Gold beyond its Melting Point remain Solid

Prelims: *Current events of national and international importance*

Why in News?

Recent observations of Gold superheated far beyond its melting point can remain solid, suggesting that scientists should develop materials that tolerate extreme environments.

- **Publication** - The research is published in the journal "Nature".
- **Focus** - It investigates the phenomenon of superheating in gold when heated rapidly.
- **Key concepts**
  - **Superheating** - It occurs when a solid remains solid at temperatures exceeding its melting point.
  - **Role of entropy** - Entropy measures disorder, which increases as a substance is heated.

> ***Entropy catastrophe*** *is an underlying limit based on thermodynamic principles that suggests solids should not maintain their state beyond certain temperatures.*

- **Historical context** –
  - **Kauzmann paradox (1948)** - Walter Kauzmann found that cooled liquids could have lower entropy than their crystalline forms.
  - **Fecht-Johnson findings (1980's)** - Hans-Jörg Fecht and William Johnson discovered that superheated solids could possess greater entropy than liquids, defying established thermodynamic expectations.
  - **Outcomes** – Both are "catastrophic" because of the second law of thermodynamics, which states that in an isolated system evolving spontaneously, the entropy can't decrease over time.
- **Recent findings** - Researchers utilized *powerful laser pulses for rapid heating* of gold films approximately 50 nm thick.
- **Duration of laser pulses** - Each laser pulse lasted 45 femtoseconds. **Measurement technique** - *High-resolution inelastic X-ray scattering* was employed to ascertain the temperature of gold atoms.
- **Results** - Superheating limit observed that solid gold was found to remain solid at ***14 times*** its melting point for a few trillionths of a second.
- **Atomic structure confirmation** - X-ray diffraction patterns showed the atoms maintained an organized crystalline structure.
- **Implications** –
  - **Material design importance** - Insights into superheating can help engineers develop materials for extreme environments.

- **Technological advances** - The ability to conduct this research was made possible by recent technological advancements.

Reference

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