Atmospheres of neutron stars through X-rays

STAG RESEARCH CENTRE

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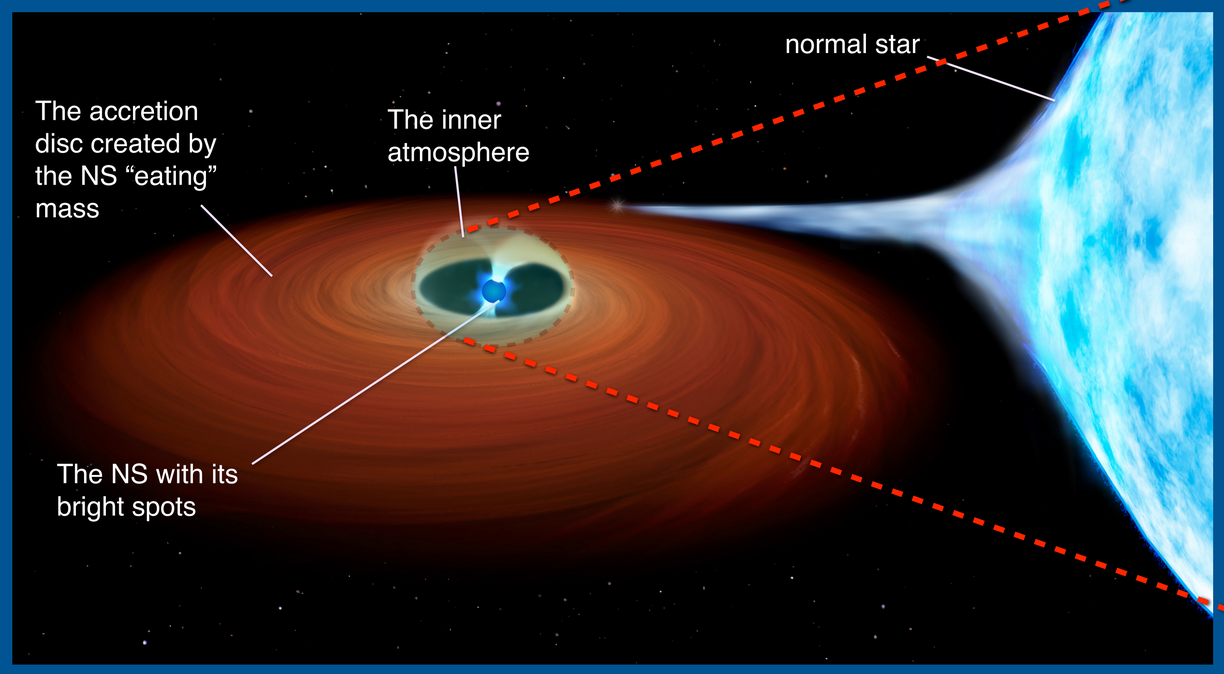
1) What are neutron stars and how do we detect them?

Neutron stars (NS) are the leftovers of dying stars. NS are as small as the city of Southampton but their gravity is billions of times stronger than that of our own sun. When a normal star is orbiting around a NS, the NS constantly attracts mass from the normal star and due to its strong gravity an accretion disc is formed, around the NS, that is only visible in the X-rays and so we need special satellites to detect them.

2) What is the atmosphere of a NS and why is it interesting?

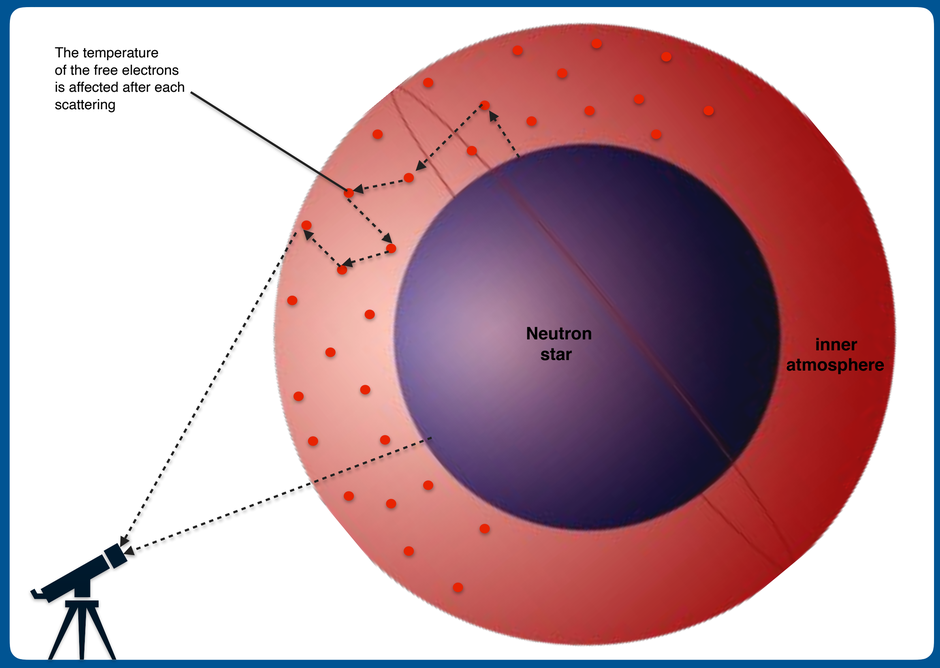
The atmosphere of a NS is a cloud of fast-moving electrons around the NS. The bright spots on the NS surface (visible in the image) are rotating ~500 times per second, acting as a "lighthouse". This "lighthouse" is illuminating the inner atmosphere causing its temperature to oscillate at the same rate. Through this process we learn about the physics and geometry of the atmosphere.



3) How can we study a neutron star atmosphere?

In practise, photons of different energies are released from the NS surface and while travelling through the atmosphere, collide with the electrons and gain energy before they escape. This phenomenon is called inverse Compton scattering. Through these collisions the photons interact with the atmosphere and cause changes in its properties. By modelling the process of multiple collisions in the atmosphere, I calculated how much the atmospheric temperature oscillates and I compared it to the observed X-ray variability when the "lighthouse" is at difference frequencies. This comparison is shown in Figure 1.

4) Scattering process in a neutron star atmosphere.



5) One of our results

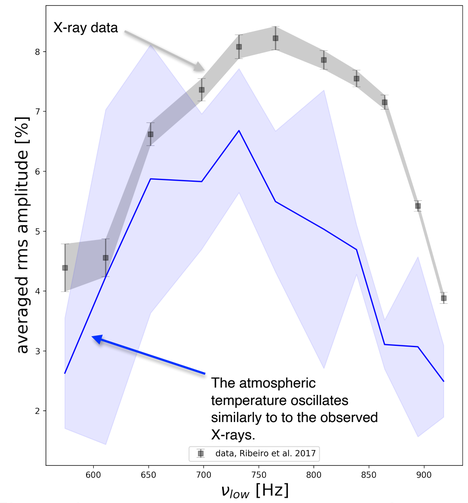


Figure 1: Comparison between atmospheric temperature variability and observed X-ray variability.

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