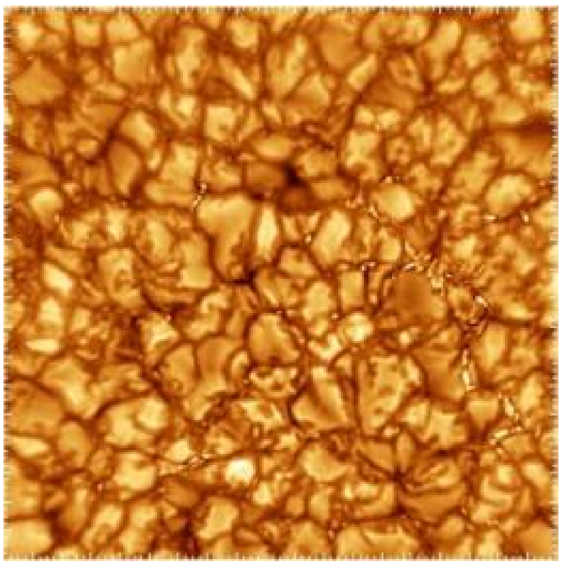
New insights into sun's photosphere reported

January 10 2011



The primary mirror of the new solar telescope at Big Bear Solar Observatory offers the highest power resolution ever available from a land-based telescope. To demonstrate this power, solar granulation covering a field of 12,000 by 12,000 miles or 19,000 by 19,000 kilometers is shown. Bright points appear side-by-side in dark lanes between granules. These bright points are believed to be associated with magnetic field concentrations on the Sun and are 50 miles in diameter. If you were to view an equivalent image on earth, you'd need an instrument that would allow you to see a row of dimes from a distance of more than 20 miles. Tick marks are separated by intervals of 620 miles or 1000 kilometers. Credit: BBSO/NJIT

NJIT Distinguished Professor Philip R. Goode and the research team at Big Bear Solar Observatory (BBSO) have reported new insights into the small-scale dynamics of the Sun's photosphere. The observations were made during a period of historic inactivity on the Sun and reported in The *Astrophysical Journal*. The high-resolution capabilities of BBSO's new 1.6-meter aperture solar telescope have made such work possible.

"The smallest scale photospheric magnetic field seems to come in isolated points in the dark intergranular lanes, rather than the predicted continuous sheets confined to the lanes," said Goode. "The unexpected longevity of the bright points implies a deeper anchoring than predicted."

Following classical Kolmogorov turbulence theory, the researchers demonstrated for the first time how photospheric plasma motion and magnetic fields are in equipartition over a wide dynamic range, while unleashing energy in ever-smaller scales.

This equipartition is one of the basic plasma properties used in magnetogydrodynamic models. "Our data clearly illustrates that the Sun can generate magnetic fields not only as previously known in the convective zone but also on the near-surface layer. We believe small-scale turbulent flows of less than 500 km to be the catalyst," said NJIT Research Professor Valentyna Abramenko at BBSO.

Tiny jet-like features originating in the dark lanes surrounding the ubiquitous granules that characterize the solar surface were also discovered. Such small-scale events hold the key to unlocking the mystery of heating the solar atmosphere, the researchers said. The origins of such events appear to be neither unequivocally tied to strong magnetic field concentrations, nor associated with the vertex formed by converging flows.

"The solar chromosphere shows itself ceaselessly changing character with small-scale energetic events occurring constantly on the solar surface, said NJIT Research Professor Vasyl Yurchyshyn, also at BBSO.

Such events suggest a similarity of magnetic structures and events from the hemisphere to its granular scales. The researchers hope to establish how such dynamics can explain the movement underlying convective flows and turbulent magnetic fields.

The telescope is the crown jewel of BBSO, the first facility-class solar observatory built in more than a generation in the U.S. The instrument is undergoing commissioning at BBSO. Since 1997, under Goode's direction, NJIT has owned and operated BBSO, located in a clear mountain lake.

The mountain lake is characterized by sustained atmospheric stability, which is essential for BBSO's primary interests of measuring and understanding solar complex phenomena utilizing dedicated telescopes and instruments.

The images were taken with the new instrument with atmospheric distortion corrected by its 97 actuator deformable mirror. By the summer of 2011, in collaboration with the National Solar Observatory, BBSO will have upgraded the current adaptive optics system to one utilizing a 349 actuator deformable mirror.

The new telescope began operation in the summer of 2009, with support from the National Science Foundation (NSF), Air Force Office of Scientific Research, NASA and NJIT. Additional NSF support was received a few months ago to fund further upgrades to this new optical system.

The telescope will be the pathfinder for an even larger ground-based telescope, the Advanced Technology Solar Telescope (ATST), to be built over the next decade. NJIT is an ATST co-principal investigator on this NSF project.

Scientists believe that magnetic structures like sunspots hold the key to space weather. Such weather, originating in the Sun, can affect Earth's climate and environment. A bad storm can disrupt power grids and communication, destroy satellites and even expose airline pilots, crew and passengers to radiation.

The new telescope now feeds a high-order adaptive optics system, which in turn feeds the next generation of technologies for measuring magnetic fields and dynamic events using visible and infrared light. A parallel computer system for real-time image enhancement highlights it. Goode and his research team, who study solar magnetic, are expert at combining BBSO ground-based data with satellite data to determine dynamic properties of the solar magnetic fields.

More information: http://iopscience.iop.org/2041-8205/714/1/L31

Provided by New Jersey Institute of Technology