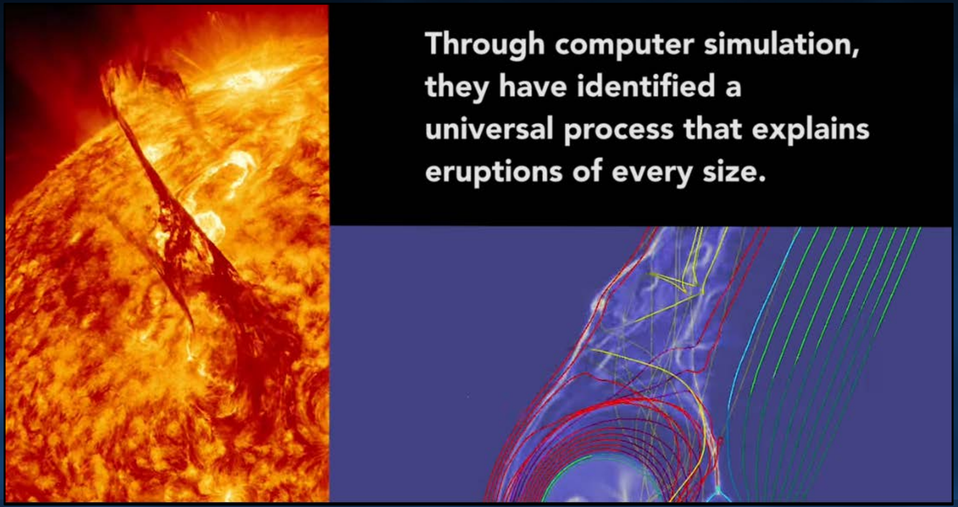
Scientists Propose Mechanism to Describe Solar Eruptions of All Sizes

Scientists from Durham University in the United Kingdom and NASA propose that a universal mechanism can explain the whole spectrum of solar eruptions, as described in a paper recently published in Nature. The research team used 3-D computer simulations (bottom right of the image below) to demonstrate that a variety of solar eruptions can theoretically be thought of as the same kind of event that manifests in different ways and sizes.

Filaments are large solar structures that erupt when they become unstable. They are known to be associated with coronal mass ejections (CMEs), which can initiate processes that result in space weather events near Earth. Recent data from observations of the solar atmosphere have shown that similar filament-like structures also appear before eruptions of coronal jets, which are smaller in scale than CMEs.



This image to the right is part of a video combining SDO data and "the breakout model." The model simulation (bottom right) matches what scientists saw occur in the SDO observation (left). Watch the full video, A Solar Eruption in 5 Steps, here.

Credit: NASA GSFC/Genna Duberstein

The study was motivated by high-resolution observations of solar filaments from the NASA Heliophysics SDO mission and the joint Japan Aerospace Exploration Agency/NASA Hinode satellite. The model they developed to show the similarities between different solar events is called *the breakout model* for the way stressed filaments on the sun relentlessly push — and ultimately break through — their magnetic restraints into space.

The key to understanding a solar eruption is in recognizing how and when the filament system loses equilibrium. In the breakout model, instability occurs as a result of magnetic reconnection, which then triggers an eruption. Exactly which kind of eruption occurs depends on the initial strength and configuration of the magnetic field lines containing the filament. In a CME, field lines form closed loops completely surrounding the filament, from which a bubble-shaped cloud ultimately bursts from the sun. In a coronal jet, material from the filament flows out along magnetic field lines that are already streaming freely from the sun's surface into interplanetary space.

Confirming this theoretical mechanism will require data from high-resolution observations of the solar atmosphere. Two NASA Heliophysics missions planned for launch in 2018 and 2019 – the Parker Solar Probe and the joint NASA/ESA collaboration, Solar Orbiter – will take images and in situ measurements from the closest approaches that satellites will ever have made to the sun. This will help scientists further our understanding of the mechanisms that heat the solar corona and accelerate the solar wind.