Plasmoids and sheaths mean success or failure for solar eruptions

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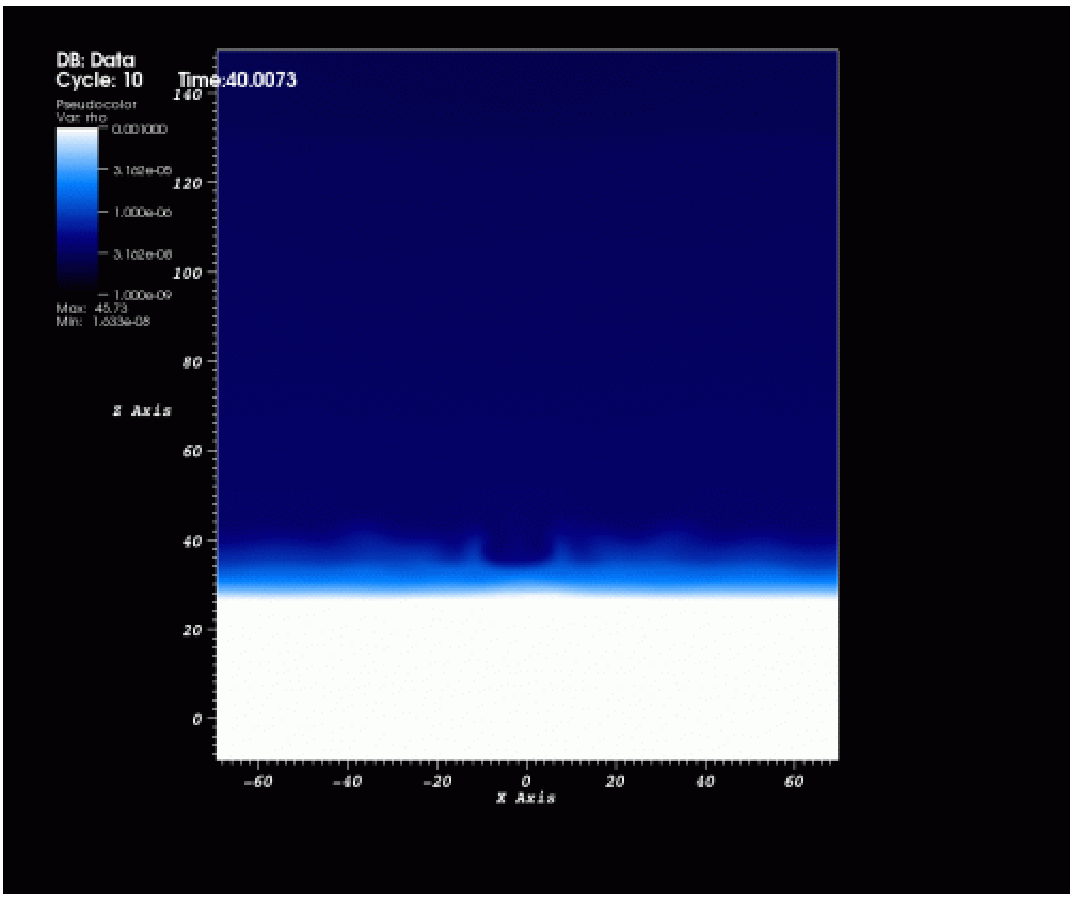


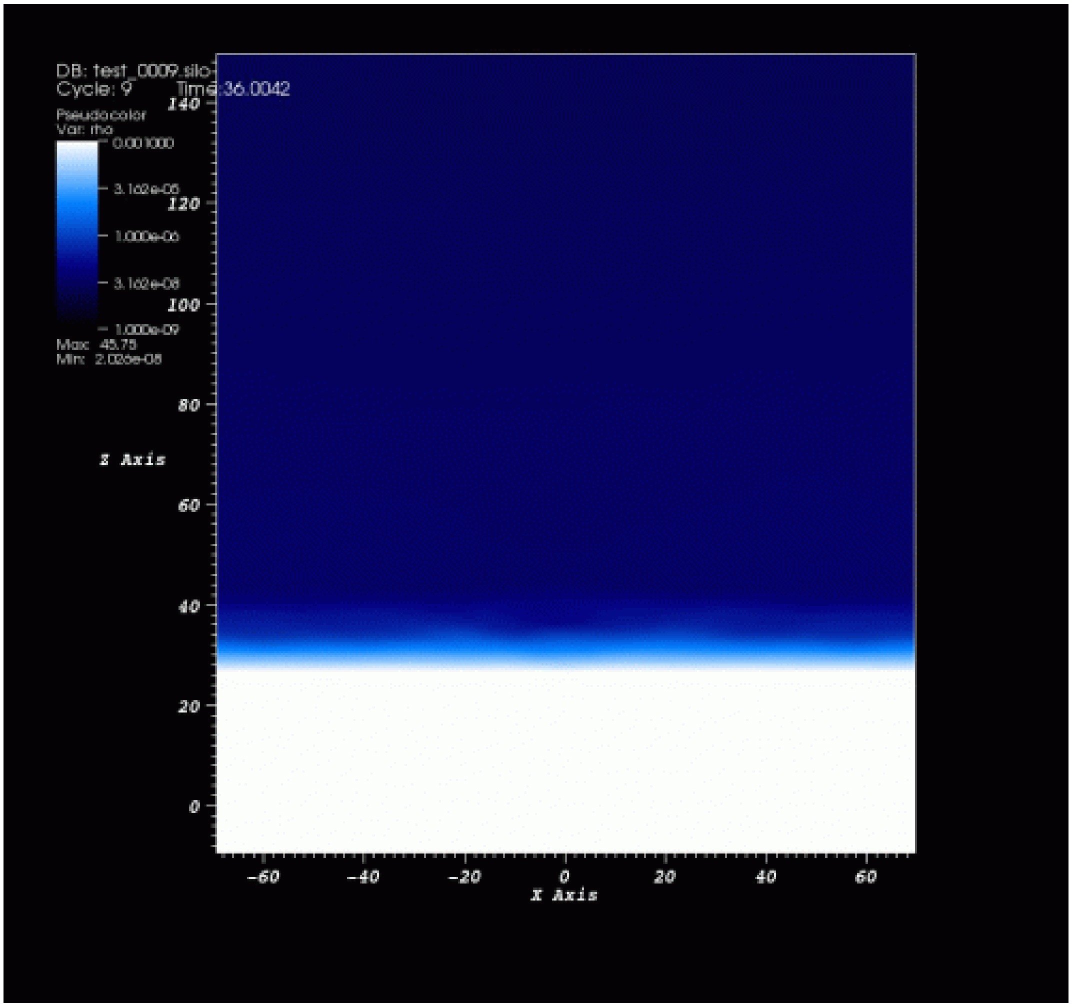
A simulation of the evolution of plasma density in an experiment where the eruption of the plasmoid is 'failed'. The dense material rises but it does not manage to break through the sheath magnetic field. Credit: Vasilis Archontis

Our Sun experiences regular eruptions of material into space, but solar physicists still have difficulty in explaining why these dramatic events take place. Now a group of scientists from the University of St Andrews think they have the answer: clouds of ionized gas (plasma) constrained by magnetic fields and known as 'plasmoids' that struggle to break free of the Sun's magnetic field. Dr Vasilis Archontis will present their work on Monday 18 April at the National Astronomy Meeting in Llandudno, Wales.

Active regions on the solar surface are often the site of eruptions. These are associated with magnetic fields from the solar interior rising to the surface and gradually expanding into the Sun's outer atmosphere, the corona, in a process known as magnetic flux emergence.

The St Andrews team developed 3D computer models of these phenomena, revealing that the emergence of magnetic flux naturally leads to the formation and expulsion of plasmoids that adopt a twisted tube configuration.

The formation of the plasmoids is due to the motion of plasma in the lower atmosphere of the Sun. These motions bring magnetic fieldlines closer together to reconnect and build a new magnetic flux system (i.e. the plasmoid). Whether the plasmoids are 'failed' or 'successful' (i.e. they erupt into space) depends on the level of interaction between the new emerging field and the old, pre-existing magnetic field in the solar corona.



A simulation of the evolution of plasma density in an experiment where the eruption of the plasmoid is 'successful'. The dense material rises slowly first, but eventually it accelerates to experience a rapid ejection out through the solar corona (at the top). Credit: Vasilis Archontis

When the new emerging field expands into the corona, it forms a 'magnetic sheath' with a fan-like shape. The sheath magnetic field consists of loop-like fieldlines, which are anchored to the solar surface and enclose the plasmoids.

A striking result from the simulations is that the plasmoids remain trapped in the solar atmosphere if the magnetic sheath is not removed by some other external mechanism. In this case, the sheath fieldlines manage to stop the plasmoids erupting.

But if the sheath magnetic field breaks and connects with the other magnetic fields in the surrounding solar corona, the researchers believe that this opens the way for the plasmoids to erupt at speeds of up to at least 500 km per second. During the faster part of this eruption the plasmoids are pushed up, transfer heavy plasma to the solar corona, expand without constraint and accelerate out into space.

Provided by Royal Astronomical Society

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