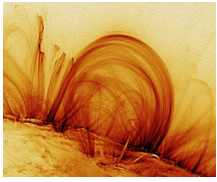


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Solar Mayhem

What causes the solar flares?

Satellites and communication networks on Earth are occasionally disturbed by events happening on the Sun. These are the solar flares, giant bursts of energy equivalent to 10 million volcanoes exploding within a few minutes, having electromagnetic effects even at such huge distances as Earth. But what causes them? Researchers don't know for sure but at the end of last year a daring new theory was proposed by James Drake and his colleagues from the University of Maryland. The Sun is mainly plasma of protons and electrons flowing around at random and that are kept together inside the Sun by gravitation. The Sun emits light due to a nuclear fusion process: protons and electrons sometimes hit against each other and form helium nuclei. In this process, neutrons are produced and remain included in the helium nuclei as well as photons (light) and neutrinos. Most of the latter two get out of the Sun into outer space (and, eventually, some of them reach Earth). The nuclear process taking place is this: $4 \text{ protons} + 2 \text{ electrons} \rightarrow 1 \text{ helium nucleus} + 2 \text{ neutrinos} + 6 \text{ photons}$. The important thing for the current discussion is that all the particles inside the Sun, like protons (hydrogen nuclei), helium nuclei and electrons, are electrically charged particles. Thus, they generate all sorts of electric and magnetic fields. The motion of the particles creates the magnetic fields and, in turn, these fields influence the motion of the particles. Solar flares, the giant bursts of energy that occasionally appear at the surface of the Sun, are caused by massive and sudden changes in the solar magnetic fields, but researchers wonder how exactly can the fields rearrange quickly enough to trigger such a flare. According to Drake's new theory a flare occurs when magnetic field lines are squeezed past a critical point. One can imagine a line of the magnetic field as being shaped like a 0 and that this line gradually twists and changes into the shape of an 8. Then, the 8 shaped field separates into two 0 shaped fields. Such a process can take months, but occasionally, in a way researchers don't fully understand, it accelerates dramatically and creates a flare. You may see a computer simulation of the effect [here](#) (it is an animated gif). The "spark" that ignites a flare occurs when field lines at the reconnection point are squeezed together beyond a critical density, says Drake. Reconnection is normally slow because each field line drags around the weight of particles stuck to it like beads on a string. Electrons, having a lighter mass, zip around in tight orbits, while the much heavier positive particles (protons and helium nuclei) circulate at a longer distance. However if the positive particles' orbits get disturbed, the lines suddenly shed their load of ions and can burst into reconnection tens of thousands of times faster, in a mode called Hall reconnection. The confined magnetic energy explodes with a blast of particles. Drake and his colleagues confirmed their theoretical predictions with supercomputer simulations. Researchers haven't been able to detect Hall reconnection in the sun because the key effects occur in such small regions, but satellites have spotted it in the earth's magnetosphere. "The authors have made a bold prediction, based on solid calculations," says Spiro Antiochos of the Naval Research Laboratory in Washington, D.C. Eric Priest of the University of St. Andrews in Scotland says the paper "is likely to have wide implications for the onset of reconnection in solar flares, geomagnetic substorms, and other examples of dynamic plasma behavior in the universe."