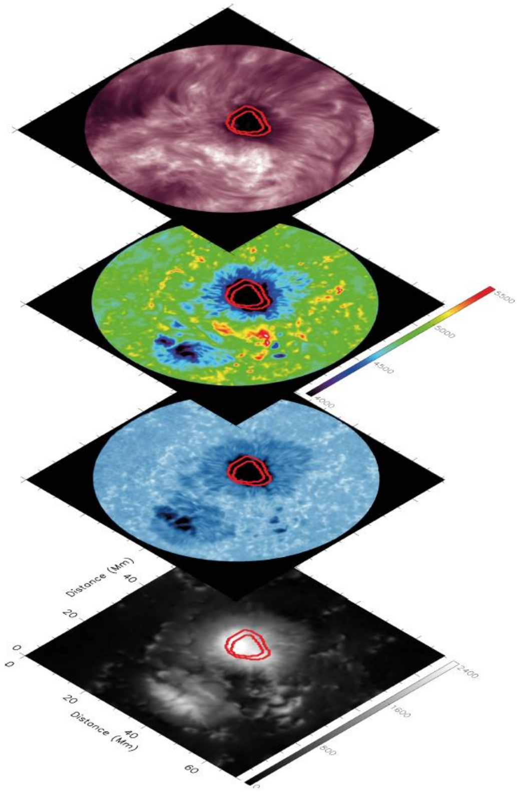
In 1942, a Swedish engineer and physicist by the name of Hannes Alfvén predicted the existence of a new type of wave – one that could exist purely as a result of magnetism. The important nature of these revolutionary waves earned Hannes Alfvén the Nobel Prize for Physics in 1970. Since his prediction, Alfvén waves have been associated with a variety of sources, including nuclear reactors, the coma of comets, laboratory experiments, medical MRI imaging, and in the atmosphere of our nearest star – the Sun. It is here, in the turbulent multi-million-degree atmosphere of the Sun, that Alfvén waves have been hypothesized to play an important role in maintaining such elevated temperatures.



The building blocks of the magnetized solar atmosphere observed on 2014 August 24.

In a similar fashion to ocean waves, Alfvén waves were believed to travel upwards from the solar surface, before eventually 'crashing' in the outermost regions of the Sun's atmosphere and giving off immense heat energy. Within the last 10 years, the existence of Alfvén waves in the Sun's atmosphere has been proven beyond doubt. However, to date there has been no conclusive direct evidence of these waves converting their motion into physical heat; something that has puzzled physicists since their confirmed existence. Using cutting edge data products from both ground- and space-based observatories, California State University Northridge's Solar physicists, as a part of an international team, spanning the UK, USA, Spain, Austria and Georgia, to finally detect and confirm the previously elusive heating potential of solar Alfvén waves, predicted some 75 years ago. This opens the door for a better understanding of these widespread phenomena across all scientific disciplines, including energy reactors and medical devices.

The study employed advanced high-resolution observations from the National Solar Observatory's Dunn Solar Telescope, New Mexico, alongside complementary observations from NASA's flagship $817 million Solar Dynamics Observatory spacecraft, to study the strongest magnetic features anchored into the solar surface. These features, known as sunspots, can have magnetic field strengths exceeding those found in modern hospital MRI machines, yet spanning a diameter exceeding that of our own Earth.

By breaking the Sun's light up into its constituent colors, the international team of researchers were able to examine the behavior of certain elements from the periodic table within its atmosphere, including calcium and iron. Once these elements had been extracted, intense brightenings were detected in the resulting image sequences. These intensely bright signatures bore the hallmarks of the embedded Alfvén waves converting their energy into shock waves, in a similar way to supersonic aircraft creating a 'sonic boom' as they exceed the speed of sound. The resulting shock waves ripple through the surrounding plasma, producing a wake of extreme heat. By modelling the observed signatures with modern supercomputers, the heating capability of Alfvén waves was, for the first time, found to increase plasma temperatures by approximately 5%. The research team have now provided the first evidence that the continual barrage of Alfvén wave driven shocks in the Sun's atmosphere can play an important role in maintaining the elevated temperatures found in our neighboring star.