SOLAR SCIENCE | Waves Might Heat Sun's Atmosphere

Two new studies in the *Astrophysical Journal* suggest a possible solution to the mystery of why the solar corona is 100 times hotter than the chromosphere below it. Perhaps more convincingly, the solution — *Alfvénic waves* — might also explain how the fastest particles in the solar wind attain such high speeds.

Alfvénic waves are oscillations that move along magnetic field lines like vibrations in a plucked string. Scientists first suggested them as a driving force behind both the corona's heat and the acceleration of the fast solar wind in the 1940s, but they weren't observed in the corona until 2007, when a team including Scott McIntosh (National Center for Atmospheric Research) caught sight of them. Last year, McIntosh and his colleagues discovered that these waves permeate the corona.

Now, two independent teams have cemented the key role these magnetic vibrations play on the Sun. The teams used the Extreme Ultraviolet Imaging Spectrometer on Japan's Hinode spacecraft to observe a hole in the corona over the Sun's south pole. In coronal holes the Sun's magnetic field lines stream out straight, instead of curving back down again in big loops. The particles that make up the fast solar wind whiz forth from these regions, zooming through space at 800 kilometers per second (2 million miles per hour).

The teams observed spectral-line broadening in the corona's hot, ionized gas to measure how much energy the Alfvénic waves carry at different heights. Determining the lines' widths allows astronomers to detect the waves, because the waves slosh the corona's ions back and forth along the line of sight at a velocity that depends on the waves' energy.

Both teams, a trio made up of Michael Hahn (Columbia University) and his colleagues, the other a duo comprising Alessandro Bemporad and Lucia Abbo (National Institute of Astrophysics, Italy), found that the Alfvénic wave energy dropped off rapidly within the lowest quarter or so of the solar atmosphere. The drop suggests that the energy is somehow being dumped into the corona's lowest region, where temperatures already reach 1 million kelvin. This energy is then conducted by particle motion throughout the corona. Hahn's team also calculated that the energy dissipated could provide up to 70% of that needed to heat the polar coronal hole and accelerate the fast solar wind. (The lower limit is still zero.)

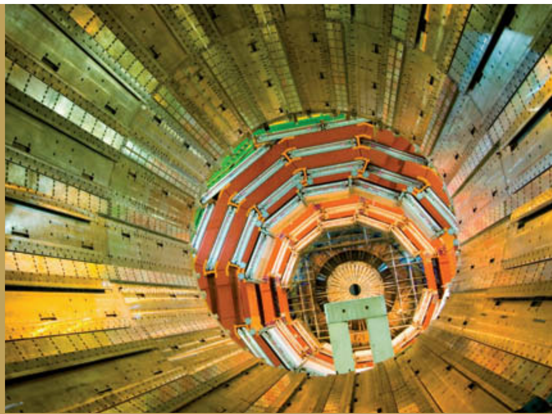
Coronal holes are cooler than other parts of the Sun, and magnetic waves appear to deposit more energy in the cooler regions than in the atmosphere's warmer parts. How much Alfvénic waves could contribute to the corona's temperature overall — or even how their energy is deposited in the first place — is unclear.

McIntosh says he's excited that people are probing this enigmatic energy source in the Sun's atmosphere. But while he's convinced the waves have an impact, he's not so sure they're needed to heat the material in the coronal holes. Jets shooting up from the chromosphere might do that just fine. Riding these jets, the waves could then accelerate the jet-heated ions and send them rocketing into space.

Other researchers vote instead for energy bursts released when magnetic field lines snap into new configurations or even "magnetic tornadoes" channeling energy up from below.

■ **CAMILLE M. CARLISLE**

PARTICLES | Higgs Hype Merited



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On July 4th physicists using the proton-smashing Large Hadron Collider near Geneva, Switzerland, announced their discovery of a "Higgs-like particle." Just as the photon is the particle associated with an electromagnetic field, the Higgs boson is the particle associated with the Higgs field, the theoretical field that permeates space and imparts mass to particles depending on how strongly they interact with it.

The LHC announcement wasn't a surprise: it was the culmination of several years of hints and upholds the wonderfully successful Standard Model of particle physics. Physicists first predicted the Higgs boson in the early 1960s, and its detection is yet another demonstration of the predictive power of science. By upholding current theories, the detection gives physicists confidence they're heading in the right direction in their quest to understand the universe.

The LHC results put the Higgs-like particle at about 125 billion electron volts, 133 times more massive than a proton. According to the LHC team, there's only about 1 chance in 3 million that the signals detected are a statistical fluke, assuming there are no systematic errors. (Systematic errors are what led to the recent faster-than-light neutrino result: a faulty yardstick ruins even careful measurements.) The work used two experiments at the LHC, including the Compact Muon Solenoid (shown here), which detects protons smashed together with energies of up to 8 trillion electron volts.

The work might also lead to new physics. Some theories predict more than one type of Higgs particle, so as the LHC cranks up the energy of its collisions it might bust open entirely new particles — perhaps particles responsible for dark matter or something completely unexpected. ✦

■ **ROBERT NAEYE**