

Talking Points for K. Schrijver

What the Hi-C observations are showing is likely to be happening all over the Sun. The processes of magnetic braiding and relaxation are fundamental to how the entire outer atmosphere evolves.

Let's look at Movie #1. This shows the global perspective for the month prior to the Hi-C flight, in the same light as used for the Hi-C instrument. We see the Sun as a dark sphere underneath its own atmosphere: the solar surface does not shine in the extreme ultraviolet, so it is dark. Above it, the hot atmosphere, the corona, glows in the extreme ultraviolet. We see the atmosphere rotate, spinning with the surface, once every 27 days. As it spins, all of the Sun's atmosphere is changing all the time. In most places, the changes appear gradual, but they likely are happening because on small scales, only visible with an instrument like Hi-C, the field changes in little jumps that all together allow the whole corona to change. But sometimes this small-scale process stalls, extra stress builds up, and then the relaxation happens on a much larger scale, causing a flare or a coronal mass ejection. Those larger explosions and eruptions drive space weather around Earth.

The Solar Dynamics Observatory enables us to see the Sun's atmosphere in all of its colors. In movie #2 we see much more richness: relatively cool blues and hot reds. We have even more colors for yet higher temperatures, but we cannot combine all in one movie. This movie shows the eruptions and explosions much better than the first. In the extreme ultraviolet or in X-rays, such flares can outshine the rest of the solar atmosphere by factors of more than ten thousand for a bright flare.

The flaring on the small scales and on the large scales all happen together. To understand why the solar corona behaves as it does, we need to see both the small and the large to understand how they connect, and ultimately drive space weather.

Space weather is important because solar storms affect things electronic and electrical, both in space and on the ground. Our society is increasingly dependent on space technology for navigation and communication. And we cannot even imagine living without electricity. Yet, the largest solar storms could cause enormous problems and may damage large parts of the power grid or disable the GPS system. NASA's Living With a Star program, of which the Solar Dynamics Observatory is part, aims to understand space weather and its impacts, from the short interruptions that may cost many millions of dollars, to the possible serious ones that could be much larger.

Another reason for astronomers to look at the Sun at high resolution is that the processes we see on the Sun occur on all stars in the universe in some form or other. But those other stars are all too far away to be more than a single point of light. So, to understand the stars, we need to look at our own Sun for clues as to what is going on elsewhere in the galaxy.

The NASA rocket program has a track record as being a great testbed for new

technologies. But discoveries like these made with Hi-C show that it is also important as a pathfinder for new space missions: now that we have seen a glimpse of what is hiding in the small things, we know we have to investigate. NASA is planning one part of that with its upcoming IRIS mission that will look below what Hi-C has shown us. With the next-generation solar mission we could also see the higher layers of the atmosphere. In a way, we could think of this a how we study weather: we can think of a mission like IRIS as seeing how water evaporates from the Earth's oceans and how water rains back into the oceans. It takes other instruments to see what role the clouds play in the weather cycle. That is what instruments like Hi-C can do for our understanding of the Sun's atmosphere, of other stars, and of the origins of space weather.

The NASA rocket program also is a training ground for the next generation of scientists and engineers. Dr. Amy Winebarger is one of those having experienced how much one can learn hands on from getting ready for and executing a rocket flight. Amy will tell you more about that next.