Researchers describe the emergence of a coronal mass ejection from mini flux tubes

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Coronal mass ejections originating from the sun and propagating through interplanetary space are responsible for turbulent space weather. They can have severe effects on Earth, leading to disturbances in air traffic or even causing power outages. Astrid Veronig from the Institute of Physics and Kanzelhöhe Observatory for Solar and Environmental Research of the University of Graz studies solar eruptions. A detailed understanding of these high-energy processes will enhance scientists' ability to provide more precise forecasts regarding space weather.

"We can show for the first time that coronal mass ejections can originate in a large number of very small plasma structures in the form of individual magnetic flux tubes," Veronig explains, referring to the new findings, published in *Science Advances*. First author on the publication is Tingyu Gou of the University of Science and Technology China (USTC). She completed her research while on a one-year doctoral candidate exchange at the University of Graz, during which she worked with Astrid Veronig.

Coronal mass ejections number among the highest energy processes in our solar system. "During these events, huge clouds of magnetised solar plasma are hurled into interplanetary space, where they spread out at speeds of up to several million kilometres per hour," explains Veronig. It was already known that magnetic reconnection in the sun's corona is behind these types of ejections. How this happens in detail, however, and how the underlying small-scale physical processes lead to these enormous mass ejections are questions that have been answered for the first time by an international collaborative effort involving the University of Graz, the USTC and the University of Potsdam. To do this, the researchers have analysed recordings of a coronal mass ejection from 2013 collected by the Solar Dynamics Observatory (SDO) and the RHESSI satellite mission – both NASA-funded projects.

The data, which provides information about density, temperature and magnetic field of the solar plasma as well as about high-energy particle streams, provides a clearer picture: "Everything starts with a large number of small magnetic flux tubes with diameters of a few thousand kilometres, which then peel off one after another through magnetic reconnection, whereby – in a type of snowball effect – increasingly larger structures are created until the magnetic flux tubes achieve dimensions of many millions of kilometres," explains Veronig, describing the process. These insights can be used to construct new models, provide better descriptions of the physical processes that lead to the eruption of coronal mass ejections and, finally, enable better predictions of their ramifications for Earth.

More information: Tingyu Gou et al. The birth of a coronal mass ejection, *Science Advances* (2019). DOI: 10.1126/sciadv.aau7004

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