



Our life here on Earth is entirely dependent on the Sun. But although we have been observing the Sun's passage across the sky for millennia, there are many things about it we still don't understand. Amongst the hundreds of billions of stars that make up the Milky Way Galaxy, the Sun is also the only one that is close enough for us to study in detail.

Scientists at the Atomic Astrophysics Group here at DAMTP, led by Dr Helen Mason, are particularly interested in the Sun's magnetic activity, which strongly influences space and the Earth's environment, and is responsible for the production of huge energetic events, such as solar flares.

The Sun's magnetic field

Over the past decades, the advent of high-resolution space observatories has provided us with new insights into the Sun's activity. Scientists continuously observe energetic events in the solar atmosphere, ranging from small transient brightenings to large-scale, spectacular explosions. They believe that the Sun's magnetic field plays a major role in producing these phenomena.

The Sun exhibits a cycle of magnetic activity repeating every 11 years, in which magnetic fields are continuously generated from the motion of hot gas in the convective zone, the outermost layer of the solar interior. Arising from the Sun's surface, these strong magnetic fields create active regions with sunspots, magnetic loops of hot ionised gas (plasma) as well as energetic solar flares and ejections of hot gas and energetic particles from the corona.

What are solar flares?

Solar flares are rapid explosions in the solar atmosphere associated with a large release of

energy (up to 10^{26} joules) in the form of radiation over a broad range of wavelengths, particle acceleration and wave motions. Scientists believe that solar flares are triggered by the release of energy stored in the solar magnetic field. However, the details of this energy conversion are still not fully understood.

Solar flares can produce energetic particles and huge eruptions of coronal gas. These can affect human activity in space, create disturbances in space satellites and seriously influence the Earth's environment. It is therefore extremely important to understand how flares and energetic events are produced in the solar atmosphere.

How do we observe and study solar flares?

Since the flare plasma is very hot (up to tens of million degrees), it gives rise to strong emission in the ultraviolet (UV) and X-ray parts of the electromagnetic spectrum, which we can observe with space telescopes. Scientists use spectacular images in UV filters to study the context of the analysed events. An important source of information is the Atmospheric Imaging Assembly

(AIA) on board the Solar Dynamics Observatory. Part of NASA's *Living with a Star* programme, this space-based observatory orbits the Earth to observe the Sun. The AIA provides high-resolution images of the Sun in several extreme ultraviolet (EUV) and ultraviolet filters, showing gas at different temperatures. In addition, spectroscopic instruments can observe many individual spectral lines simultaneously providing important information about the physical condition of the plasma.

The observations provide information about the emitting plasma; for example the number density of ions and electrons, their temperature, and also the dynamics and the chemical composition of the plasma. Scientists use this information to refine and improve their theoretical models of solar flares. This will not only help us understand our own parent star, but also provide clues about all those other stars within our galaxy; many, many light years away.

Images: Top left: Representation of a solar coronal mass ejection affecting the Earth's atmosphere. Image courtesy NASA/ESA
Top right: Image of a solar flare observed by the AIA instrument on board the Solar Dynamics Observatory. Image courtesy NASA
Bottom right: Atmospheric Imaging Assembly (AIA) images of the Sun in different ultraviolet filters. The white lines represent an extrapolation of the magnetic field in the solar surface. Image courtesy NASA

This poster was produced by Vanessa Polito, Helen Mason and Giulio Del Zanna, in collaboration with Plus, the free online mathematics magazine (plus.maths.org). To find out more about the Sun visit www.suntrek.org

