THE UNIVERSITY OF TEXAS AT AUSTIN
TEXAS ADVANCED COMPUTING CENTER TACC

Solar Revisions

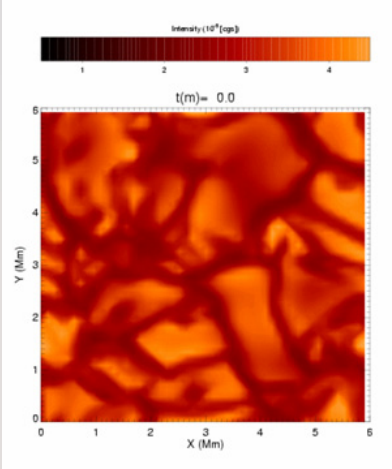
3D simulations at TACC force scientists to reevaluate the Sun's composition

In 2001, Carlos Allende Prieto, a researcher at the Institute of Astrophysics of the Canary Islands, discovered that the amount of carbon and oxygen in the Sun was 30 to 40 percent lower than previously believed.

The chemical composition of the Sun is used as a reference for measurements of the composition of other objects in the Universe, so other models that relied on the higher abundance of carbon and oxygen were put into question by Prieto's hypothesis. At the time, his conclusions were based on only a few lines of the solar spectrum. A full spectrum analysis, using 3-D models, required computers a million times more powerful than what was available.

Seven years later, comprehensive simulations performed at the Texas Advanced Computing Center (TACC) proved that Prieto's measurements were indeed accurate. This discovery is leading to new notions about our cosmic evolution, and a reevaluation of the distinctiveness of the Sun.

By integrating a new 3-D model into his analysis, Prieto discovered a spectrum that indicated lower amounts of carbon and oxygen than those previously determined by solar seismologists. "The strength looked fine with 1-D models, but because the 3-D models can better reproduce the observed shape of the line profiles, it was obvious something was wrong," Prieto said.



The image represents the observable surface of a star about 3000 degrees cooler than our sun. The bright regions correspond to the "granules" of hot ascending gas, which are surrounded by "intergranular lanes" of cool material sinking back into the star's interior. [Credit: I. Ramirez, M. Asplund, C. Allende Prieto, L. Koesterke, D. L. Lambert.

Carlos Allende Prieto (left), researcher at the Institute of Astrophysics of the Canary Islands (IAC), and Lars Koesterke (right, research associate at the Texas Advanced Computing Center.

Using TACC's computational resources, Prieto was able to complete full calculations in 3-D in just one day, proving that his 2001 assessment was not a fluke. He has published several papers describing this work, and increasingly, the new abundances are being accepted and integrated into solar models. These findings align the Sun more closely with the stars in the vicinity, and suggest a common galactic history.

"Astrophysics relies on correctly identifying the chemical composition of the stars," Prieto said. "We now have the right computing power, and the right code, so we're going to do better science."

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