

# **Team Project 2: “Fun in the Sun”**

## *Solar Prominence Imaging*

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### **Image Intent:**

The purpose of this image is to visualize a plasma flow created by on the surface of the sun. In these photos one can see two different prominences of the surface of the sun that create very beautiful and powerful images. The sun is one of the largest visible fluid flows from the earth because it is essentially a huge ball of plasma. The sun goes through different, periodic, levels of surface activity and the purpose of the images is to capture the current state of the sun's activity.

### **Flow Phenomenon:**

The sun is composed mainly of Hydrogen and some Helium as well as very small percentages of Oxygen, Carbon, Nitrogen, Silicon, Magnesium, Neon, Iron and Sulfur. These elements exist in a plasma state with a surface temperature of about 6,000 degrees Kelvin. The portion of the sun that is visible is the photosphere. This portion of the sun is the outermost layers of the sun. The core and the corona of the sun on the other hand, are not visible because they are opaque and do not allow light to pass through them. The photosphere of the sun is where the majority of solar activity occurs, such as the prominences visible in the photos. The sun yields energy to the solar system by fusion, which is where a proton and a neutron bond, forming a deuteron. <sup>i</sup>

The majority of the sun's activity is the result of magnetic fields, which reduce the convection rate between the corona and the photosphere. The reduced convection then leads to an increase in thermal energy in the area that results in active spots on the sun, which lead to sunspots, solar flares, coronal mass ejections and prominences. The sun's activity tends to exist

in 11-year cycles. During solar minimums there are very small amounts of activity, while large amounts of activity exist in the maximums. According to the 11-year cycle, the Sun should currently be experiencing a solar maximum, but this does not appear to be the case.

A solar prominence is a bright projection extending from the surface of the sun. Prominences vary widely in their shape and size and exist in 2 different varieties, active and quiescent. Active prominences are generally very bright and last for only a few minutes, up to a few hours.

Quiescent prominences appear much more smoothly and can last several months. The prominences pictured are Quiescent, which is known because they were there over a period of many days. <sup>ii</sup>

The size of the prominence on the top left is determined to be approximately  $2.5 \times 10^7$  m wide and  $1.59 \times 10^7$  m high. This is equivalent to  $1.5 \times 10^4$  mi by  $9.8 \times 10^3$  mi., which gives the prominence an area of approximately  $3.97 \times 10^{14}$  m<sup>2</sup>. This was determined by calculating the ratio of the number of pixels in the solar flare to the number of pixels across the radius of the sun and then multiplying this ratio by the known radius of the sun (in meters). See Equation 1.

### **Visualization & Photographic Technique:**

The sun is one Astronomical Unit away from Earth and yet, it is one of the most powerful sources of light and heat (caused by nuclear fusion) that reaches Earth. However, from our planet this fusion reaction remains unnoticed except for heat and light emissions. So what is the best way to visualize this magnificent plasma phenomenon from a distance of approximately 149 million kilometers? Using a Nikon D90 SLR, 12.3 megapixel digital camera, Fabio Mezzalira, an SBO Assistant and Computer Specialist, helped our group attach a quarter-inch telescope

adaptor to a Coronado SolarMax Telescope containing an Hydrogen-alpha filter. The Coronado has an aperture of 44mm and a focal length of 400mm. The f/ratio of f/10, and alteration of the ISO based on the natural light conditions (sunny, cloudy, snowy...) focused the area for our project to the edges of the solar image surface. This is because there is a larger atmosphere on the outside of the sphere of the sun causing it to appear darker, and therefore allowing the visualization of more solar sun texture.

The H-alpha filter is an optical filter that allows for the wavelength specific transmission of the H-alpha. This narrow bandwidth of light is the only wavelength that is transmitted through the filter allowing for spectacular photos of this specific red emission line. This H-alpha that radiates from the Sun is basically a 6562.8 Angstrom wavelength of hydrogen, which occurs when the hydrogen is ionized. This particular H-alpha filter came with a “< 0.7 angstrom bandpass, which results in increased surface detail across the disk.”<sup>iii</sup> The Nikon D90 SLR camera and the Coronado SolarMax 60 Telescope were then placed on top of an 18-Inch DFM Telescope in the Sommers Bausch Observatory. This telescope has a PC-based control system that is linked to an auxiliary computer, which runs computer software that allows for an operator to select a star from the display, and then the computer forces the telescope to move to the correction position where the object is visible in the viewfinder. By mounting our setup to this 18-Inch DFM computer-telescope system, we managed to keep the sun in the frame as it moved across the sky allowing for little to no adjustment when tracking the sun’s movement.<sup>iv</sup>

### **Image Quality**

This particular photo was taken with a Nikon D90 SLR digital camera. Using photo-editing software, such as Aperture and Photoshop, the contrast and exposure were boosted to

accentuate the H-alpha coloring. This creates a vibrant, fiery glow based on the bright hot red color juxtaposed to the cold, dark black background. The shutter speed of the camera was 1/60<sup>th</sup> of a second with an f/stop value of f/0. The ISO Speed Rating was 100 and the focal length was 0.0 mm since no lens was attached. The image distance is approximately  $1.5 \times 10^{11}$  m. It was taken on March 11, 2009 at 2:56PM facing southwest. The boxes around the two prominences emphasize the flow and draw the viewer's eye to a focus point. Finally, the photo was cropped to pull the attention to the prominences. Overall, the photo flow visualization project was very informative and successful and the only flaw in the photo is the quality because the focal range of the telescope is much more difficult to focus than just a lens. In the future, Tucker Porter (the camera owner) and myself will attempt to master this technique and create flawless photos of these solar prominences.

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<sup>i</sup> "Solar Fusion." 31 March 2009. Online. Available at:

<<http://facultystaff.richmond.edu/~ggilfoyl/qm/homework/fusion/fusion.html>>.

<sup>ii</sup> "Solar Prominence." *Encyclopædia Britannica*. 2009. Encyclopædia Britannica Online. 30 March 2009. Online. Available at: <<http://www.britannica.com/EBchecked/topic/552973/solar-prominence>>.

<sup>iii</sup> "MaxScope 40 Product Description." *Coronado*. Online. Available at:

<[http://www.coronadofilters.com/Maxscope\\_40.html](http://www.coronadofilters.com/Maxscope_40.html)>.

<sup>iv</sup> "18 – Inch DFM Telescope." SBO Observing Deck. Online. Available at:

<<http://lyra.colorado.edu/sbo/telescopes/18inch/18inch.html>>.