Team Project 2

Sun Prominence Imaging

By

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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 suns 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. [i]

The majority of the suns 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 sun spots, solar flares, coronal mass ejections and prominences. The suns 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. [ii]

The size of the prominence on the top left is determined to be approximately 2.5*10^7m wide and 1.59*10^7m high. This is equivalent to 1.5*10^4 mi by 9.8*10^3 mi. This gives the prominence an area of approximately 3.97*10^14 m^2. This was determined by finding the ratio of the number of pixels in the solar flare to the number of pixels across the radius of the sun and multiplying this ratio by the known radius of the sun in meters. See Equation 1.

Equation 1:
Pixel Dimension of prominence = P_flare
Pixel Dimension of Solar Radius = P_Sun
Radius of the Sun = r_sun

$P\_flare := 82$ pixels $\quad P\_Sun := 2292$ pixels

$$Ratio := \frac{P\_flare}{P\_Sun} \qquad r\_sun := 6.995 \cdot 10^{8}\ \mathbf{I}$$

$$Flare := Ratio \cdot r\_sun \qquad Flare = 2.503 \times 10^{7}\ \mathbf{I}$$

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 out group attached a quarter-inch telescope adaptor to a Coronado SolarMax Telescope containing a 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." [iii] The Nikon D90 SLR camera and the Coronado SolarMax 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 the computer will move the telescope 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. [iv]

I did perform photo processing in Photoshop. I greatly changed the RGB color spectrum sensitivities to significantly alter the colors. This made the orange/red sun a neat bright turquoise color. I also increased the slope of the line in the curves option. With the color shift I also made the black background white. I believe that the turquoise sun on top of the white background really brings the sun forward in the image and enhances the contrast. This makes it easier to see the solar prominence on the circumference of the sun.

Conclusion

I believe that the image does successfully reveal the solar prominence to the audience. I like the overall simplicity of the image. My previous images have been very "busy" compared to this one. I think the cleanness of this picture directs the viewer's attention to the prominence. I do wish there was something more to the image, probably texture. I was able to bring out some nice texture with different shades of turquoise but this blurred the background and reduced the contrast significantly. I tried to compromise to re gain contrast but unfortunately my Photoshop editing skills are not there yet. The fluid physics are clearly shown and are mathematically discussed in the previous sections of the report. As a group we fulfilled our intent of capturing a nice image of a solar prominence. In the future I would have consulted others for help in Photoshop to create the image I intended with contrast and texture.

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[i] "Solar Fusion." 31 March 2009. Online. Available at: <http://facultystaff.richmond.edu/~ggilfoyl/qm/homework/fusion/fusion.html>.

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

[iii] "MaxScope 40 Product Description." Coronado. Online. Available at: <http://www.coronadofilters.com/Maxscope_40.html>.

[iv] "18 – Inch DFM Telescope." SBO Observing Deck. Online. Available at: <http://lyra.colorado.edu/sbo/telescopes/18inch/18inch.html>.