White Dwarf

Why in News

Recently, an international team saw **a white dwarf losing its brightness in 30 minutes**, which usually takes a period of several days to months.

- This peculiarity in brightness of white dwarfs can be referred to as **switch on and off phenomena.**
- Using the **Hubble Space telescope** and **Transiting Exoplanet Survey Satellite (TESS)**, astronomers have identified several white dwarfs over the years.

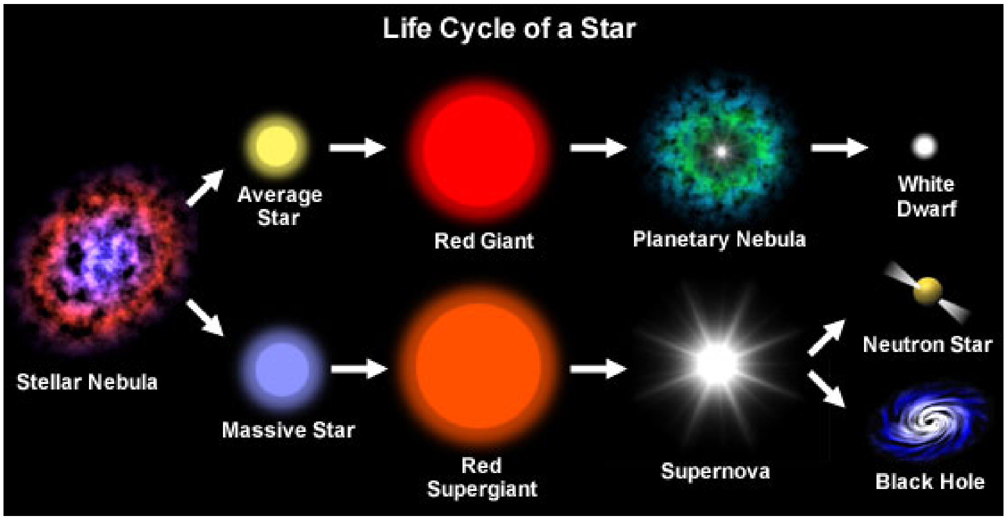
Key Points

- **About White Dwarfs:**
  - **Formation:**
    - White dwarfs are **stars that have burned up all of the hydrogen** they once used as nuclear fuel.
      - Such stars have very high density.
      - A typical white dwarf is half the size of our Sun and has a surface gravity 1,00,000 times that of Earth.
    - Stars like our **sun fuse hydrogen in their cores into helium** through **<u>nuclear fusion reactions.</u>**
    - **Fusion in a star's core produces heat and outward pressure** (they bloat up as enormous red giants), but this pressure is **kept in balance by the inward push of gravity** generated by a star's mass.
    - When the **hydrogen, used as fuel, vanishes and fusion slows**, gravity causes the **star to collapse in on itself into white dwarfs.**
  - **Black Dwarfs:**
    - Eventually - **over tens or even hundreds of billions of years - a white dwarf cools** until it **becomes a black dwarf, which emits no energy.** Because the universe's oldest stars are only 10 billion to 20 billion years old there are **no known black dwarfs.**
    - It must be noted that **not all white dwarfs cool** and transform into black dwarfs.
  - **Chandrasekhar Limit:**
    - Those **white dwarfs which have enough mass reach a level** called the **Chandrasekhar Limit.**
    - At this point the pressure at its center becomes so great that the star will detonate in a **thermonuclear supernova** (explosion).

- **Switch on and off Phenomena:**
    - The **white dwarf,** which is discussed, is **part of a binary system called TW Pictoris**, where a star and a white dwarf orbit each other.
        The two objects are so close to each other that the **star transfers material to the white dwarf.**
    - **As this material approaches the white dwarf it forms an accretion disk** or a disk of gas, plasma, and other particles around it.
    - As the **accretion disk** material slowly sinks closer towards the white dwarf it **generally becomes brighter.**
    - Also there are **cases when the donor stars stop feeding the white dwarf disk**. However, reasons for this are still not clear.
    - When this happens the **disk is still bright** as it "**drains" material that was previously still there.**
        It then **takes the disk about 1-2 months** to drain most of the material.
    - However, **TW Pictoris' drop in brightness in 30 mins** was totally unexpected and it may be **due to the process called magnetic gating**.
        Magnetic gating happens when the **magnetic field is spinning so rapidly around the white Dwarf** it creates a barrier disrupting the amount of matter the white dwarf can receive.
- **Significance**: This discovery will help **understand the physics behind accretion** – how **black holes and neutron stars** feed material from their nearby stars.

Chandrasekhar Limit

- Chandrasekhar Limit is the **maximum mass theoretically possible** for a stable white dwarf star.
- A limit which mandates that **no white dwarf** (a collapsed, degenerate star) can be more massive than about **1.4 times the mass of the Sun**.
- Any degenerate object **more massive must inevitably collapse into a neutron star or black hole.**
- The limit is **named after the Nobel laureate Subrahmanyan Chandrasekhar,** who first proposed the idea in 1931.
    He was awarded the **Nobel Prize in Physics** in 1983 for his work on the physical processes involved in the structure and evolution of stars.



Life Cycle of a Star
Average Star
Red Giant
Planetary Nebula
White Dwarf
Stellar Nebula
Massive Star
Red Supergiant
Supernova
Neutron Star
Black Hole

Source: IE