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Selenology Today

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Selenology Today is devoted to the publication of contributions in the field of lunar studies. Manuscripts reporting the results of new research concerning the astronomy, geology, physics, chemistry and other scientific aspects of Earth's Moon are welcome. Selenology Today publishes papers devoted exclusively to the Moon. Reviews, historical papers and manuscripts describing observing or spacecraft instrumentation are considered.

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http://www.lunar-captures.com/SelenologyToday.html

Selenology Today is under a reorganization, so that further comments sent to us will help for the new structure. So please doesn't exit to contact us for any ideas and suggestion about the Journal. Comments and suggestions can be sent to Raffaello Lena editor in chief :

gibbidomine@libero.it

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Partial Solar Eclipse of March 20th 2015

by Cristina Cellini

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Studying Lunar Domes with LOLA Data

By **Anthony Mallama**

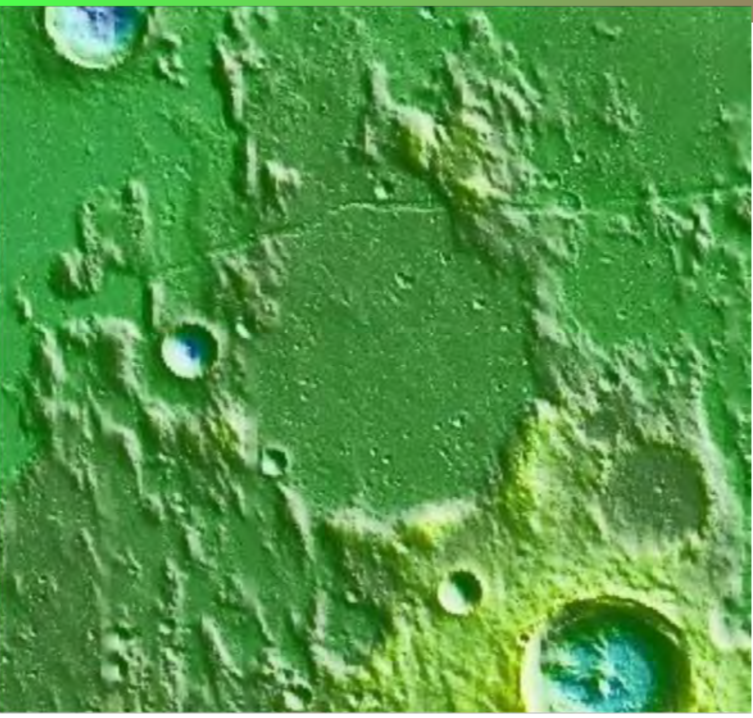

Figure 1

Flammarion is the large crater at the center of this excerpt from a LOLA browse image. Located at 3.4S and 3.7W the crater is 75 km in diameter and 1.5 km deep. This depiction of elevation does not reveal any obvious domes

Introduction

My interest in lunar domes was inspired by a book from the past century titled A Portfolio of Lunar Drawings (Hill, 1991). Harold Hill was a prolific observer of the Moon and an extraordinary draftsman. His artistic renderings of lunar features as seen through the telescope are beautiful and timeless.

Most of his subjects, like the dome northeast of Linné, are classic structures that are well known to students of the Moon. However, Hill also drew some low relief features which are not widely recognized. One example is a group of subtle mounds which he termed 'The Flammarion Domes'. I wanted to learn more about these features but a Google search did not return any information about them. The search did, however, lead me to the catalog of domes maintained by the Geologic Lunar Research group which is how I learned of the GLR. That listing does not record any domes at the coordinates of Flammarion either, though, which left me further puzzled.

Since I worked on several planetary laser altimetry projects during my career at NASA, I then decided to browse the topographic charts of the Lunar Orbiter Laser Altimeter (LOLA) for this area. While no domes are apparent on the floor of the crater Flammarion (Figure 1) this was not entirely surprising. The charts are color coded to represent the full range of lunar elevations which span more than 10 km. Therefore, subtle dome-like features with elevations of only a hundred meters or less might not register. Next, I decided to examine the LOLA altimetry itself. That is how I became interested in analyzing LOLA data. I will return to the Flammarion domes at the end of this article but I want to concentrate mostly on the LOLA data and on how I use it, because those subjects may be of general interest.

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The LOLA instrument and GDR dataset

LOLA is a science instrument on the Lunar Reconnaissance Orbiter (LRO) spacecraft. LRO is still orbiting the Moon and the altimeter continues to collect data. The precision of topographic data from LOLA is estimated to be about 10 cm. In fact, the LOLA dataset was used as the reference for evaluating the quality of the GLD100 dataset (Scholten, 2012).
The general science goals of LOLA are to provide topographic, surface roughness, surface slope, and surface reflectance measurements of the Moon. With regard to volcanic features such as domes, the LOLA measurements are intended to provide quantitative information on landforms and lava flows, to characterize surface deformation due to magmatic intrusions, and to discriminate between volcanic and non-volcanic tectonism (Smith et al. 2010). Volcanic research pertaining to the planet Mars has been performed by Schultz et al. 2004) using a precursor of LOLA called MOLA (Mars Orbiter Laser Altimeter). The dataset of LOLA Gridded Data Records (GDR) is comprised of 64 gigabytes of surface elevations measured relative to the lunar radius of 1737.4 km and covering the whole Moon. The data is stored in JPL PC_REAL 4-byte binary words. I wrote a Fortran program to decode the binary format so that I could analyze the data.

Measurements derived from the altimeter data

The software for decoding binary words is one portion of a program for reading and analyzing LOLA GDR data for selected areas on the Moon. The program, which is unimaginatively named Read_GDR, can generate a 2- or 3-dimensional output files containing latitudes, longitudes and elevations. Read_GDR uses only simple geometry and numerical integration for its computations. An example of 2-D output showing a traverse through the dome Hortensius 2 is plotted in Figure 2. Notice that the crater centered on this dome extends practically down to the level of the surrounding terrain. Figures 3 and 4 show 3-D output for Hortensius 2 in the forms of a contour map and a surface rendering, respectively.

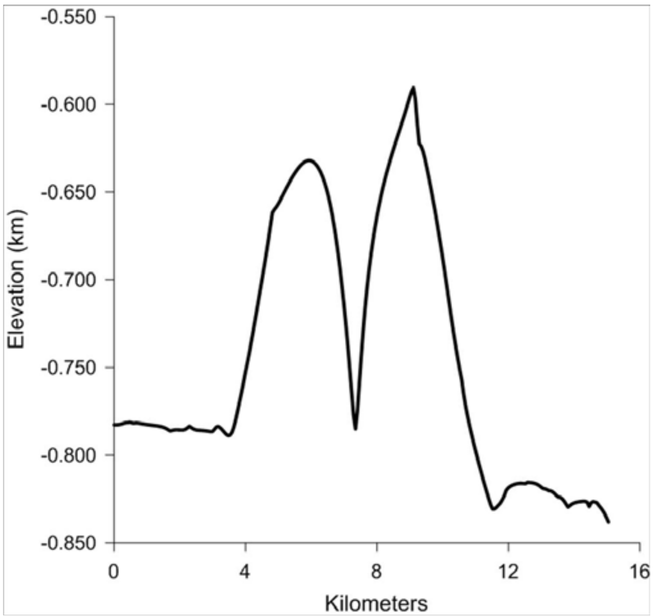

Figure 2

A traverse elevation through Hortensius 2 shows that the central crater is about as deep as the dome is high.

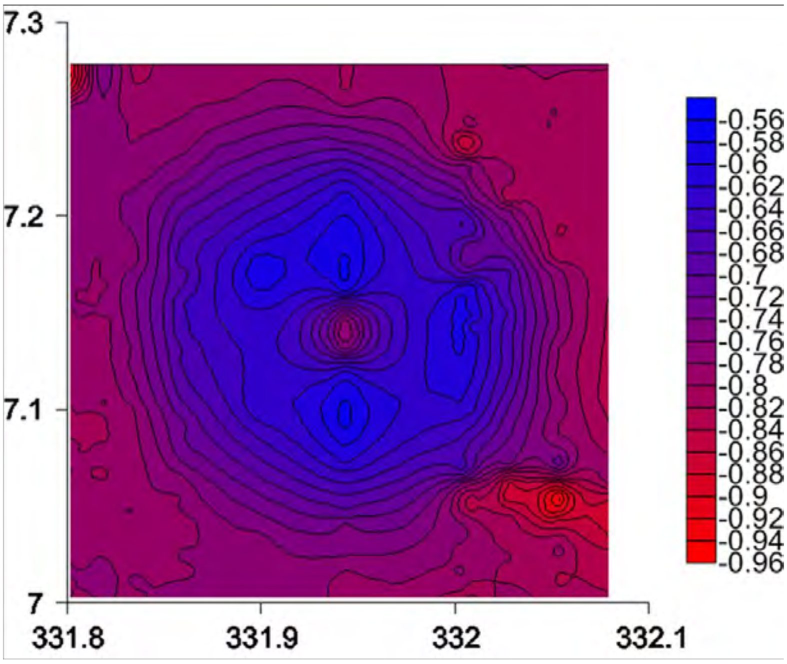

Figure 3

Contour lines at 20 m separation for Hortensius 2. Notice the four individual summits and the central crater.

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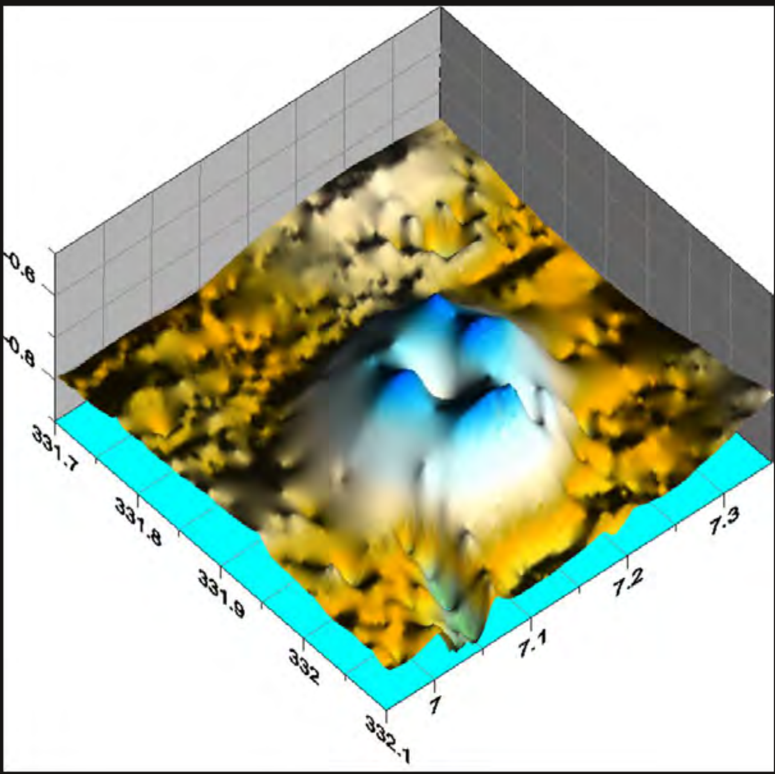

Figure 4

A surface depiction of Hortensius 2 showing the dome and its surrounding terrain. Compare this to Figure 3.

When 3-D output is generated a set of geometric measurements including diameter, height, slope and volume is also calculated. These parameters were chosen to match the quantities used by the GLR group for geological analysis. Again using Hortensisus 2 as an example, Table 1 shows that Read_GDR derives quantities that agree reasonably well with those from the GLR catalog.

Table 1. Comparison between GLR catalog values and Read_GDR program output for Hortensius 2

	Diameter	Height	Slope	Volume
GLR catalog	7.6	230	3.45	6.3
Read_GDR program	6.9	250	4.14	5.2

Note: The GLR catalog values are based on shape-from-shading techniques and are principally from telescope CCD images whose resolution is lower than that of LOLA.

One question which I have discussed with Raf Lena (leader of the GLR group) is from what level of elevation should the height of a dome be measured? There are at least two answers corresponding with different methodologies. In method 1, the height may be measured from the lowest point at the base of the dome. This is the method used by GLR. In method 2, height may be measured above the average level of the terrain in the vicinity of the dome.

These method can lead to significantly different results if the dome is on tilted terrain. In a test case of one particular dome, Raf recently indicated to me a height of 160 m using method 1, but Read_GDR computed only 88 m using method 2. Figure 5 shows a LOLA traverse through the dome and illustrates why method 2 gives a reduced height. Read_GDR originally measured height only using method 2. Now I have added method 1 in order to calculate heights that are compatible with GLR results as well.

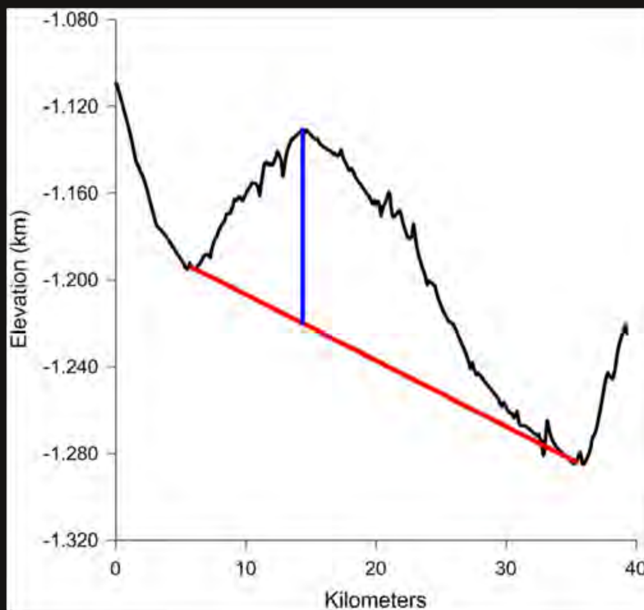

Figure 5

This 2-D representation shows how the height of a dome on tilted terrain can be measured relative to the sloping terrain (blue line above red). Height can also be measured relative to the lowest point where the red line touches the black line around km 35.

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There are two questions of a similar nature related to the computation of volume. As with height, one question is 'above what elevation should the volume be measured' and, again, there are separate methods for measuring volume above the lowest point and above the average terrain elevation. Measuring above the average terrain is analogous to measuring above the red line in Figure 5.
The second question pertaining to volume is 'what method of volume computation should be used'. Method 1 is to fit a parabola to the surface of the dome and then determine the volume by solving for the volume under a parabola. Method 2 is to directly integrate height over the footprint of the dome using numerical integral calculus. Raf's volume using the lowest point and parabolic fit is 58.3 km^3. Read_GDR uses direct integration and, originally, it integrated only above the average terrain height. The result of that pair of methods was a volume of 5.8 km^3 which is only 10% as large as Raf's. I have since modified the program so that it also integrates volume above the low point in addition to the average terrain height. The resulting volume is then 65.9 km^3 which obviously agrees much more closely.

Conclusion

I was never able to determine with certainty whether there are actually any domes on the floor of Flammarion as depicted by Hill. The main problem is that the interior of the crater is not flat. If domes exist at all, they are extremely subtle features.
In any case, my investigation led to the development of a tool which may have some value for measuring the geometrical properties of domes. I would be glad to provide such measurements if they are needed for geological studies of the Moon.

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Three detection of meteoroidal impacts on the Moon

Marco Iten (a), Raffaello Lena (b), Stefano Sposetti (c)
(a) Garden Observatory
(b) Geologic Lunar Research (GLR) Group
(c) Gnosca Observatory

Abstract

We report the detection of three luminous events probably generated by meteoroidal impacts on the lunar surface during pre and post-new Moon time periods in 2013. Such flashes were simultaneously recorded by two telescopes equipped with videocams. The instruments were located at a distance of some kilometers.

1. Instruments and observing methods

Our equipment and observing procedure was presented and discussed in preceding reports published in [1-5].

We observed with different telescopes from different locations:

- a 125 mm refractor, located in Gordola,Switzerland.
- a 150 mm refractor located in Bellinzona, Switzerland.
- a 280 mm reflector located in Gnosca, Switzerland.

The instruments were equipped with Watec 902H2 Ultimate and KT&C-SLL650BH videocameras working in CCIR mode. GPS time inserters (KIWI-OSD and IOTA-VTI) printed the Universal Time with millisecond precision in the video frames. Time synchronicity of the recorded files was therefore assured.

2. Detections

Table 1 shows all important informations about the detections. Some of them were calculated using the software TheSkySix ®.

2.1. Artificial satellites

We checked for artificial satellites in the field of views with www.calsky.com ©.
No satellites were along the line of sight in a 3° diameter circle centred on the Moon at the specified times for the flashes N. 1 and 2. For flash N. 3, the satellite INTELSAT 907 (27683 2003-009-A) was at an angular distance of 1.3 degree. We exclude that this flash was caused by a sunlight reflection of this satellite.

2.2. Luminosity

We could evaluate the maximum luminosity (during the 20 ms field integration time) of flashes N. 1 and N. 3.

The flash N.1 reached a peak brightness of 10.0 ± 0.5 mag. The photometry was estimated using the star SAO 93833 (Sp.Type: F8, 9.3 mag) inside the field of view at about 02:11:32 UT.

We have no photometry for the flash N.2 because no detectable stars were in the field of view during the observing run.

The flash N. 3 reached a maximum brightness of 9.7 ± 0.5 mag. The photometry was done using star HIP 110378 (Sp.Type: A2 D ~ ; 7,50 magV) in the field of view at 17:39:33 UT and HIP 110406 (Sp.Type: M0 D ~ ; 7,70 magV) in the field of view at 17:52:17 UT. Informations about the stars were

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extracted from http://cdsweb.u-strasbg.fr/ ©.

3. Active Meteor Showers

Images N. 1, 2 and 3 show the active showers accordingly to the predictions of the software Lunarscan ©.

Here we list the meteor showers around Aug 1 and Dec 7-8.

PAU Maximum: July 28 (λ= 125°); ZHR = 5;
SDA Maximum: July 30 (λ = 127°); ZHR = 16;
CAP Maximum: July 30 (λ = 127°); ZHR = 5;
PER Maximum: August 12, 18^h15^m to 20^h45^m UT (λ= 140.0°—140.1°); ZHR = 100;

PHO December 6, ZHR = variable, usually none

PUP December 7 ; ZHR = 10;
MON December 9 ; ZHR = 2;
HYD December 12 ; ZHR = 3;
GEM December 14, 05h45m UT ; ZHR = 120;

We can argue that the flash N.1 was produced by an SDA meteoroid or a SPO (sporadic) one. We can suppose that the flash N.2 and N. 3 were produced by a PUP meteoroid or a SPO (sporadic) one.

4. Size of the probable impactors and of their produced craters

According to Ortiz et al. (2006) the mass of the impactor is estimated using a nominal model with conversion efficiency from kinetic to optical energy of 2×10^{-3} and 2×10^{-2} [6]. The parameters used in the calculation are the projectile density (2000 kg m^3), the target density (2000 kg m^3) and the impact velocity.
For flash 1 the whole duration of the flash corresponds to 0.02s lasting 1 video field (1 field = 20 ms). According to the International Meteor Organization the SDA meteor shower (V_∞ = 43 km s-1) was active. However, the impact could also be attributable to a sporadic meteoroid (V_∞ = 16.9 km s^{-1}). Based on a nominal model with conversion efficiency from kinetic to optical energy of 2×10^{-3}, the mass of the impactor is estimated to be about 0.003 kg or 0.0018 kg assuming a sporadic origin a SDA shower, respectively. A luminous efficiency of 2 x 10^{-2} yields a mass of the impactor and the impact energy considerably less than the preceding inferred value by a factor of 10. Based on a modeling analysis (Gault's scaling law assuming the density of both meteoroid and lunar material to be 2000 kg m^{-3}), the meteoroid likely produced a crater of about 1-2 m in diameter [7]. It should be noted, however, that these values are "nominal", since the results includes uncertainties in the projectile density, meteoroid mass, and luminous efficiency.

For flash 3 the whole duration of the flash corresponds to 0.04 s lasting 2 video fields (1 field = 20 ms). Using the luminous efficiency η= 2 x 10^{-3} the mass of the impactor would be of the gram with an impact crater estimated of about 1-2 m, principally due to low brightness and short duration of the event. The meteoroid is likely to range in size from about 2 to 4 cm in diameters, for a PUP (V_∞ = 40 km s^{-1}) or sporadic meteor shower respectively.

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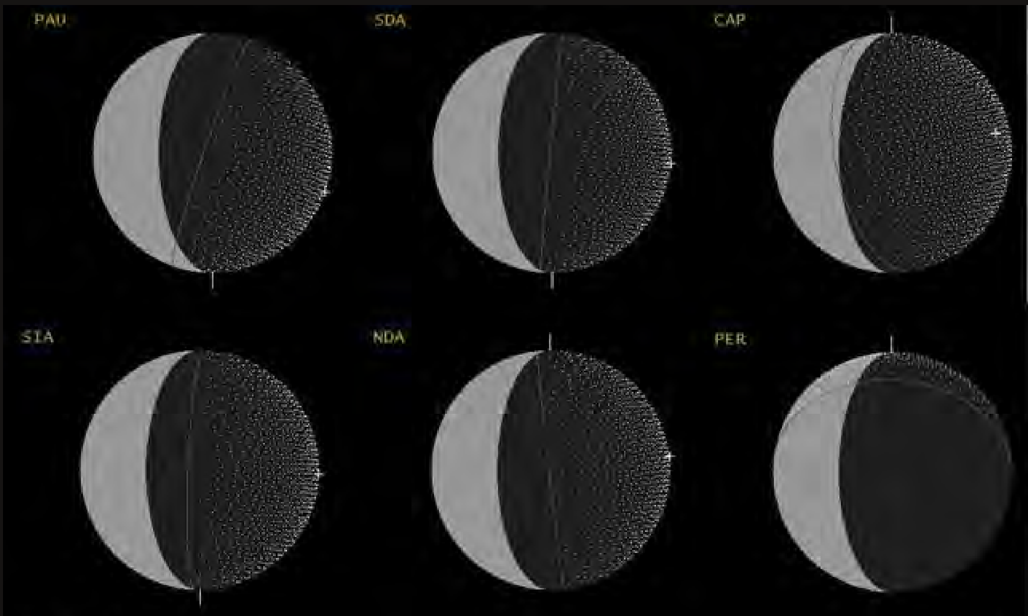
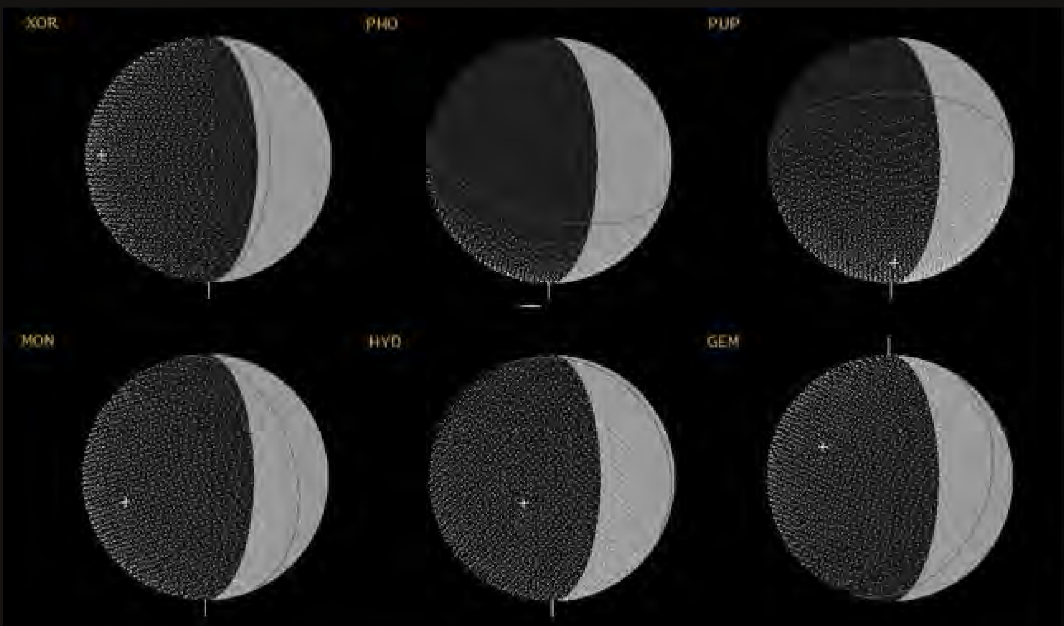


Enter desired date & UT
8/1/2013 03:07:10
opened log file Data\lunar_impact.log for writing

IMO Shower Code	Date	Time UT	Arrival Delay Hours	Moon-Sun Rise/Set Hours	Impacts unlit face %	Polar Graze Angle	ZHR
PAU	08/01/2013	03:07:10	+0.2	-4.2	52	-18	5
SDA	08/01/2013	03:07:10	+0.0	-4.2	51	-5	20
CAP	08/01/2013	03:07:10	+2.1	-4.2	73	10	4
STA	08/01/2013	03:07:10	+0.3	-4.2	54	-1	2
NDA	08/01/2013	03:07:10	+0.0	-4.2	51	6	4
PER	08/01/2013	03:07:10	-1.4	-4.2	7	37	100

Figure 1.

Impact geometries of the active meteor showers when flash N.1 happened.



Enter desired date & UT
12/7/2013 19:31:06
opened log file Data\lunar_impact.log for writing

IMO Shower Code	Date	Time UT	Arrival Delay Hours	Moon-Sun Rise/Set Hours	Impacts unlit face %	Polar Graze Angle	ZHR
XOR	12/07/2013	19:31:06	+1.9	4.4	74	-1	3
PHO	12/07/2013	19:31:06	-2.0	4.4	19	-52	2
PUP	12/07/2013	19:31:06	+1.5	4.4	50	-63	10
MON	12/07/2013	19:31:06	+1.9	4.4	81	-16	3
HYD	12/07/2013	19:31:06	+1.8	4.4	76	-18	2
GEM	12/07/2013	19:31:06	+2.5	4.4	81	9	120

Figure 2.

Impact geometries of the active meteor showers when flash N. 2 happened.

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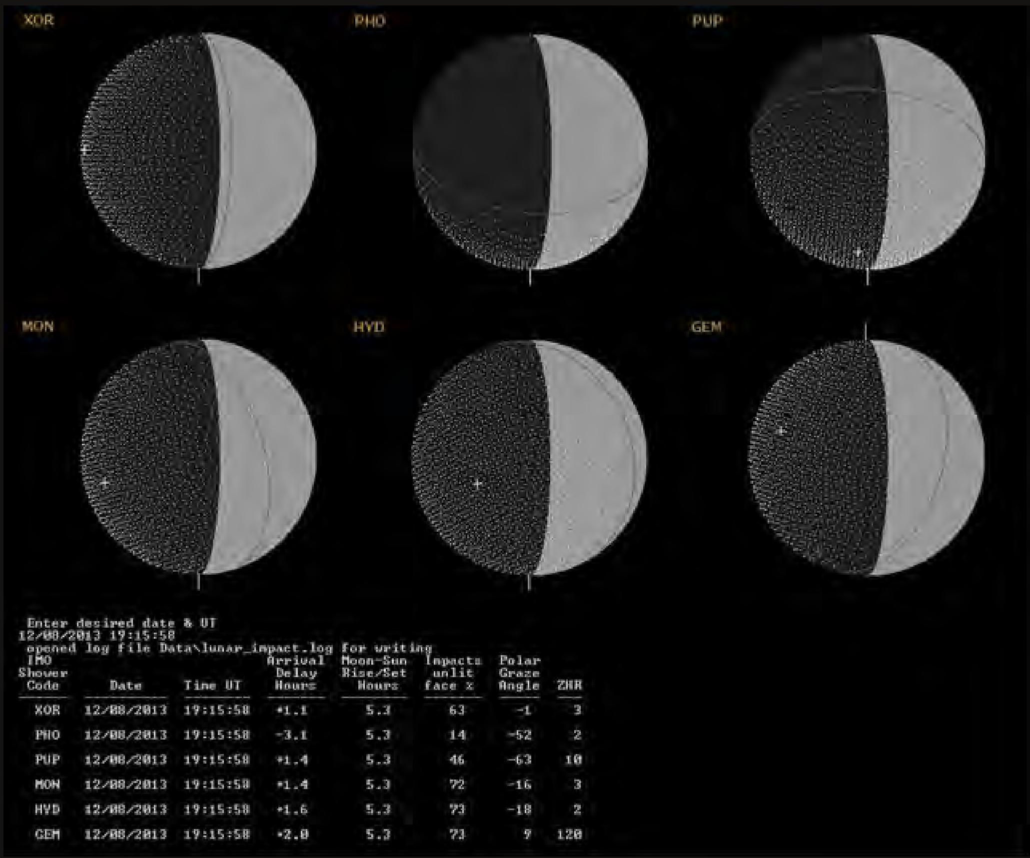

IMO Shower Code	Date	Time UT	Arrival Delay Hours	Moon-Sun Rise/Set Hours	Impacts unlit face %	Polar Graze Angle	ZHR
XOR	12/08/2013	19:15:58	+1.1	5.3	63	-1	3
PHO	12/08/2013	19:15:58	-3.1	5.3	14	-52	2
PUP	12/08/2013	19:15:58	+1.4	5.3	46	-63	10
MON	12/08/2013	19:15:58	+1.4	5.3	72	-16	3
HYD	12/08/2013	19:15:58	+1.6	5.3	73	-18	2
GEM	12/08/2013	19:15:58	+2.0	5.3	73	9	120

Figure 3.

Impact geometries of the active meteor showers when flash N.3 happened.

Figure 4.

Flash N. 1, occurred the 2013 Aug 1 at 03:07:10 UT in M. Iten (left) and S. Sposetti (right) recordings.

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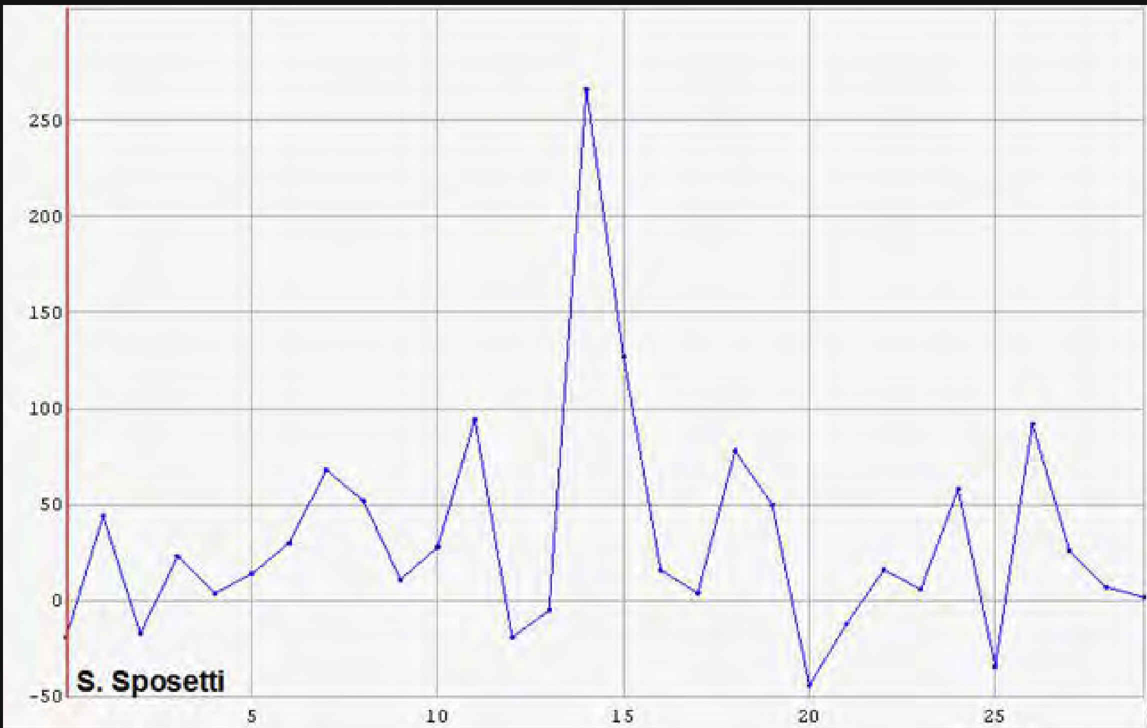

Figure 5.

Lightcurve plotting the intensity versus time of the flash N.1 in Sposetti's recording. Every dot represents one field, ie. 20 ms.

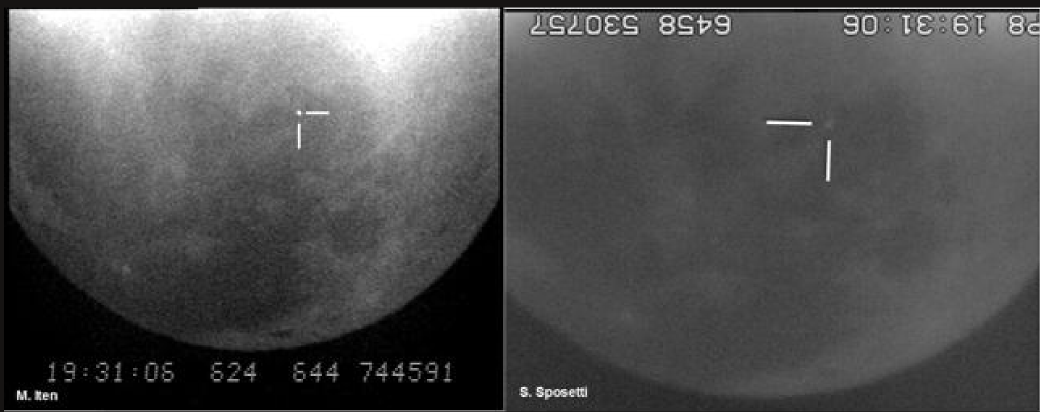

Figure 6.

Flash N. 2, occurred the 2013 Dec 7 at 19:31:06 UT in M. Iten (left) and S. Sposetti (right) recordings. Because of strong wind, the flash of light is “washed” in Sposetti's image
.

Figure 7.

Light intensity versus time of the flash N.2 in Iten's (left) and Sposetti's (right) recordings. Every dot represents one field, ie. 20 ms.

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Figure 8.

Flash N. 3, occurred the 2013 Dec 8 at 19:15:58 UT in M. Iten (left) and S. Sposetti (right) recordings.

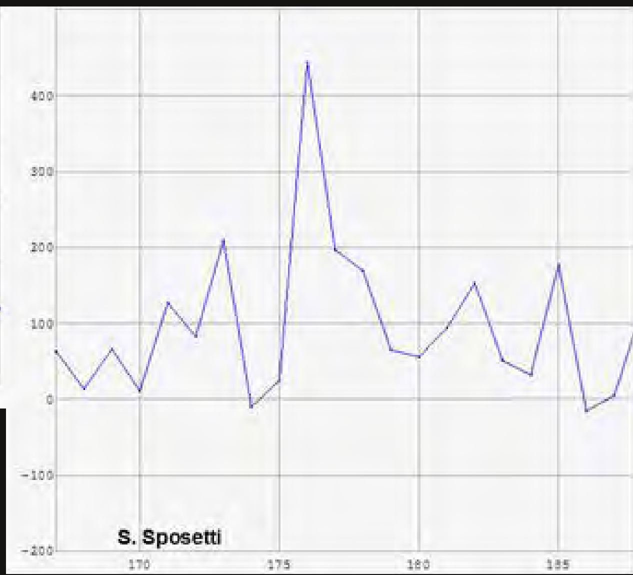

Figure 9.

Light intensity versus time of the flash N.3 in Iten's (left) and Sposetti's (right) recordings.

	Event N. 1	Event N. 2	Event N. 3
Date	Aug 01 2013	Dec 07 2013	Dec 08 2013
UTC Time (hh:mm:ss)	03:07:10	19:31:06	19:15:58
Duration (s)	0.02	0.04	0.04
N. Fields	1	2	2
Magnitude (V)	10 ± 0.5	-	9.7 ± 0.5
Selenographic Coordinates	64° E ; 32° N	11° W ; 14° S	18° W ; 50° S
Lunar region	Burckhardt-Berosus	Mare Nubium	Longomontanus border
Probably type	SDA or SPO ?	PUP or SPO ?	PUP or SPO ?
Captured in	2 telescopes	2 telescopes	2 telescopes
Moon Coordinates, Eq. 2000.0	RA:04 18 DE:+18 47	RA:21 29 DE:-10 11.5	RA:22 23 DE:-05 50
Moon Horizon Coordinates	Az: 99 03 Alt: +34 46	Az: 237 39 Alt: +14 37	Az: 225 43 Alt: +27 08
Phase (%)	27.7	30.1	40.9
Air Mass	1.75	3.94	2.2
Moon angular diameter (arcmin)	29.6	32.4	32.0
Observing Site 1 (M. Iten)	Gordola	Gordola	Gordola
Telescope Site 1	125mm refractor	125mm refractor	125mm refractor
Videocamera Site 1 (CCIR mode)	KT&C-SLL650BH	Watec 902H2Ult	Watec 902H2Ult
Observing Site 2 (S. Sposetti)	Gnosca	Bellinzona	Bellinzona
Telescope Site 2	280mm reflector	150mm refractor	150mm refractor
Videocamera Site 2 (CCIR mode)	Watec 902H2Ult	Watec 902H2Ult	Watec 902H2Ult

Table 1. Informations about the events, the Moon and the observing sites.

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My Partial Solar Eclipse of March 20th 2015

By Cristina Cellini

Every eclipse of the Sun is always a special event. For my location (San Romualdo a small village north of Ravenna - Italy) the partiality was about 65%. For this Partial Solar Eclipse my idea was to take two different set of images. So my husband setup our EQ5 with two telescopes: The achromatic Antares Callisto 120/1000 with Heschel 2” prisma and Baader Continuum filter and the achromatic Antares Marte 80/400 with Coronado Solarmax 60 BF10 filter. I also have two different cameras to take the images. On Antares Callisto I used my Canon 450D unmodded while on Antares Marte I used my Point Grey Chameleon mono to take avi film.

I took my first image in white light at 08:32 UT.

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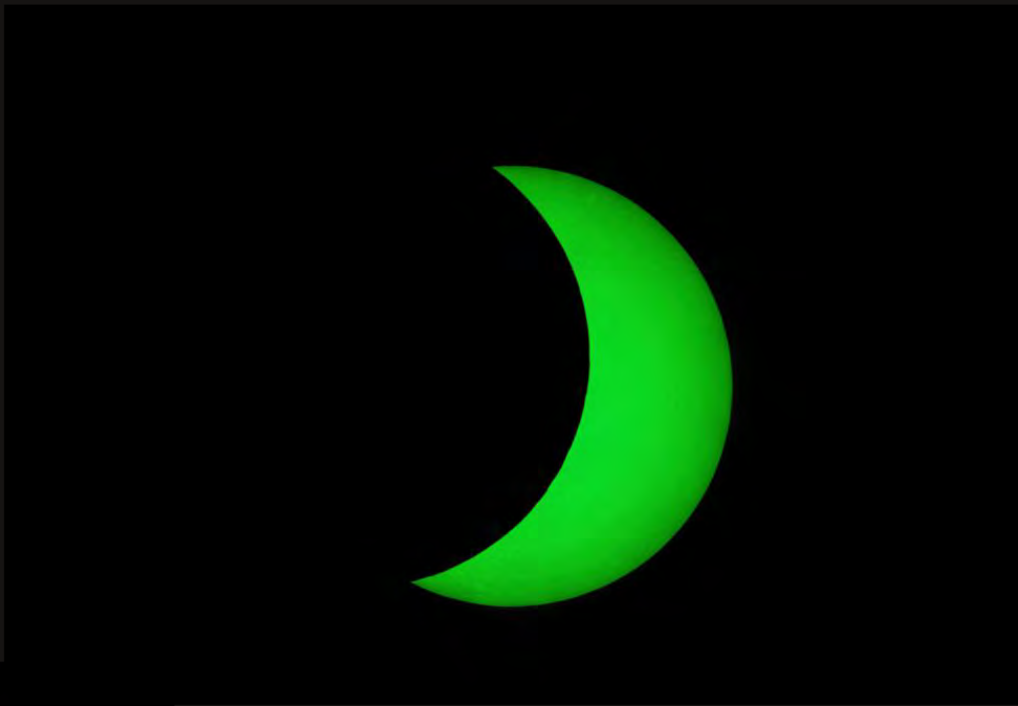
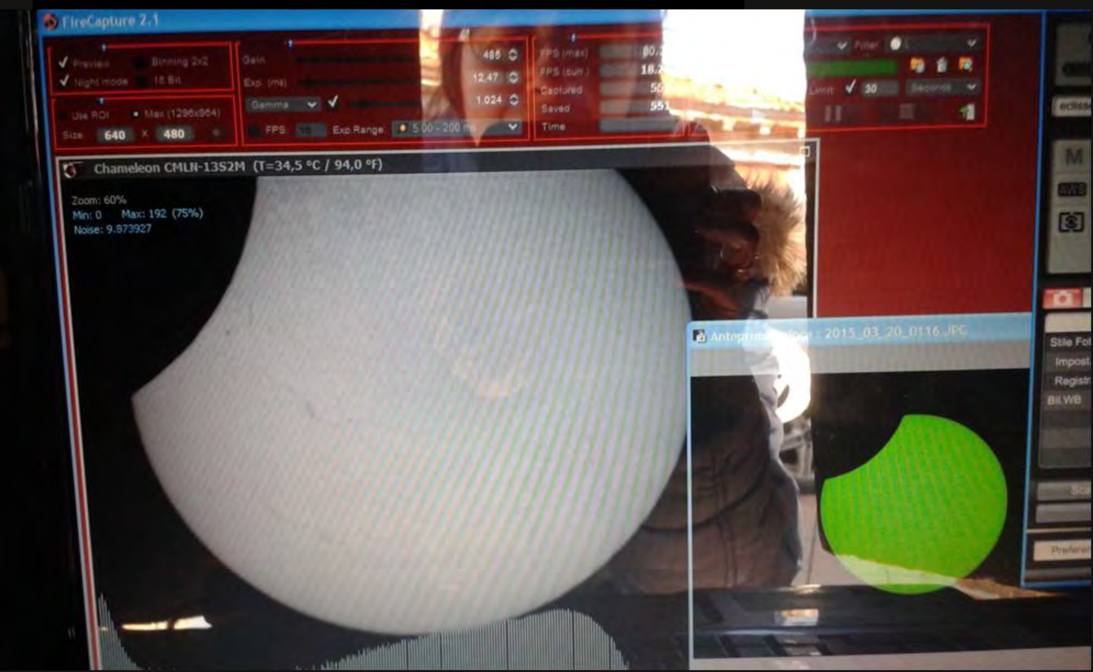
The green color of the image derive to the Baader Continuum filter. I took 33 images to cover all the length of the Eclipse. I used 100 ISO and 1/160 to exposition. Each image was processed with Paint Shop Pro X7 and Topaz plug-in to emphasize the details of the Sun.

This is the maximum of the eclipse for my location. I took this image at 09.37 UT. We noticed a substantial drop of light at the maximum phase of the eclipse and the colors have taken a cooler hue.



I took my last image of this set at 10:45 UT.



I took the two different set of images at the same time.

This was the screen of my notebook during the eclipse. I controlled the Canon 450D and the Chameleon from the same computer. I acquired the h-alpha images with Firecapture. The sensor of the Chameleon did not cover the full solar disk, so I was forced to take two films for each image. Each film was 30 seconds long, but when I processed them I could use only 13 seconds because the movement of the Moon was very obvious. I processed each film with Iris and Paint Shop Pro X7.

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First image in h-alpha (mosaic of two images) 08:33 UT.

My Chameleon is a Monocrome camera. I get the final color of the image in synthetic mode with Paint Shop Pro X7.

The maximum of the eclipse (09:29 UT).

And the end at 10:44 UT.

Now I am waiting
for
the next Solar Eclipse!

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Partial Solar eclipse March 20, 2015

By Raffaello Lena Geologic Lunar Research (GLR) group

1. Introduction

This article describes the method used for a reconstruction of the partial solar eclipse from Rome Italy. Images of the partial eclipse were taken on March 20, 2015, between 08:10 and 10:45 UT. The seeing was estimated as II Antoniadi and transparency as 4 (scale between 1 poor to 5 excellent). AVI films were made using a 13 cm f/6 TMB apo Refractor and a Lumenera LU 075 M camera at a gamma of 1.0, with variable gain and exposure times

2. Material and Methods

The images of the Sun were obtained from AVI films made using an extension tube and a Lumenera LU 075M camera set to 30 fps. After alignment and stacking with the Registax 5.0 software package the raw image was saved in FITS format. The raw image was then processed using the wavelets in Registax 6 software package with the following prompt commands:

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initial=1
step=0

[method]
itemindex=0

[checkbox]
layer1=1
layer2=1
layer3=1
layer4=1
layer5=1
layer6=1

[slider]
layer1=110
layer2=18
layer3=11
layer4=10
layer5=10
layer6=10

[Gauss]
layer1=10
layer2=10
layer3=10
layer4=10
layer5=10
layer6=10

[Blur]
layer1=0
layer2=0
layer3=0
layer4=0
layer5=0
layer6=0
```

In order to have a soft appearance of the lunar limb a combination of de-noising and de-ringing was applied as follows:
De-noising 57
De-ringing dark 67 and bright side 125

The final images were imported into Photoshop CS2 and further processed using another smart sharpen filter (amount 25%, radius 1.5 pixels, threshold 0) with a final adjustment of the level. The mosaic of the solar disk was composed using several images and flatten.

The mosaic saved as TIF 16 bit file was then processed with Photoshop as follows:
Photo filter=> deep yellow 100%
Color balance and color levels:

Midtones => +43, -21, -48
Highlights=> +4, 0, -33
Shadows=> +18, -6, -26
Saturation adjustment with hue 0, saturation -13, lightness -8.

The single mosaic images may be easily co-registered also using Registax 4.0, with an alignment and optimizing process. At the end of the process, and after the optimization, Registax allows the creation of an AVI film.
An animation may be obtained with Photoshop Image Ready. An animation is a sequence of frames which is displayed over time. Each frame varies slightly from the preceding frame, creating the illusion of movement when the frames are viewed in quick succession. The previously chosen images are our frames that we want to view in quick succession. It is important to align each layer containing the processed single frames. Finally a delay was assigned to each frame and a looping was specified so that the animation runs continuously. The film was saved in PSD format to maintain all layers disjoined and to preserve the maximum possibility of modification and enhancement. An animated GIF was then created easily using Photoshop Image Ready.

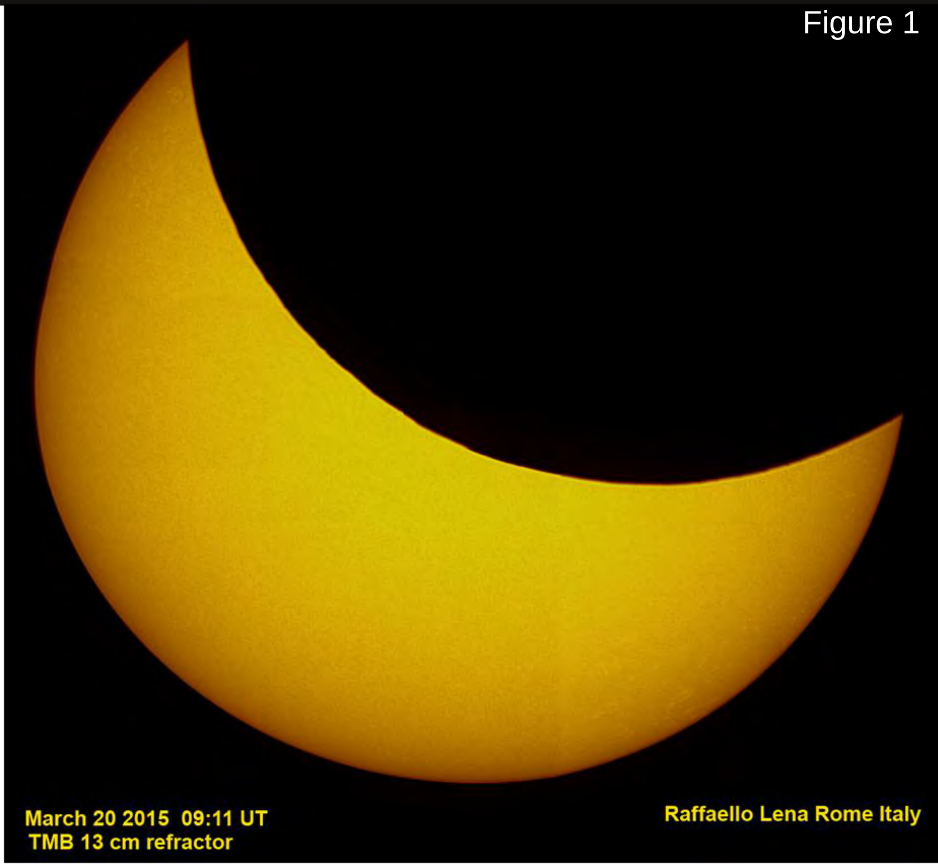

Figure 1

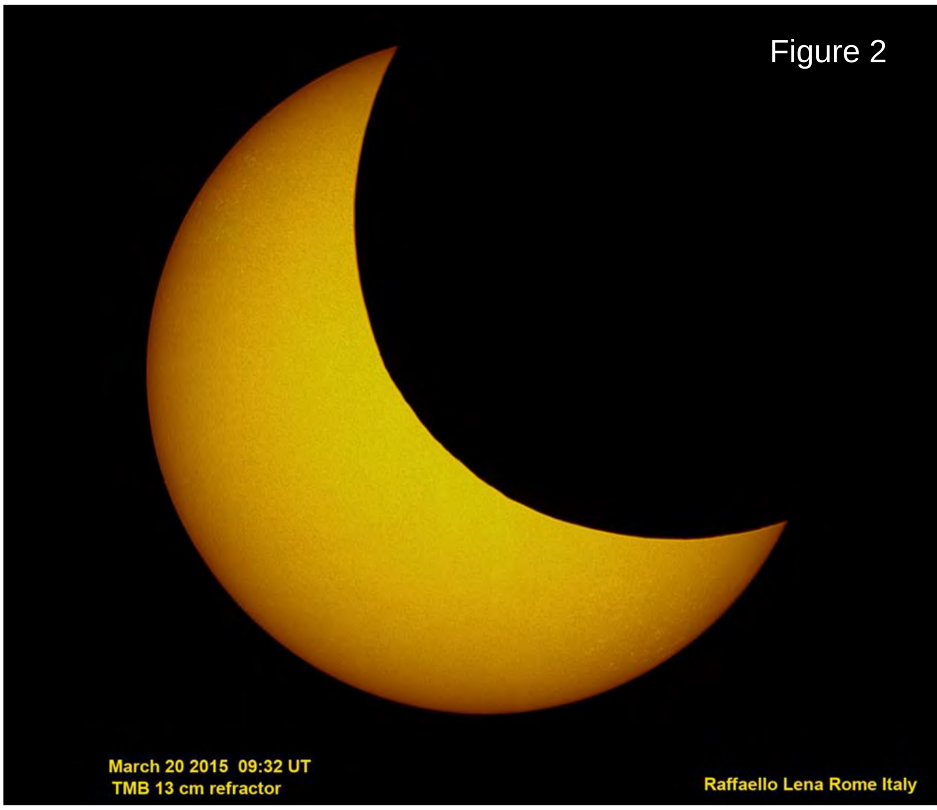

Figure 2

Figure 3

Figure 4

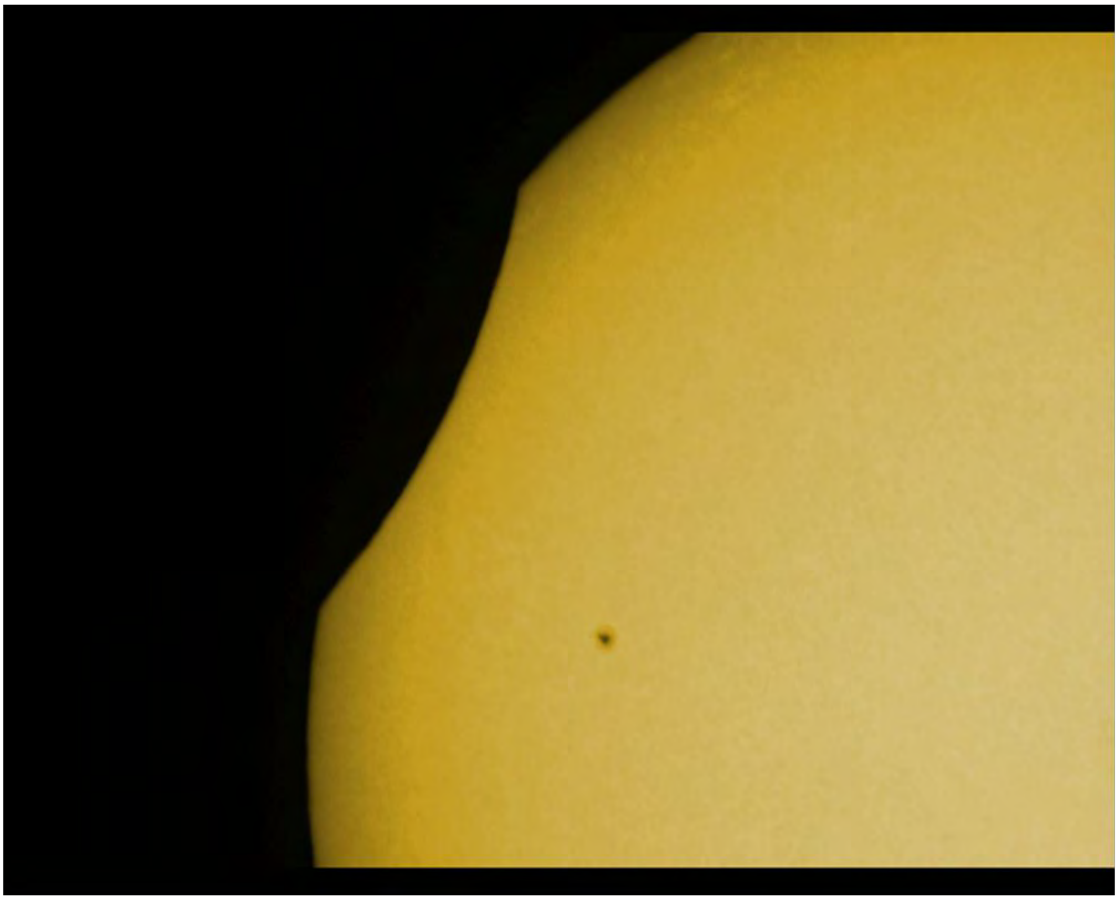

Figure 5.

Animation near the end of the eclipse. Full animation at

http://cdn.astrobin.com/images/3489/2015/1e4c3950-5281-491c-8796-5533bdfa200f.gif

Figure 6.

Animation of the eclipse. Full animation at
http://cdn.astrobin.com/images/3489/2015/9e849c2c-c520-41e6-a1da-f5858b270e86.gif

Figure 7.

Animation of the eclipse. Full animation at
http://cdn.astrobin.com/images/3489/2015/8d0d7afd-92b9-4702-b784-fa865d689e19.gif

Selenology Today

Partial Eclipse of Sun from North Greece

By George Tarsoudis Geologic Lunar Research (GLR) group

I take this image without used telescope, only with my old camera Canon 305D with lens SIGMA APO DG 300mm, BAADER Solar filter. Condition with bad seeing and transparency with cloudy. My location Alexandroupolis of North Greece. Date 20 March 2015, 09:39 UT.

Selenology Today

Partial Solar Eclipse March 20, 2015

By Carmelo Zannelli Geologic Lunar Research (GLR) group

A partial solar eclipse occurred this year. The image was made from Palermo (Italy) with a Skywatcher achro refractor 120/600; Baader Herschel prism; 1,5x chinese Barlow; Canon EOS-40D @ ISO100 – 1/200″ @ F/8.

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