Press Note from NCRA, Pune

Indian scientists discover long sought tiny explosions on the Sun

A group of scientists working at the National Centre for Radio Astrophysics (NCRA), Pune have recently discovered tiny flashes of radio light from all over the Sun. They have identified the smoking guns for these small magnetic explosions and hence the first ever evidence for their existence in explaining the long pending coronal heating problem.

This work was led by Surajit Mondal, a PhD student working under the supervision of Prof. Divya Oberoi, a faculty member at NCRA, along with Dr. Atul Mohan, his former student at NCRA, now at the Rosseland Centre for Solar Physics, Norway. In their journey to unravel this mystery, scientists have already figured out that the extra energy heating up the corona must be coming from the magnetic fields of the Sun; but exactly how this happens is still not known. The strength of the magnetic fields vary a lot from one place on the surface of the Sun to another, by more than a factor of 1000, but the corona is hot everywhere. So, this heating process has to work all over the corona, even in regions of weak magnetic fields. Until now the process of how this magnetic energy is deposited in the corona had remained a mystery.

"What made this breakthrough possible," said Prof. Divya Oberoi, "is the availability of data from a new technology instrument, the Murchison Widefield Array (MWA), and the work which we have been doing for the past few years at NCRA to build the techniques and tools to make the most sensitive solar radio images from this data. The very weak radio flashes we have discovered are about 100 times weaker than the weakest bursts reported till now."

Surajit Mondal, the lead author of this work said, "What makes this really exciting is that these flashes are present everywhere on the Sun and at all times, including in the regions of weak magnetic fields, the so-called 'quiet Sun' regions."

Dr. Atul Mohan added that, "Our preliminary estimates suggest that these tiny magnetic explosions should collectively have enough energy to heat the corona, which is exactly what is needed for solving the coronal heating problem."

"With this work, we have the strongest evidence till date that these tiny explosions, originally referred to as nanoflares by Prof. Parker, in his theory in 1988, can indeed be heating up the corona. It is just that they have turned out to be more than 1000 times weaker than his prediction and it took us a long time to find them. This is an excellent example of how progress in technology enables progress in science.", concluded Prof. Oberoi.

The Sun is the brightest object in the sky and has been studied for hundreds of years. But it continues to hide some secrets which scientists from across the world are working hard to unlock. We all know that the visible Sun is extremely hot, at temperature of about 5500 degrees. Surprisingly, on top of this sits a layer of gas which is at a temperature of almost 2 million degrees, over 300 times hotter than the surface of the Sun! We can get a glimpse of this layer of the gas during a total solar eclipse, called the corona, because it looks like a crown. ***What heats up the corona to 2 million degrees is one of the most challenging puzzles about the Sun and no one found a satisfactory answer to this till date.***

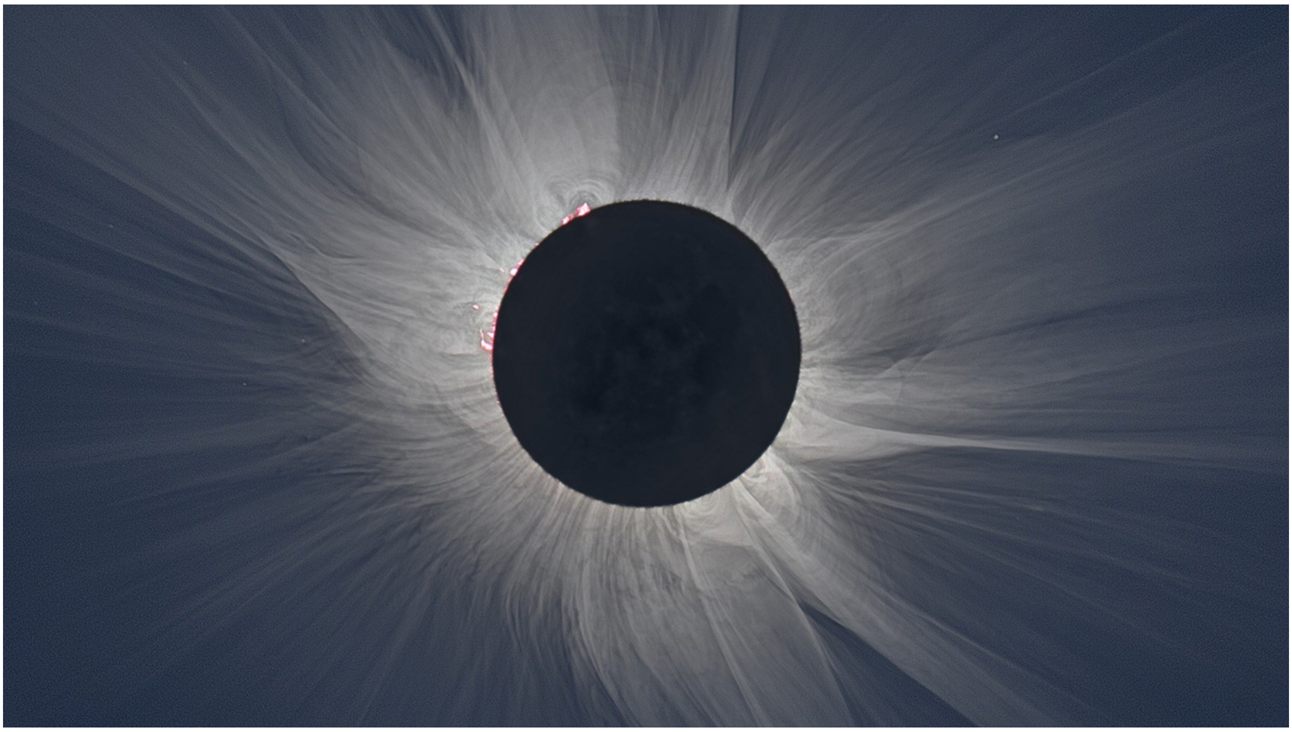
It is a well-known fact that as we get closer to a source of heat, it becomes hotter. On the Sun, the source of heat is deep inside the Sun. So, how is it that on top of the very hot surface of the Sun, there is a layer which is 300 times hotter? One efficient way of extracting this energy from the magnetic fields involves numerous tiny explosions taking place all over the Sun, all the time. Individually these explosions are too weak, but collectively they have sufficient energy to heat the entire corona due to sheer numbers. Many attempts have been made to look for X-rays and ultraviolet light emitted by these explosions and none have been successful. It was concluded that if they exist, these tiny explosions are too weak to be detected by even the best instruments available today. These explosions also expected to give rise to tiny flashes of radio lights, but till now there were no telescopes sensitive enough to detect them.

This research will appear in the June issue of the Astrophysical Journal Letters of the American Astronomical Society and is available at
https://iopscience.iop.org/article/10.3847/2041-8213/ab8817

The Murchison Widefield Array - The Murchison Widefield Array (MWA) is a low-frequency radio telescope and is located in Western Australia. The MWA is pioneering some of the technologies to be used for the largest radio telescope which has yet been envisaged, the Square Kilometre Array and laying the foundation for even more exciting science in times to come. A consortium of partner institutions from seven countries (Australia, USA, India, New Zealand, Canada, Japan, and China) financed the development, construction, commissioning, and operations of the facility. For more information see: www.mwatelescope.org.

Contact information:
Divya Oberoi (div@ncra.tifr.res.in) – Mobile: 9404059818
Surajit Mondal (surajit@ncra.tifr.res.in) – Mobile: 9403078025
Yashwant Gupta (ygupta@ncra.tifr.res.in) ; Phone: 020-25719242
Jayaram Chengalur (chengalu@ncra.tifr.res.in) ; Phone: 020-25719248
CH. Ishwara-Chandra (ishwar@ncra.tifr.res.in); Mobile: 9403136630
J. K. Solanki (solanki@ncra.tifr.res.in); Mobile: 9890447888
Anil Raut: (anil@gmrt.ncra.tifr.res.in); Mobile: 8605525945

Left to right: Surajit Mondal, Divya Oberoi and Atul Mohan
(http://www.ncra.tifr.res.in/~ishwar/pmrc/Sun_press_Team.jpg)



It is only during a total solar eclipse that the very hot gas surrounding the Sun, the corona, which is at a temperature of million degree corona becomes visible to us. This is a real image, taken during the total eclipse of 30 April, 2018. The visible disk of the Sun is completely hidden behind the moon and sunlight scattered off of the gas in the corona makes it visible. The idea behind including this image is to provide a visual for the corona, which is the object of study for this work. **Image Credit:** S. Habbal, M. Druckmüller and P. Aniol

This image shows one of the telescopes of the MWA which was used to gather the data used for this study. The MWA has 128 such telescopes distributed over about 5 km diameter. **Image credit** – Pete Wheeler/ICRAR.