Computer simulation shows the sun's "heartbeat" is magnetic

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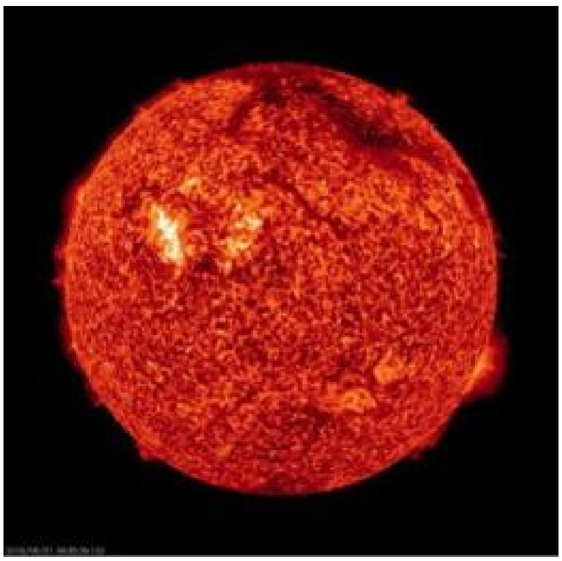

Image of sun courtesy of NASA.

(Phys.org) —A research team made up of Paul Charbonneau, a physicist with the University of Montreal and Piotr Smolarkiewicz, a weather scientist with the European Centre for Medium-Range Weather Forecasts in the U.K., has created a new kind of computer simulation of the sun's energy flow. In their Perspective article published in the journal *Science*, the two describe the solar engine deep within the sun as its "heartbeat" and suggest that it underlies virtually all solar activity.

To gain a better understanding of how the sun works, the two researchers created a simulation that models the sun's entire magnetic field activity—no small feat. They ran their simulation on University of Montreal supercomputers which are connected to a larger network across the city. In so doing, they observed that though the sun as a whole experiences an 11 year cycle of solar polar reversals (as noted here on Earth by the periodic nature of observable sun spot activity), zonal magnetic field bands undergo a polarity reversal on average every 40 years.

Scientists have for years been trying to model the sun, but thus far attempts to do so have been lacking. The problem is that there is so much going on and the sun is so huge—to simulate it all requires more computing power than is available. At the root of all the simulations is turbulence, which is where a gas or fluid flows in a chaotic fashion. The new model shows that turbulence in the sun comes from within and flows outwardly, dissipating into ever smaller vortices, but it, like other simulations can only model this dissipation to a certain degree. At some point, the vortices are as small as just meters across and thus are too small to include in a model because there are just too many of them. The simulation built and run by Charbonneau and Smolarkiewicz goes as far as modern computers are able and shows the suns' action as a dynamo—where the amplification of a magnetic field is self-sustained due to fluid motion action.

Studying the sun and how it works is not purely academic, of course, learning how to accurately predict solar flares—when they might occur and how large they might be, would be very useful as the world becomes more and more dependent on sensitive electronic instruments that can be adversely impacted by events on the sun.

More information: Modeling the Solar Dynamo, *Science* 5 April 2013: Vol. 340 no. 6128 pp. 42-43 DOI: 10.1126/science.1235954

Abstract

The Sun's magnetic field is the engine and energy channel underlying virtually all manifestations of solar activity. Its evolution takes place on a wide range of spatial and temporal scales, including a prominent 11-year cycle of successive polarity reversals over the entire star. This magnetic cycle in turn modulates the physical properties of the plasma flowing away from the Sun into interplanetary space, the frequency of all geoeffective eruptive phenomena (such as flares and coronal mass ejections), and the solar radiative flux over the full range of the electromagnetic spectrum—from x-rays through ultraviolet, visible, and infrared light, all the way down to radio frequencies (1). The Sun's heartbeat is truly magnetic, and recent numerical simulations (2–5) are providing new insights into its mode of operation.