# Robert H. Goddard Team Award for Exceptional Achievement in Science awarded to the Heliophysics Reconnection Theory Team

The team of James Leake and Lars Daldorff has received Robert H. Goddard Award for Exceptional Achievement in Science the for their recent scientific breakthrough that was published this year in the Astrophysical Journal (Vol. 891, p. 62).

It is a major achievement that provides the foundation for understanding many phenomena on the Sun, within the heliosphere, and throughout the universe. Some of these phenomena – such as solar flares, coronal mass ejections (CMEs), and nanoflares – directly affect space weather, which episodically wreaks havoc on our technology infrastructure in space and on Earth. The energy that powers these explosive phenomena comes from stressed magnetic fields. The stresses are slowly built up and then suddenly released by a fundamental process called magnetic reconnection. A major unsolved question has been why reconnection remains "switched off" to allow the stresses to become large before "switching on." If reconnection were to happen too soon, the explosions would be much weaker than observed. It has been known for some time that reconnection begins with something called the tearing instability of electric current sheets. Drs. Leake and Daldorff showed how the effectiveness of the instability – whether it quickly dies out or develops into reconnection – depends on the detailed properties of the sheet.

Not only did they identify what the critical properties are, they also gave a creative and insightful physical explanation that lays the foundation for rapid progress in this crucial area of research. It will positively impact the efforts of many teams around the world and will solidify GSFC's position as a major center of reconnection research that marries fundamental theory with cutting-edge missions (such as the Solar Dynamics Observatory (SDO), Magnetospheric Multiscale Mission (MMM), and Ramaty High Energy Solar Spectroscopic Imager (RHESSI)). These landmark results are the culmination of four years of dedicated effort based on state-of-the-art magnetohydrodynamic simulations. The problem is extremely difficult, and the technical challenges are great. Drs. Leake and Daldorff meticulously evaluated four different numerical codes before identifying the one that would produce the most trustworthy results. Even then, it took creativity and perseverance to overcome the many obstacles that they encountered.

Two aspects of their work are particularly noteworthy. First, physical parameters on the Sun, such as electrical conductivity, are extreme compared to what can be included in a numerical simulation. James and Lars had to find the right combination of modified parameters that is both numerically feasible and accurately captures the interplay among essential physical processes. Second, the tearing instability involves many different interacting modes, and the team's conceptual breakthrough was that the onset of fast reconnection depends crucially upon the relative grow rates of the modes, which in turn depend on the properties of the current sheet (its width, length, and shear angle).