Background on 'ringing' stars

The interiors of stars are completely hidden from view. Astronomers can see only 0.01 per cent of the total volume of the star we can study most closely: our Sun.

In 1979 astronomers studying the Sun's surface found that it was pulsing in and out repeatedly, on a timescale of about five minutes

Theoreticians eventually realised that the pulsing was caused by sound waves bouncing around inside the Sun.

The Sun is a ball of gas, but its temperature, density and composition change between its surface and its core. For instance, the outer layers of the Sun are rarefied hydrogen gas, but at its core the hydrogen is so tightly packed it is thirteen times denser than lead.

The speed of sound depends on the temperature of the gas, and the average mass of its particles. Gradual changes of these factors with depth will bend the path of a sound wave. Eventually this bending (refraction) will cause a sound wave that was headed into the interior of the Sun to be bent upwards towards the surface. An individual sound wave will be confined between the surface of the Sun and specific depth into the interior, just as if it were confined in a resonating cavity, such as an organ pipe, or some other musical instrument. The confined waves cause the Sun (or star) to "ring".

These waves are fluctuations in pressure transmitted through the gas, and so are called p-modes. The sun vibrates in simultaneously in many millions of p-modes and their overtones. Astronomers can use all these modes to chart how the speed of sound changes with depth below the surface of the Sun and how temperature, composition and internal rotation all vary within the Sun.

The process of studying a star's interior is analogous to seismology, the study of the Earth's interior through quakes and tremors, and so is called helioseismology (in the case of the Sun) or asteroseismology (in the case of other stars).

Source: Jaymie Matthews, *Good vibrations from the stars*, New Scientist **1701**, 26-30

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