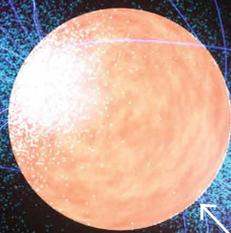


PULSARS

↑
BEAMS OF LIGHT

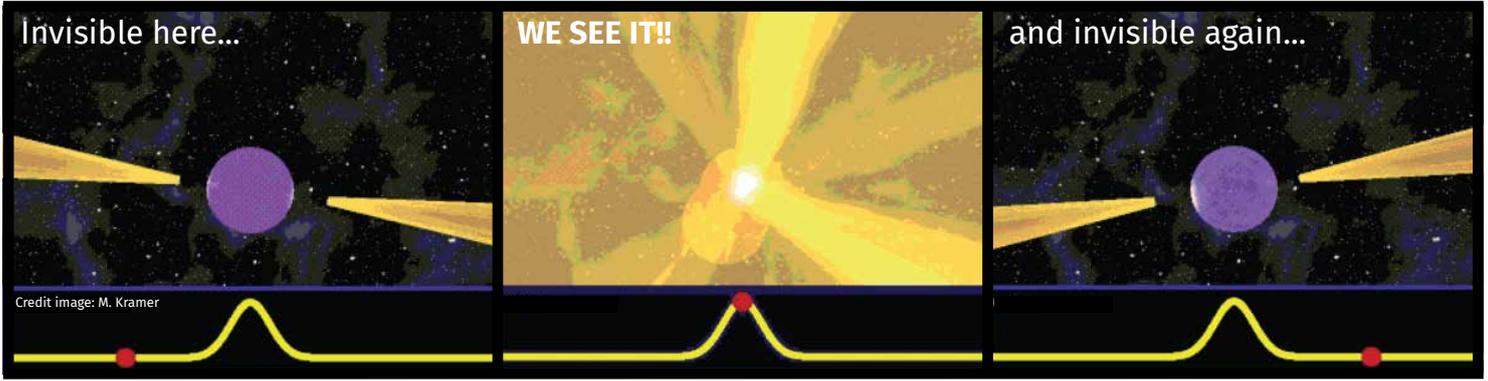
↑
INVISIBLE MAGNETIC FIELD LINES
(LIKE A MAGNET)



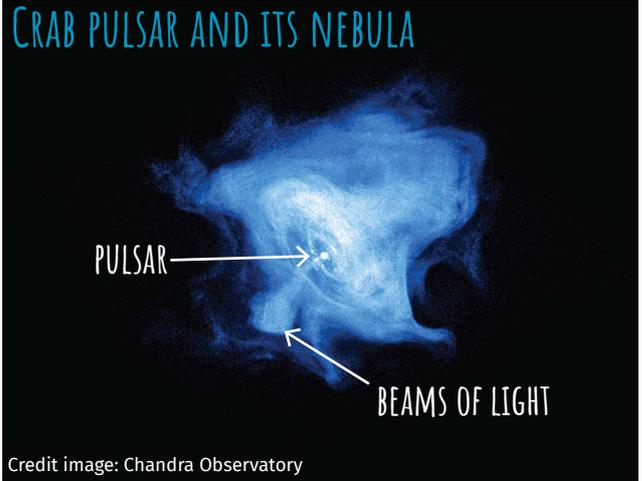
STAR

Pulsars are super rapidly spinning ultra-dense and magnetized stars that emit their light in beams, which we can only see when they cross our line of sight. They are like a **cosmic lighthouse!** They have two beams pointed in opposite directions, but, taking into account the different positions or inclinations these stars can have in the sky, we might be able to detect both or only one of the two light beams.

Credit image: NASA



Pulsars are born from the death of a massive normal star. Massive stars finish their life in huge cosmic explosions, called **supernovae**, and, in some cases, they leave behind a pulsar. This type of star is extremely dense; it can concentrate the mass of up to three "Suns" in just **20 km diameter**. They are so dense that a teaspoon of the material from within the pulsar would weigh almost 1 billion tons! Pulsars are also so tremendously fast that they complete a full rotation in **a few seconds**. Some of them are so fast they can rotate in around **0.001 seconds**. Pulsars emit light or electromagnetic radiation at all frequencies, **from radio up to gamma rays** (check out the electromagnetic spectrum on our website). At the highest frequencies, **very high-energy gamma rays**, there are only four known pulsars: **the Crab, Vela, Geminga pulsars and PSR B1706-44**. From the pulsars' surface, a wind of particles is also emitted. This is very important because these particles can interact with the surrounding medium and give rise to another astrophysical source (named Pulsar Wind Nebula). But that's another story...



This is not how we would see the Crab Pulsar with our eyes because the image shows the X-ray emission, not the visible light, emitted by this pulsar. Do you know where we can find X-rays on Earth? In hospitals, where they are used to take pictures of our bones.

Credit image: Chandra Observatory

PULSARS

READING COMPREHENSION ACTIVITIES

Credit image: NASA

1. Scientists are observing the Crab Pulsar from the Roque de los Muchachos Observatory, using the **Cherenkov Telescope Array (CTA)** to catch gamma rays. They know that, from Earth, both Crab Pulsar's light beams are visible in the gamma-ray regime and that this pulsar rotates with a period of 0.03 seconds. How many pulses can they see after 1 minute?

2. How are pulsars born?

3. Pulsars are extremely big stars:

- True
- False

4. How fast can pulsars rotate? Give some examples of objects you know on Earth with fast spinning velocity and compare the size and density.

5. Pulsars emit only gamma rays:

- True, they are so powerful that they only emit the most energetic electromagnetic radiation
- False, they can emit all electromagnetic radiation (from radio, going through microwaves, infrared, visible light, UV, X-rays and, yes, gamma rays, too)

6. How many pulsars are known to emit very high-energy gamma rays? What are their names?

7. The name "pulsar" arises from the fact that we see the light of these objects just when their beams cross our line of sight. That happens very fast, so the signal we receive looks like a "pulse." Based on other characteristics of these objects mentioned in the text, which name would you use to describe them?

Answers:
1. 4,000 pulses
2. From the death of massive stars
3. False
4. In very few seconds
5. False
6. Four: Crab, Vela, Geminga and PSR B1706-44



cherenkov
telescope
array

the observatory for
ground-based
gamma-ray astronomy