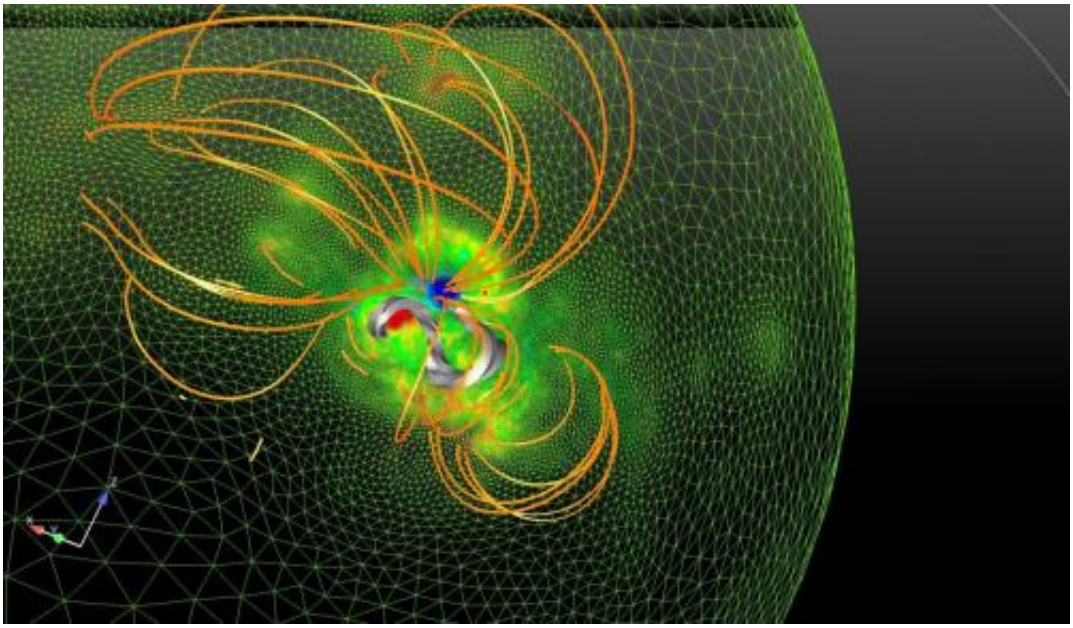
'Twisted rope' clue to dangerous solar storms

October 22 2014, by Pascale Mollard



Model of the magnetic field in the region where occurred a major flare on December 13th 2006. This model has been obtained using magnetic field data obtained at the surface of the Sun by the satellite HINODE and the high resolution model MESHMHD few hours before the eruption. It shows that a magnetic rope (grey) is maintained in equilibrium by overlaying arcades (orange). Credit: Tahar Amari /Centre de physique théorique.CNRS-Ecole Polytechnique.FRANCE.

A "twisted rope" of magnetically-charged energy precedes solar storms that have the potential to damage satellites and electricity grids, French scientists said on Wednesday.

A cord of magnetic flux emerges on the Sun's surface, grows and is squeezed upwards—and the following day, the star unleashes a blast of radiation, high-energy particles and magnetised plasma.

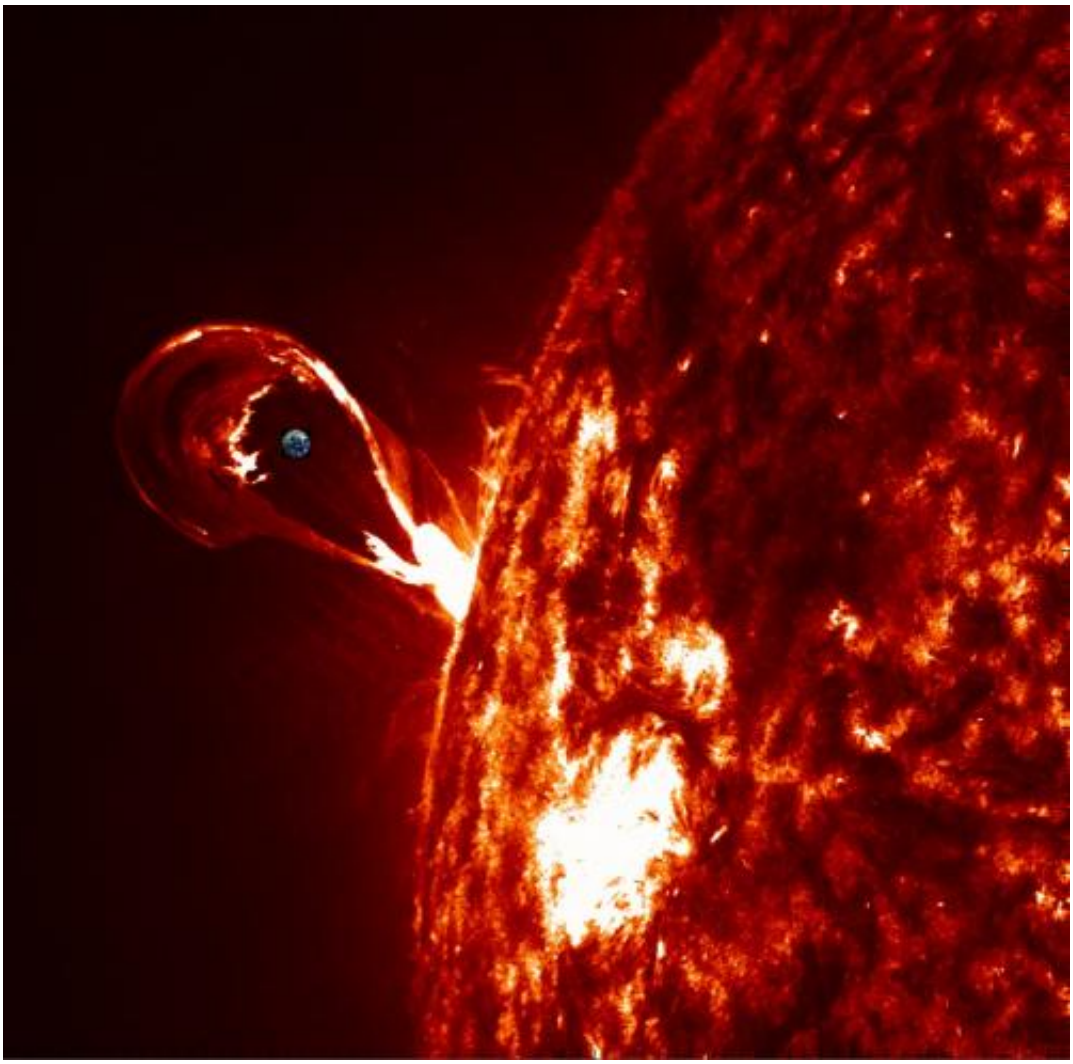
Solar outbursts are considered a rare but increasingly worrisome risk for satellites, global positioning systems (GPS) and power grids on which modern life depends.

Reporting in the journal *Nature*, a team led by Tahar Amari of France's National Centre for Scientific Research (CNRS) looked at a solar storm that brewed in December 2006 and happened to be observed by a Japanese scientific satellite.

"We were able to identify the source of the eruption four days before it developed," Amari said in an email exchange with AFP.

"The magnetic field builds up in the shape of a twisted rope. The ends of the rope are anchored in sunspots," he said, referring to notoriously magnetised features on the solar surface.

Experts say solar storms can cause widespread breakdowns, disabling everything from power and radio to GPS geo-location and water supplies which rely on electrical pumps.



View of typical solar eruption using data from the NASA Solar Dynamic Observatory space mission. The Earth has been shown to show the gigantic size of the phenomena Credit: Tahar Amari /Centre de physique théorique.CNRS-Ecole Polytechnique.FRANCE

They begin with an explosion on the Sun's surface, known as a solar flare , sending X-rays and extreme ultra-violet radiation towards Earth at light speed.

Hours later, energetic particles follow and these electrons and protons

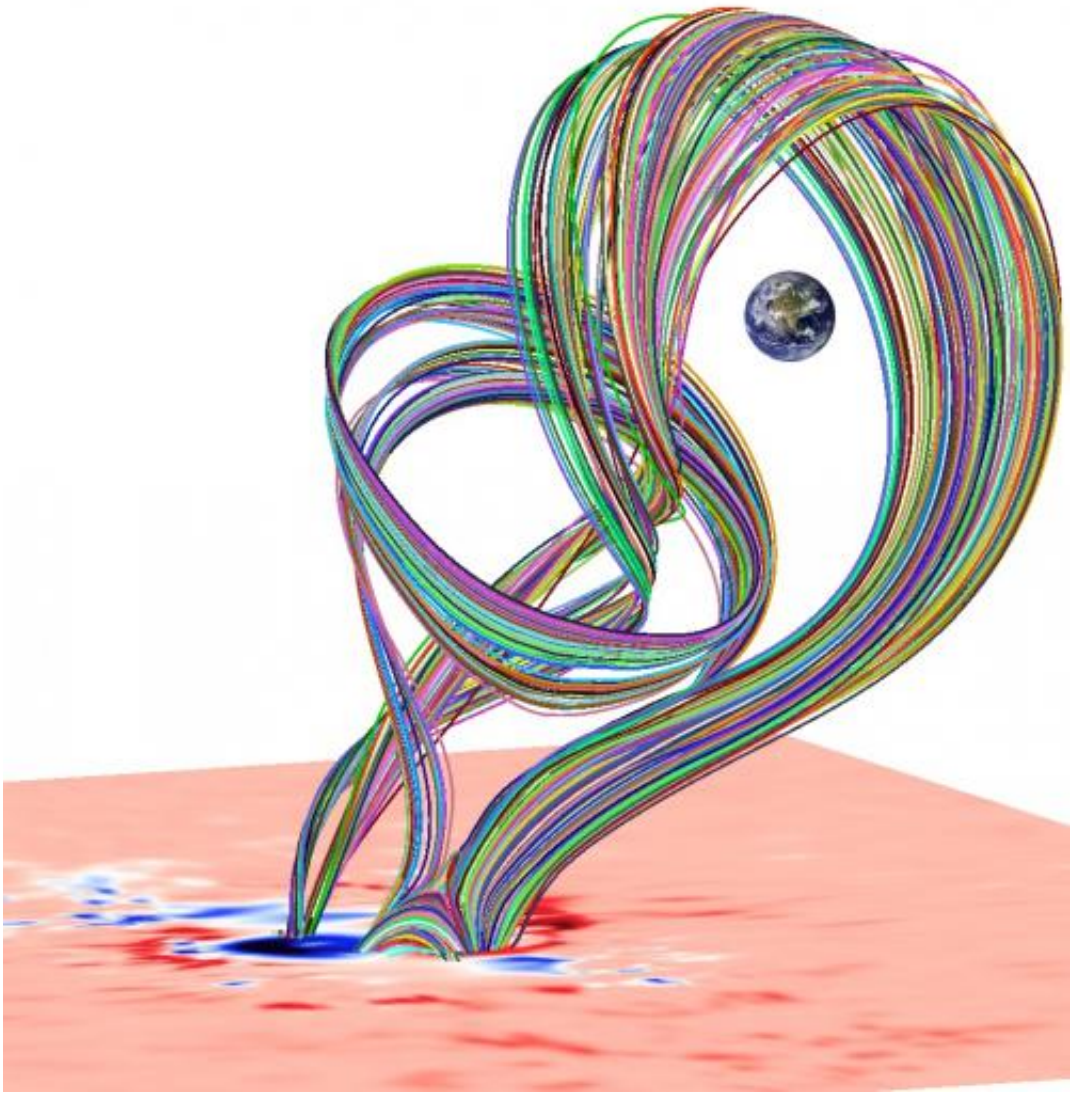
can electrify satellites and damage their electronics.

Next are coronal mass ejections (CME), billion-tonne clouds of magnetised plasma that take a day or more to cross the Sun-Earth gap.

A solar storm in 1859 caused an electrical surge on telegraph lines that prompted some offices to catch fire and operators to receive shocks. A 1989 event caused power outages for five million people in the Canadian province of Quebec.

A 2009 report by a panel of scientists assembled by NASA warned that a catastrophic solar storm could cost the United States alone up to two trillion dollars (1.6 trillion euros) in repairs in the first year—and it could take up to 10 years to fully recover.

Predicting when these events will take place, and if Earth lies in their path, has been thwart with problems.



Eruption of the magnetic rope in the dynamic model METEOSOL after its departure from equilibrium Credit: Tahar Amari /Centre de physique théorique.CNRS-Ecole Polytechnique.FRANCE

On July 23, 2012, Earth narrowly missed the biggest storm in 150 years, an event big enough to "knock modern civilisation back to the 18th century," yet few humans were even aware of the peril, NASA said last July.

At present, Earth gets a few hours' warning of a solar eruption thanks to the eyes of orbiting US satellites.

But, said Amari, warning time should eventually improve.

"The work will help us fine tune knowledge about impending solar eruptions," he said.

"Using real-time magnetic data and mathematical models, it will eventually be possible to predict space weather."

More information: Characterizing and predicting the magnetic environment leading to solar eruptions, *Nature*, dx.doi.org/10.1038/nature13815