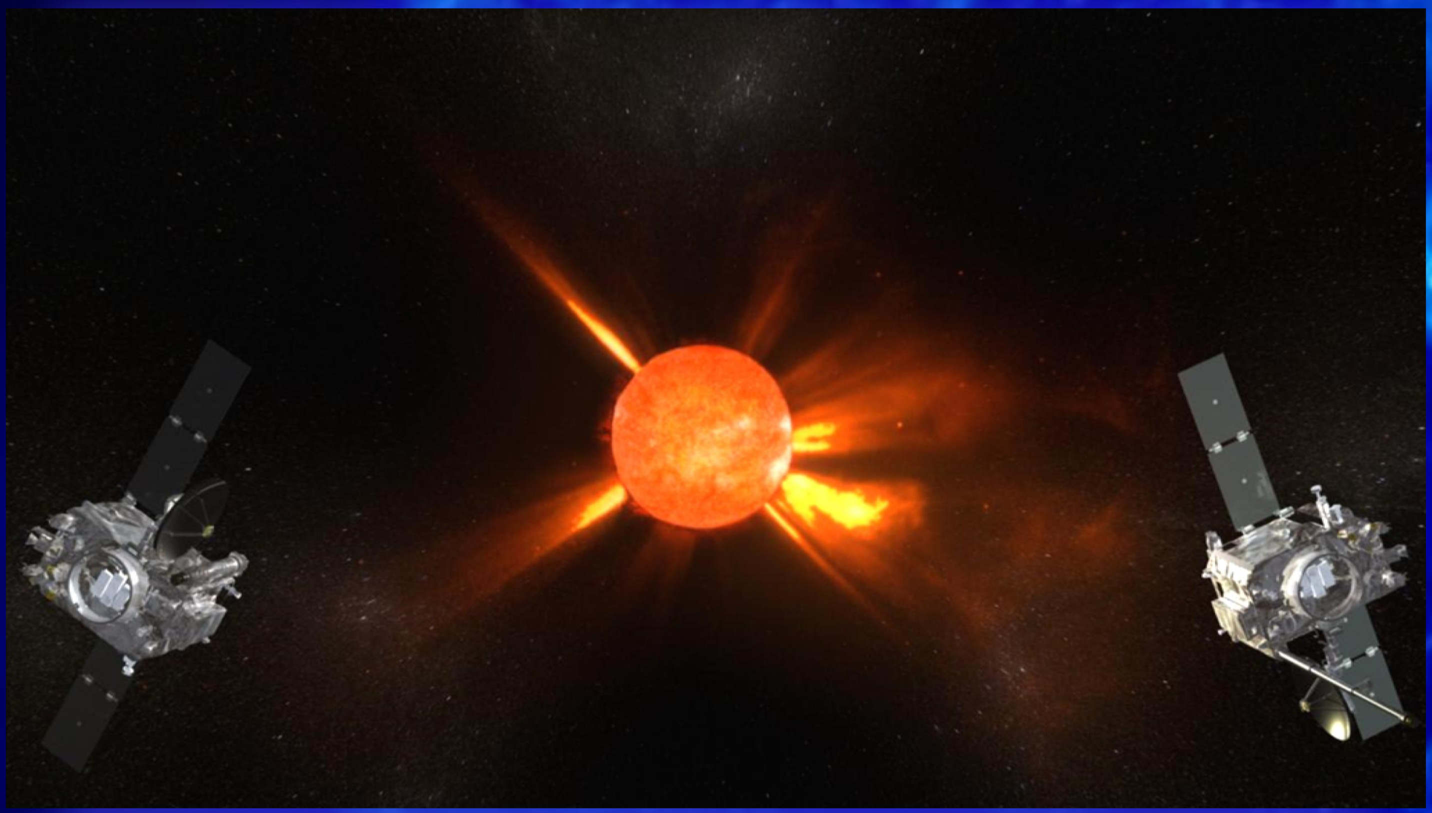
The Morphology of Cavities

Dominik Rastawicki

Mentor: Sarah Gibson

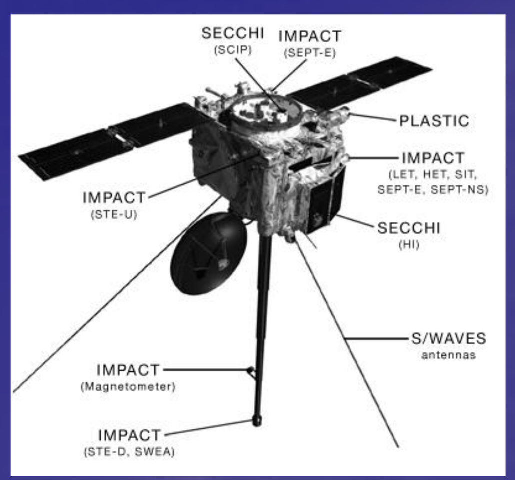


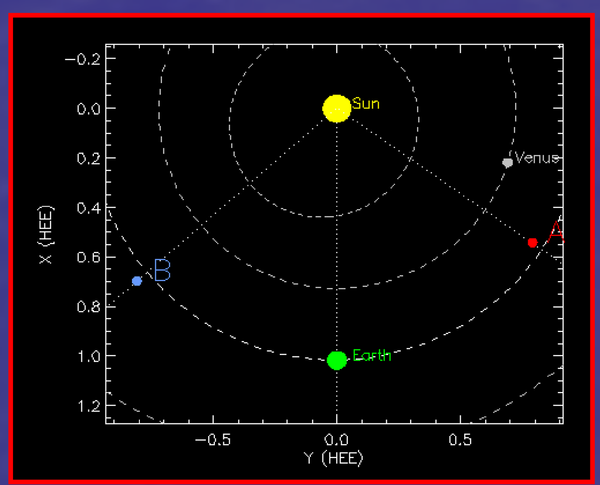
ABSTRACT

The motivation for the study of cavities in the Solar corona is the need to understand magnetic fields in the corona and to find a way to predict Coronal Mass Ejections. Thanks to the Stereo mission we now have a capability to look at the Solar corona from different angles, which gives us a chance to reconstruct three-dimensional structures on the Sun. The objective of the research is to use images from stereo to model a solar prominence cavity, and based on that model make . inferences about its visibility . and evolution in time… .

STEREO

The Solar TErrestrial RElations Observatory (STEREO) is a NASA mission launched in 2006 and still active. STEREO consists of two satellites STEREO A and STEREO B, which both stay in orbits similar to Earth's orbit, but they are increasingly farther apart, and they are at different latitudes with respect to Solar equator. The main goal of the mission is to investigate CMEs. and their influence on the planet. The instruments on both spacecrafts are SECCHI, IMPACT, PLASTIC, and S/WAVES.





DATA

The analysis used mostly 195 Å the images from Extreme UltraViolet Instrument (EUVI), which is a part of SECCHI. In the August 2007 Cavity survey it uses one image from each STEREO per three hours, and in the long term one image per day. The model images come from CavModel.

CAVMODEL

CavModel is a code that models density of the solar corona. To make a model of a cavity it creates a radially symmetric background, and puts a Gaussian shaped streamer with a depleted region of an elliptical cross-section embedded in it. The model has a capability of crating cavities of different heights, widths and lengths, as well as an arbitrary depletion profile. Additionally CavModel can create an image from any position by integrating the density along the lines of sight from that position.

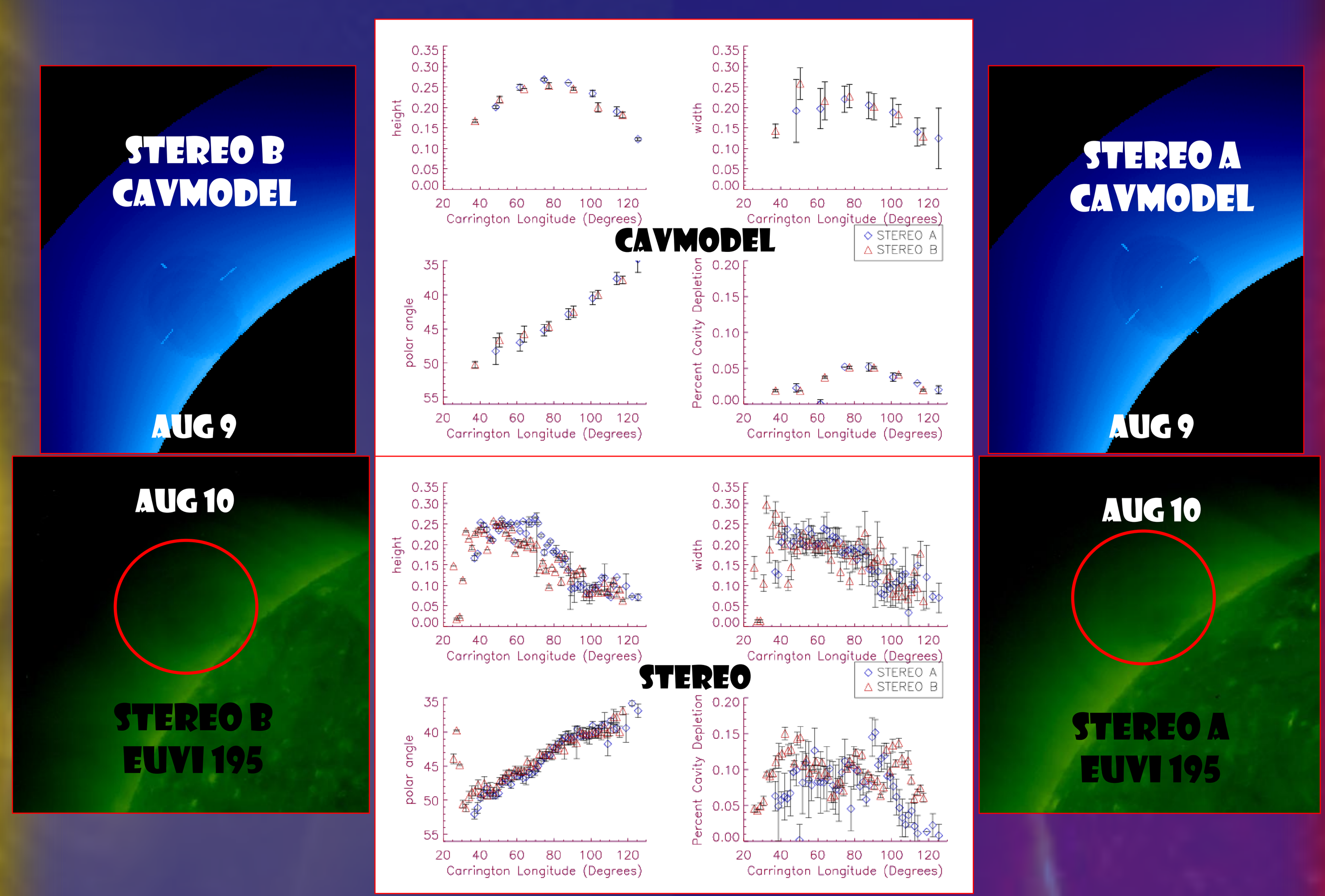
CAVITIES

The cavities are depleted regions in Solar corona of elliptical cross-section. They form above Solar prominences, and are directly connected to the magnetic field of the prominence, which makes them very important in study of magnetic fields inside the corona. Cavities can be seen in many wavelengths. In white light you can see them as a product of Thompson scattering of photons from photosphere, and in EUVI you can see them by thermal emissions from the corona itself.

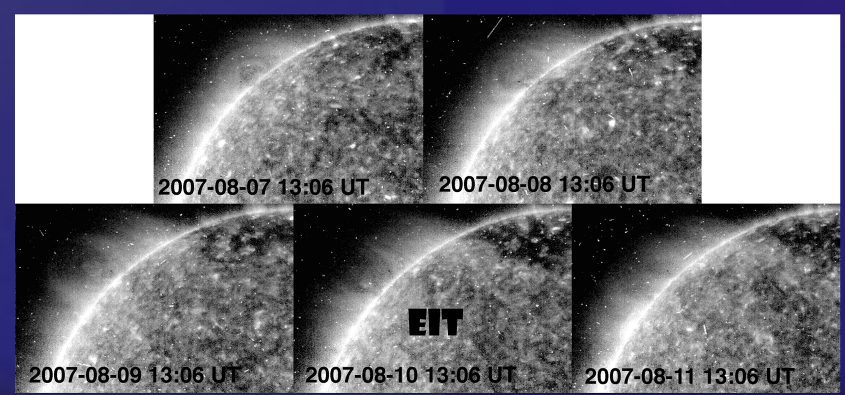
CAVITYFINDER

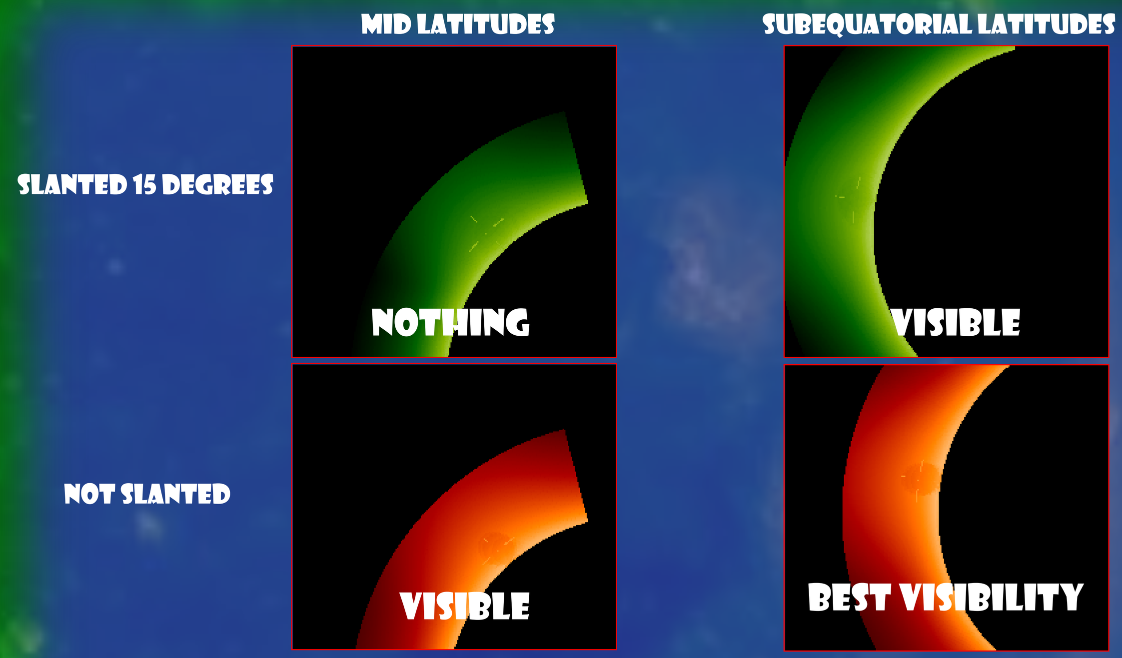
CavityFinder is an IDL code designed to identify and measure cavities. It basically prepares the raw data from STEREO, reads the position of the spacecraft, looks for cavities, and measures many of its properties, such as height, width depletion as a function of height, position on the limb, sharpness of edges, and the total area. Also it converts some of the raw data into a more useful form, and makes useful plots.

THE AUGUST 2007 CAVITY



The August 2007 Cavity has been chosen as a model cavity since it has already been thoroughly measured and investigated from the Earth, and because it is clear and does not show any unusual features. Based on the images from STEREO it is possible to use Cavmodel.pro to recreate an actual 3-D model of this cavity. The only problem is that in 2007 the spacecrafts were relatively close together and the differences caused by different viewing angle are not strikingly apparent.



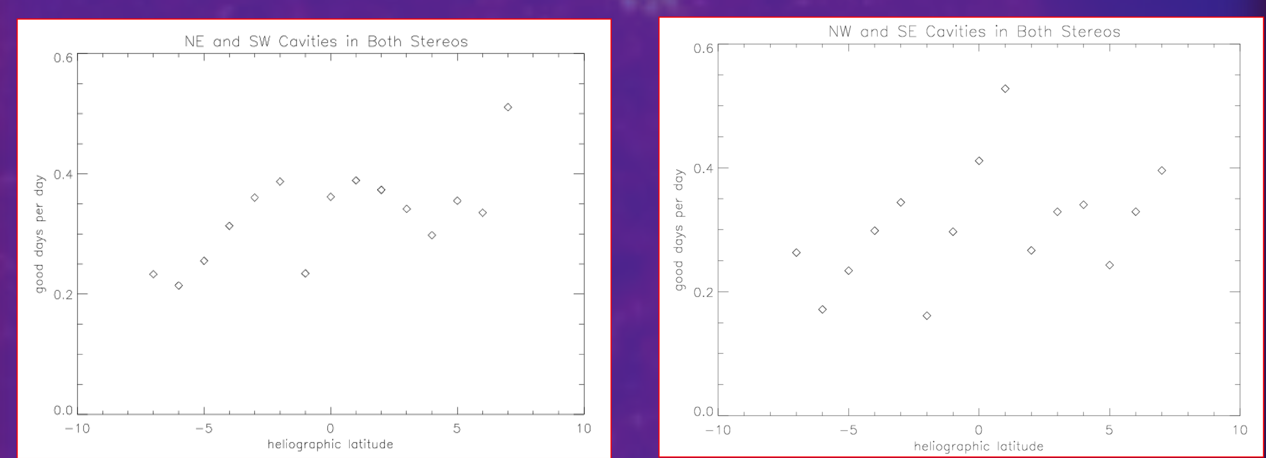


VISIBILITY

The model cavity based on the August 2007 data has been put at various latitudes, and at various slopes with respect to the equator, and looked at from different angles. The most obvious and most significant factor in visibility seems to be the angle between the line along the center of cavity and the line of sight of the observer. There also seems to be significant dependence on the curvature of the Sun along the central line. The apparent height and width as well as the position of the center of the cavity on the images at certain angles seems to be very different from the actual parameters of the cavity.

LONG TERM SURVEY

The best way to check these prediction by the model is to look at all cavities seen in STEREO, and to look for trends that could indicate that the effects seen in the model apply to actual cavities. The long term survey looked separately at each quadrant of the Sun from both STEREO A and STEREO B recording the position of each Spacecraft and date whenever they saw a cavity. Because of the differential rotation of the Sun you can expect the parts of neutral lines that are closer to the equator to move faster, thus making the cavity be slanted towards the equator. If that is the case NE and SW cavities tend to be directed to the south and NW and SE cavities tend to be directed to the north. Therefore being at southern heliolatitudes should favor seeing NE and SW cavities being at northern heliolatitudes should favor seeing NW and SE cavities. However, the survey seems to indicate that there is no dependence at all on the angle. This is most probably either because the neutral lines are not strongly influenced by the differential rotation, for example Aug 2007 Cavity opposes this trend, or because the range of the viewing angle of STEREO is not large enough to make the effect significant. Indeed the model shows a noticeable difference only at the very extremes of STEREO's latitude's range.



THE NEXT STEP

As the next step it is probably worthwhile to look at and model some cavities from later stages of STEREO mission when their time evolution is more apparent, and when the viewing angle effects play a larger role. It might be worthwhile to extend the long time survey to look at cavities in another stages of the solar cycle or only at times when STEREO spacecrafts are far apart. The CavityFinder needs to improve its filters and running time.