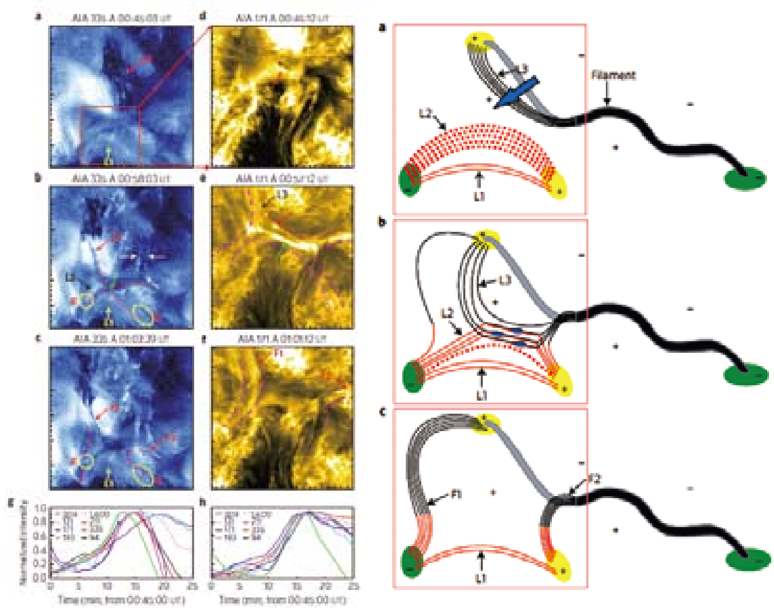
First Observational Analysis of the Magnetic Reconnection Process

Dr. LI Leping at the National Astronomical Observatories of China (NAOC), Chinese Academy of Sciences has been studying the process of magnetic reconnection for some years. Now, joining hands with researchers from the Max-Planck Institute for Solar System Research and the University of St. Andrews, he has made the first observational analysis of the fine structures and evolution of the magnetic reconnection process between a solar filament and its nearby coronal loops.

Magnetic reconnection, which is the reconfiguration of the magnetic field topology, shows a process of convergence, disconnection and reconnection of two sets of magnetic field lines with opposite polarities. It plays an essential role in rapid release of magnetic energy, which is converted to other energies (e.g. thermal and kinetic) in magnetized plasma systems (such as solar and stellar coronae, planetary magnetospheres, magnetars, accretion disks and laboratory plasmas) all over the universe. In astrophysics, it is usually employed to explain lots of astrophysical phenomena, such as solar flares, filament eruptions and γ-ray bursts. However, it is difficult to observe the magnetic reconnection process directly.

By analyzing the observations of the Solar Dynamics Observatory (SDO) and the Solar TErrestrial RElations Observatory (STEREO), LI and his colleagues found that X-type structures were formed when the erupting filament encountered the coronal loops. At the interface, more than ten bright current sheets were formed, with mean length of ~26,000 km, mean width of ~900 km, and maximum temperature of more than 7 MK. Many plasmoids appeared in these current sheets and propagated bi-directionally. The current sheets gradually dispersed and disappeared, lasting for more than ten minutes. The filament was disconnected from the current sheets, and then reconnected to the coronal loops. At last, new filaments were formed.



(Left) SDO/AIA 335 Å and 171 Å images before (**a** and **d**), during (**b** and **e**) and after (**c** and **f**) the magnetic reconnection between the filament and the coronal loops. **(Right)** Schematic diagrams before (**a**), during (**b**) and after (**c**) the magnetic reconnection between the filament and the coronal loops.

The researchers believed that such an evolution indicates the successive magnetic reconnection process, which has been predicted by theory but poorly identified in observations with such clarity. The results confirmed the three-dimensional magnetic reconnection theory with further implications for the release of magnetic energy and the evolution of dissipation regions for magnetic reconnection in all magnetized plasma systems.

Their work has been published online by *Nature Physics* on May 9, 2016 (DOI: 10.1038/NPHYS3768).