Superkilonova

Prelims: *Current events of national and international importance | Science & Technology*

Why in News?

Scientists have recently observed an event that resembles a superkilonova at 1.3 billion light-years away.

- **Superkilonova –** It is a ***rare kind of cosmic explosion***, an enhanced version of a kilonova, which itself results from the collision of two neutron stars.

Formation: From Supernova to Kilonova

- **Supernova Explosion –** A massive star explodes in a supernova (left), which generates elements like carbon and iron.
- **Birth of Neutron Stars –** In the aftermath, two neutron stars are born (middle), at least one smaller than the Sun.
- **Gravitational Waves –** The neutron stars spiral together, sending gravitational waves rippling through the cosmos, before merging in a dramatic kilonova (right).
- **Kilonova Merger –** Finally, they collide in a kilonova, creating heavy elements like gold and platinum.

Kilonova	Superkilonova

• It is a confirmed event caused by the ***merger of two neutron stars.*** • The material ejected into space includes heavy, radioactive elements (gold, platinum, neodymium). • As these elements decay, they emit light in the optical and infrared parts of the spectrum.	• It is ***similar in origin*** (neutron star merger) but with an extra energy source. • After the merger, some ejected matter may fall back towards the merged object and become hotter. • This heat energises the surrounding ejecta. • It resulted in brighter, bluer, and longer-lasting than a normal kilonova.

Recent Discovery –

- The astronomers detected a bright source 1.3 billion light-years away.
- Initially, it looked like a kilonova for three days, then resembled a supernova, but more data is needed.

Key Findings

- **Event AT2025ulz –** Observed in August 2025, this transient may represent the first superkilonova—a supernova followed by a neutron star merger.
- **Dual Explosion –** Evidence suggests a massive star exploded, forming two neutron stars that quickly merged.
- **Gravitational Waves** – LIGO, Virgo, and KAGRA detected a signal from a merger involving at least one unusually tiny neutron star.
- **Optical Counterpart –** Caltech's Zwicky Transient Facility (ZTF) spotted AT2025ulz, a fading red object 1.3 billion light-years away.
- **Spectral Evolution –** It started as a fading red emission, then brightened into blue light accompanied by hydrogen features.
- **Possible Mechanism –** A rapidly spinning star may have split (fission) or fragmented, producing two sub-solar neutron stars that merged.

📊 Comparison: Supernova vs. Kilonova vs. Superkilonova

Feature	Supernova 🌟	Kilonova 💥	Superkilonova 🌀
Cause	Collapse of massive star	Merger of two neutron stars	Supernova creates neutron stars that then merge
Elements Produced	Carbon, iron	Gold, platinum, uranium	Both sets of elements
Light Signature	Bright, hydrogen lines	Rapidly fading red glow	Hybrid: red → blue, hydrogen present
Gravitational Waves	Weak, usually undetectable	Strong, detectable	Strong, detectable
Rarity	Common in galaxies	Extremely rare (only 1 confirmed before)	Hypothesized, possibly first observed

References

1. The Hindu | Superkilonova
2. Caltech | Possible "Superkilonova" exploded