy):

- **About: RDSNS** is an advanced **all-optical technique** for measuring magnetic fields using **laser light** and **Rubidium atoms**.
  - Atoms naturally exhibit tiny, random **spin movements**, known as **spin noise**.
  - When exposed to a **magnetic field**, the pattern of this noise changes.
  - By detecting these changes with laser light, researchers can measure the magnetic field **without disturbing the atoms**.
- **Key Advantages:**
  - It enables **shield-free**, **compact/portable**, and **field-deployable** magnetic sensing with a **wide dynamic range** and **high sensitivity**.
  - It remains effective even in **outdoor or noisy environments** and is **resistant to electrical and mechanical interference**.
- **Applications:** RDSNS is useful in **medical imaging** (MRI alternative), **geological surveys** (mineral detection), **space exploration** (planetary magnetic fields), and **quantum research** (atomic and spin studies).

Magnetometer:

- **About:** A **magnetometer** is a device used to measure the **strength and direction of magnetic fields**, commonly applied in **medical imaging**, **navigation**, and **earth/space studies**.
  - In **ocean exploration**, it helps detect **shipwrecks, aircraft debris**, and **geological features** on the seafloor.
- **Working:** The **Earth's magnetic field** is generated by **molten iron and nickel** in its outer core and varies by location.
  - Magnetometers detect this variation by recording **magnetic readings** (typically at **1 Hz**). When encountering **ferrous objects** (like anchors, wreckage, or basalt), the device senses **magnetic anomalies**, sudden, unexpected changes in the field.
- **Modern Magnetometers:** Modern magnetometers such as **Optically Pumped Atomic Magnetometers (OPAMs)** and **Spin-Exchange Relaxation-Free (SERF)** use **laser light and alkali atoms** (e.g., Rubidium) to detect magnetic fields with high sensitivity.
  - However, they require **costly magnetic shielding**, function only in **noise-free lab settings**, and have a **limited detection range**.

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