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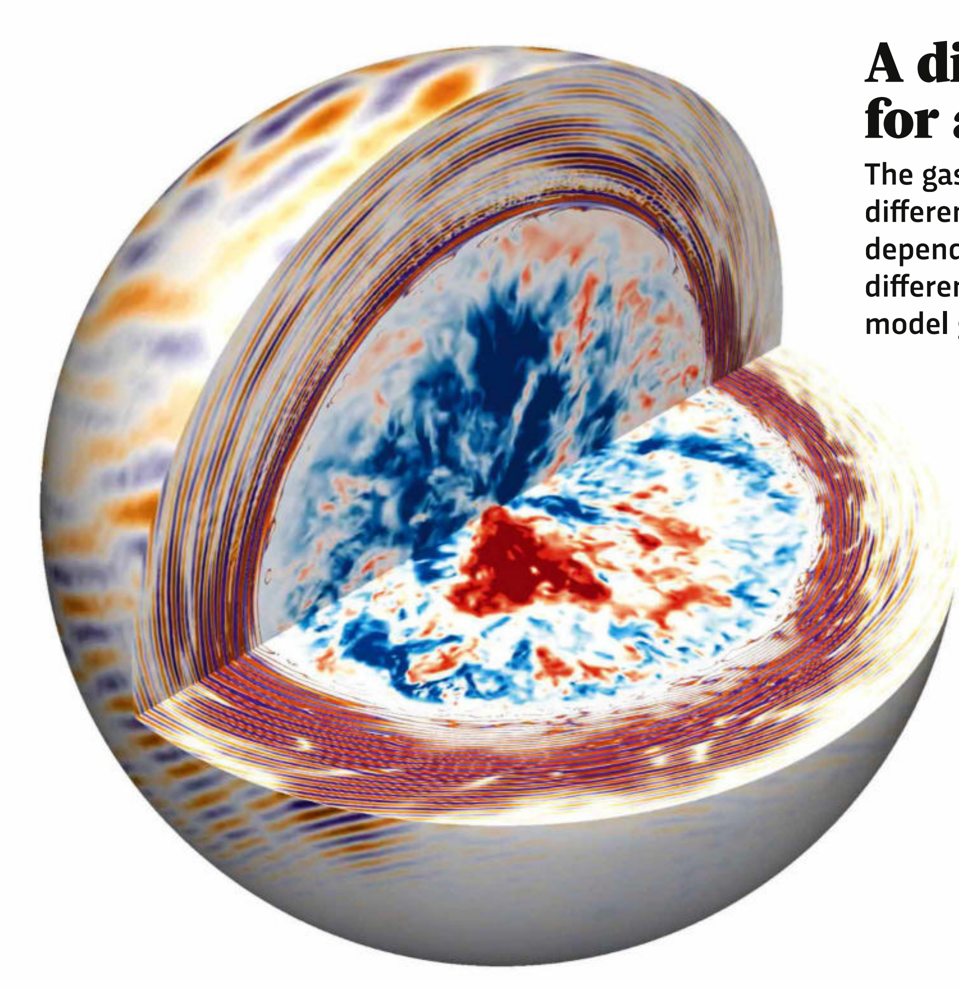


A different song for a different size

The gases in a massive star's core create different frequencies and intensities of waves depending on its size or brightness. Those differences are reflected in the 'songs' the model generated for each type of massive star

Large massive star
(40 TIMES MORE MASSIVE THAN THE SUN)
What initially sounds like the blast from a ray gun in a sci-fi film, gradually warps to become, a low, resonant thrum (like the sound of jet engines heard inside an aeroplane cabin).

Medium massive star
(15 TIMES MORE MASSIVE THAN THE SUN)
The scientists behind the audio simulations describe the waves for this size of star as a "persistent hum through a windswept terrain."

Small massive star
(3 TIMES MORE MASSIVE THAN THE SUN)
The eeriest of the three, the sound of a smaller star's inherent twinkle translates as a high-pitched, plaintive ringing – a little like a warning siren.

ASTRONOMY

EERIE 'SONG' OF TWINKLING STARS DRIVES UNDERSTANDING OF THEIR NUCLEAR CORES

Taking a musical approach helps scientists determine how much a star should shine

ABOVE One of the 3D simulations of the gas waves moving from a star's core to its surface

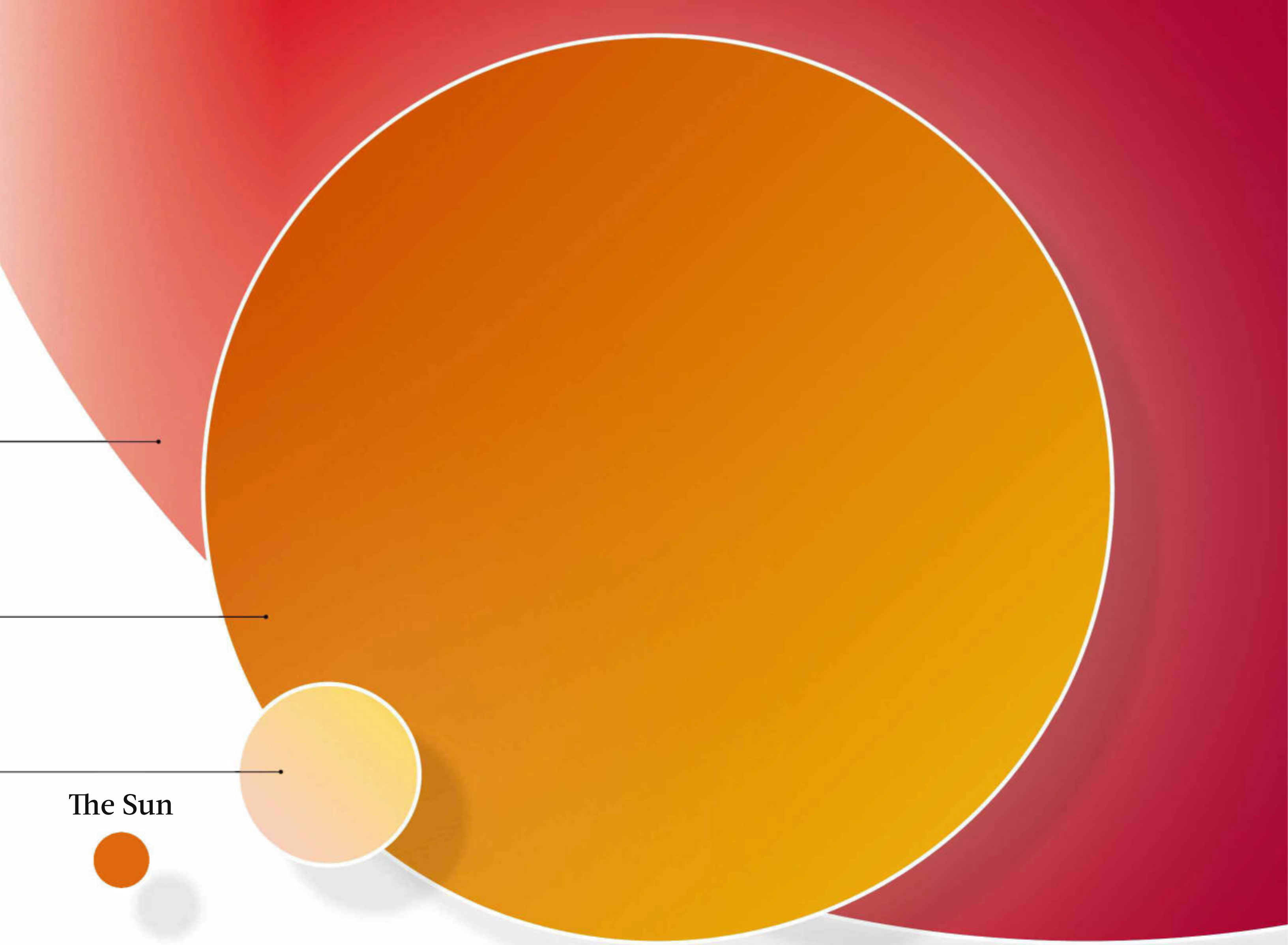
NORTHWESTERN UNIVERSITY ILLINOIS

Scientists have developed a new method to predict the brightness of a star's inherent twinkle. What's more, they've also managed to simulate how that twinkle might sound. And it seems that massive stars sing a strangely eerie song (hear an example for yourself on the *BBC Science Focus* website at bit.ly/InherentTwinkle).

Unlike the visible twinkle we see from Earth, which is caused by a star's light being distorted as it passes through this planet's atmosphere, a star's inherent twinkle is caused by rippling waves of gas on its surface.

The gas waves originate in the nuclear reactions that take place in a star's core and move out towards the surface. As they move, the waves create turbulence and chaos in the gases around them, increasing or decreasing the star's shine to produce its inherent twinkle. This inherent twinkle is invisible, however – to the naked eye as well as the current generation of powerful ground-based telescopes.

But a team, led by scientists from Northwestern University in Illinois, America, has developed a method to produce 3D simulations of the gas waves moving from a star's core to its surface. These simulations have, for the first time ever,



enabled the scientists to determine a given star's inherent twinkle.

The new method, which was detailed in a study published in the journal *Nature Astronomy*, may help us learn more about what's happening inside massive stars (those more than 1.2 times larger than the Sun). Furthermore, it has the potential to shed light on how stars and galaxies form and evolve, as well as help explain how the elements we depend on – such as oxygen – are created.

"Motions in the cores of stars launch waves like those on the ocean," said Dr Evan Anders, who led the study. "When the waves arrive at the star's surface, they make it twinkle in a way that astronomers may [one day] be able to observe."

But how did they come up with the sounds of those stars' twinkles?

After developing the simulations into computer models and using the models to calculate how much twinkling is caused by different frequencies and intensities of waves, Anders and his team then converted these calculations into an audio track to illustrate the movement of the waves.

The resulting track is a human 'translation' of the song, however, because the waves are outside the range of human hearing. As such, the researchers had to increase the frequencies of the waves in order to make them audible.

The sound of the chosen star's inherent twinkling has a clear, commanding ring with an eerie, reverberating pulse underneath. The pulse represents the movement of the waves from the core out to the star's surface.

Studying the calculations in audio form allowed the scientists to combine two processes that operate on different timescales: the initial turbulence of the gases colliding, which happens over a matter of weeks; and the waves themselves, which reverberate for hundreds of thousands of years.

This new method developed by Anders and his team will help to direct powerful future telescopes towards the inner regions of stars where heavier elements are forged.

"This study provides an out-of-the-box method to search for stars' signatures that are largely masked and invisible even to more powerful telescopes and to the human eye," Dr Wanda Díaz-Merced, a sonification astronomer who was not involved in the research, told *BBC Science Focus*.

"I congratulate the team!"