Solar Eclipse 101: Radio and Photographic Observations

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NASA Marshall Space Flight Center

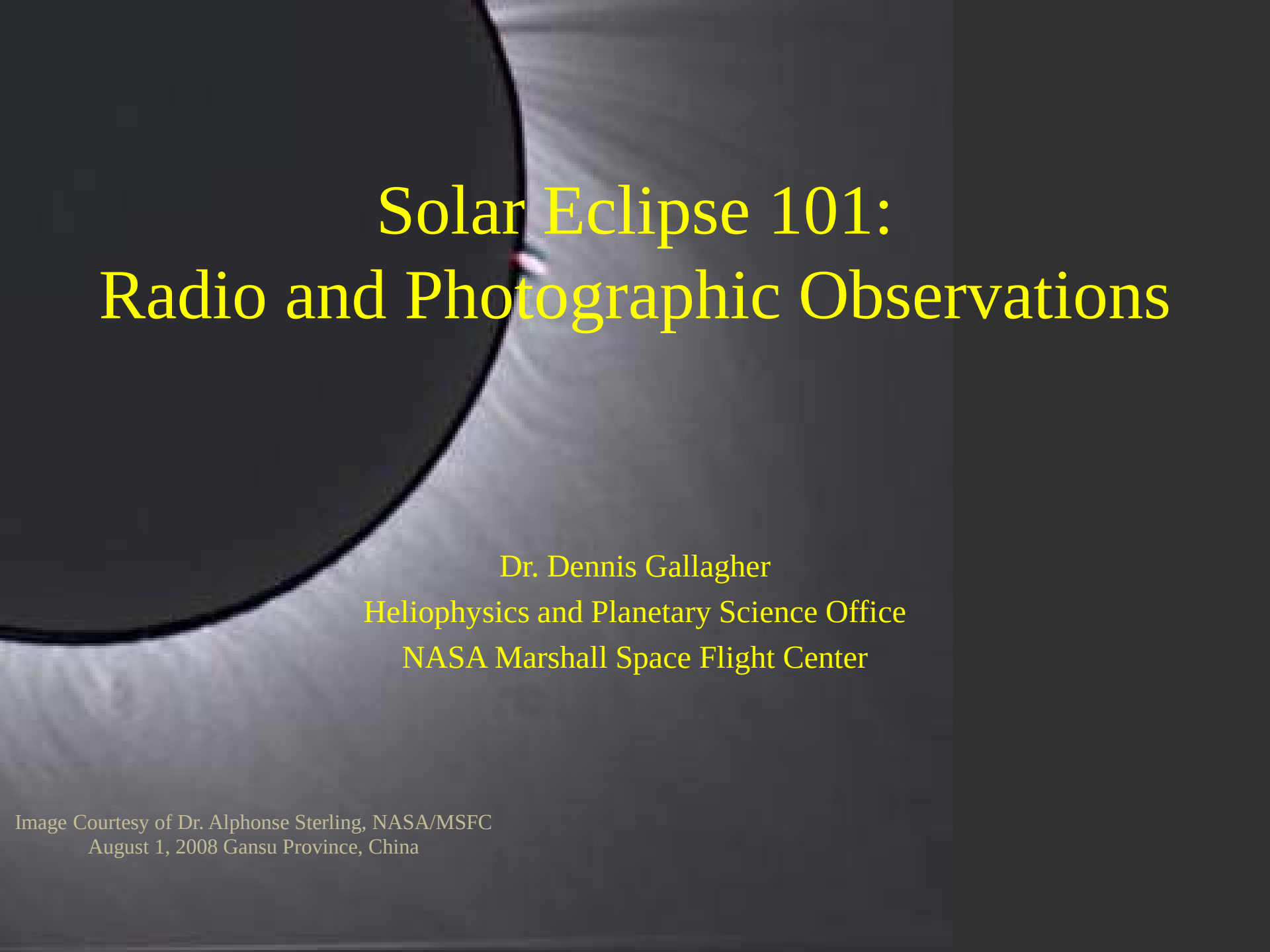

Image Courtesy of Dr. Alphonse Sterling, NASA/MSFC
August 1, 2008 Gansu Province, China

- Safety… “I’m with NASA, I’m here to help”
- The basics, outside looking in
- Inside looking out
- Experiencing the Scientific Method-VLF radio
- Photography of the Sun (to stimulate, not substitute for your memory of the experience)

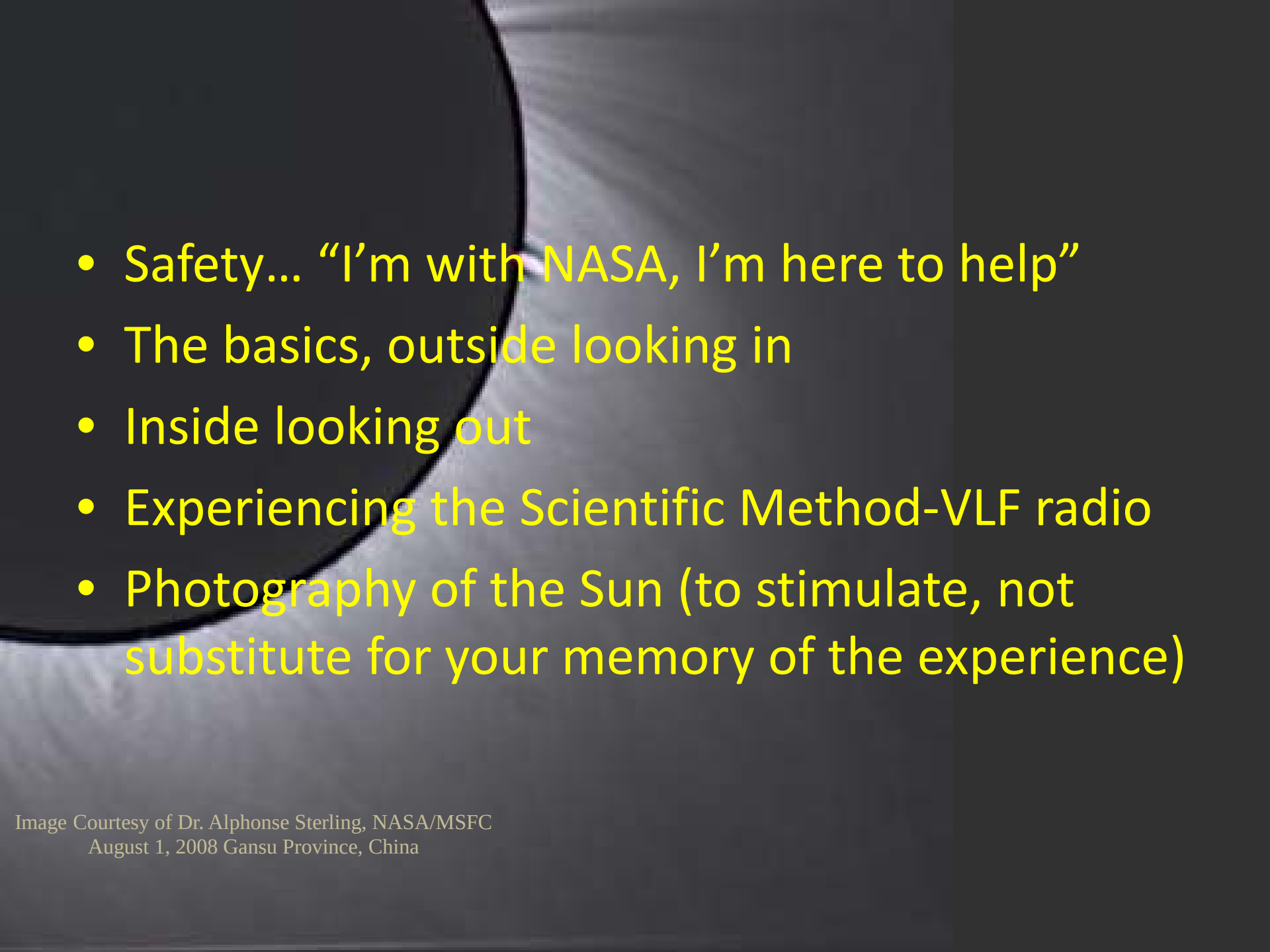

Image Courtesy of Dr. Alphonse Sterling, NASA/MSFC
August 1, 2008 Gansu Province, China

Never look at the Sun directly without proper eye protection, **except** during **totality** of a solar eclipse.

During the partial phases of a solar eclipse you **must** use special solar filters, eclipse glasses, #14 welder's glass, or handheld solar viewers. **Never** use homemade or un-tested materials for direct solar viewing.

Check the American Astronomical Society's List of Reputable Vendors of Solar Filters and Viewers https://eclipse.aas.org/resources/solar-filters. We recommend that you only buy filters from retail chains in brick and mortar stores, and not online."

Safely observing an eclipse

National Aeronautics and Space Administration

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Check eclipse glasses for ISO number 12312-2 or European Union certification (CE), which certifies that the product meets international standards.

Partial Eclipse Glasses on

The eclipse begins when the sun's disk is partially blocked by the moon. This partial eclipse phase can last over an hour.

Diamond Ring Glasses on

The last of the sunlight streaming through the Moon's valleys creates a single bright flash of light on the side of the Moon. This is known as the diamond-ring effect, and it marks the last few seconds before totality begins.

Baily's Beads Glasses on

As totality approaches, only the low-lying valleys on the Moon's edge allow sunlight through, forming bright spots of light called Baily's Beads.

Totality Glasses off

Once the diamond ring disappears and the moon completely covers the entire disk of the sun, you may safely look at the eclipse without a solar filter. Be careful to protect your eyes again before the end of totality—the total eclipse may last less than a minute in some locations.

Final Stages Glasses on

A crescent will begin to grow on the opposite side of the sun from where the Baily's Beads shone at the beginning. This crescent is the sun beginning to peek out from behind the Moon and its your signal to stop looking directly at the eclipse. Make sure you have safety glasses back on!

Safely observing the Sun!

Warning! Never look directly at the sun without proper eye protection. You can seriously injure your eyes. Check with local science museums, schools and astronomy clubs for eclipse glasses—or purchase an ISO 12312-2 compliant and CE certified pair of these special shades!

www.nasa.gov

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THE ONLY TIME

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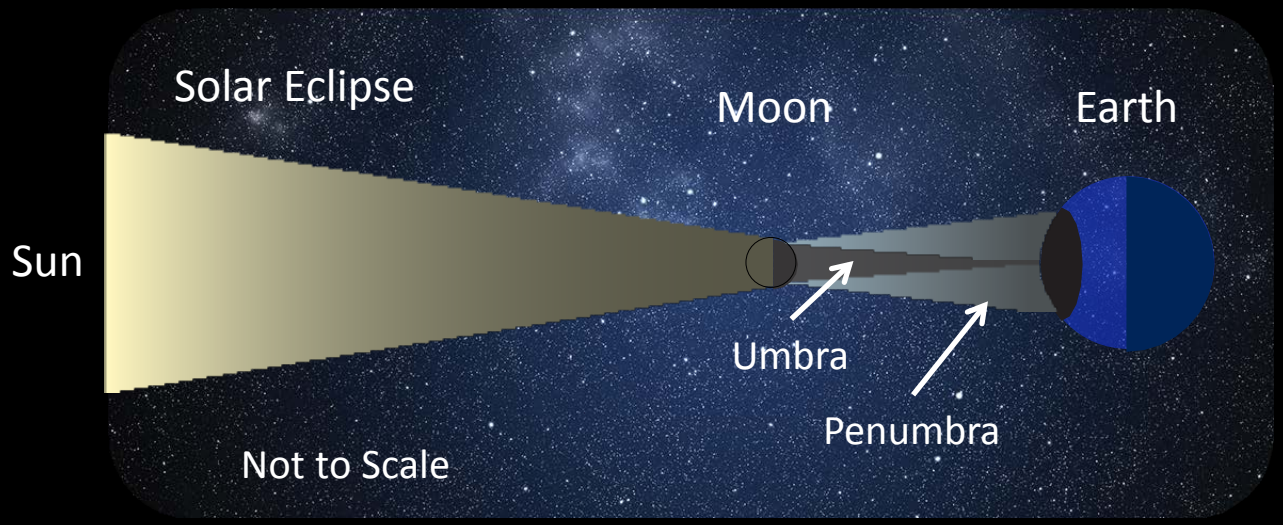
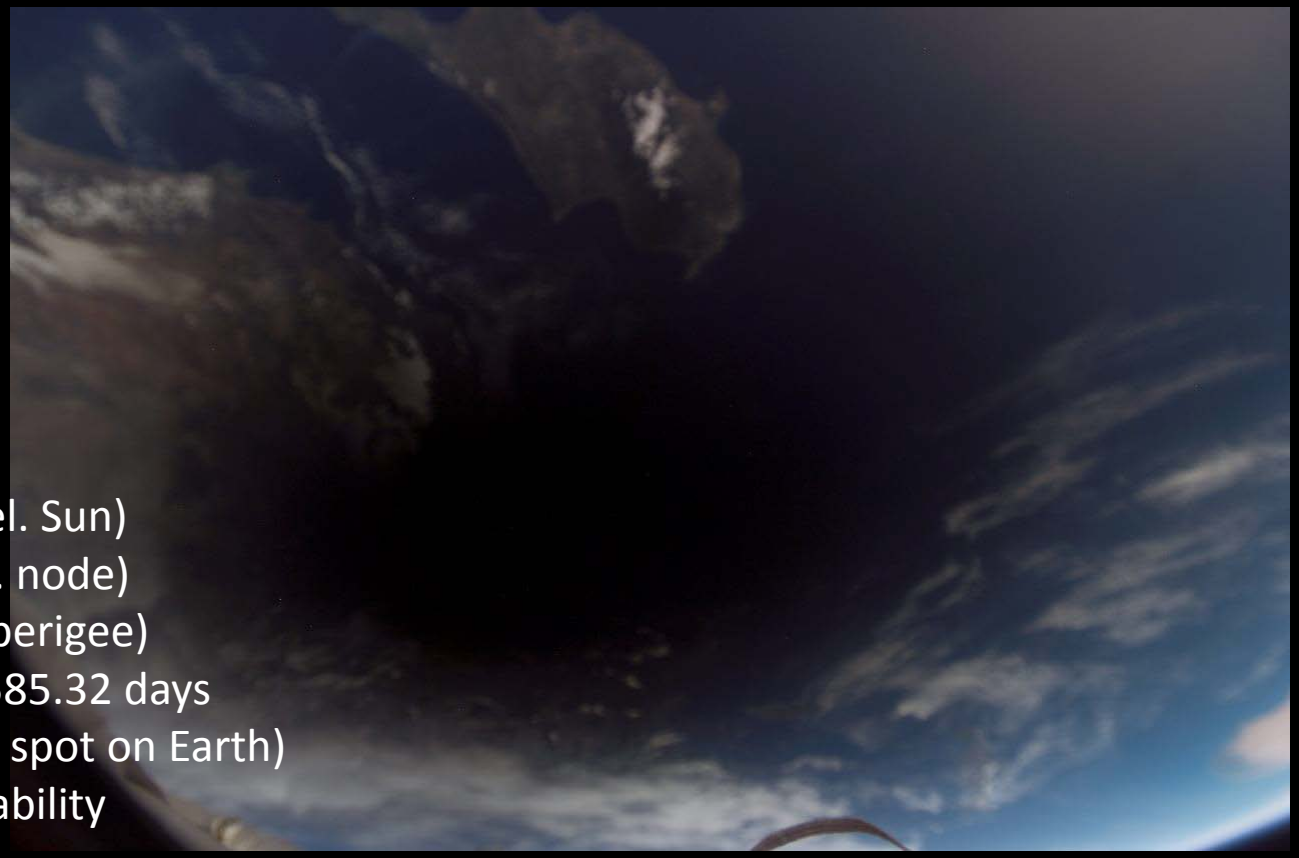
Ref: https://eclipse.aas.org/resources/solar-filters
And https://aas.org/media/press-releases/aas-offers-updated-advice-safely-viewing-solar-eclipse

When Planetary Bodies Align

The Sun, Moon, and Earth must align before the shadow cast by the Moon sweeps across Earth's surface. The ±5° tilt in the Moon's orbit around Earth, the Moon's shifting orbit, and Earth's rotation make this an infrequent event at any given location on Earth's surface.





For Inquiring Minds…

Periods of Lunar Motion:
Synodic: 29.53 days (orb. rel. Sun)
+ Draconic: 27.21 days (asc. node)
+ Anomalistic: 27.55 days (perigee)
= Saros cycle: ~ 18 yrs or 6585.32 days
& Exeligmos: ~54 yrs (same spot on Earth)
Yet there is even more variability

How Much Totality Means What?

Image Courtesy of Dr. Alphonse Sterling, NASA/MSFC
August 1, 2008 Gansu Province, China

WOW!

Eclipse

No Eye Protection

Eye Protection

96%

97%

98%

99%
Still no corona

Huntsville

50%

60%

70%

80%

90%

Let's Next Talk About Radio Waves: Natural and Manmade

Where they go depends on our ionosphere

- The ionosphere is at the top of our atmosphere
- ~90 km to 1000 km in altitude
- Made of atmospheric gas ionized by solar UV

Manmade

Natural

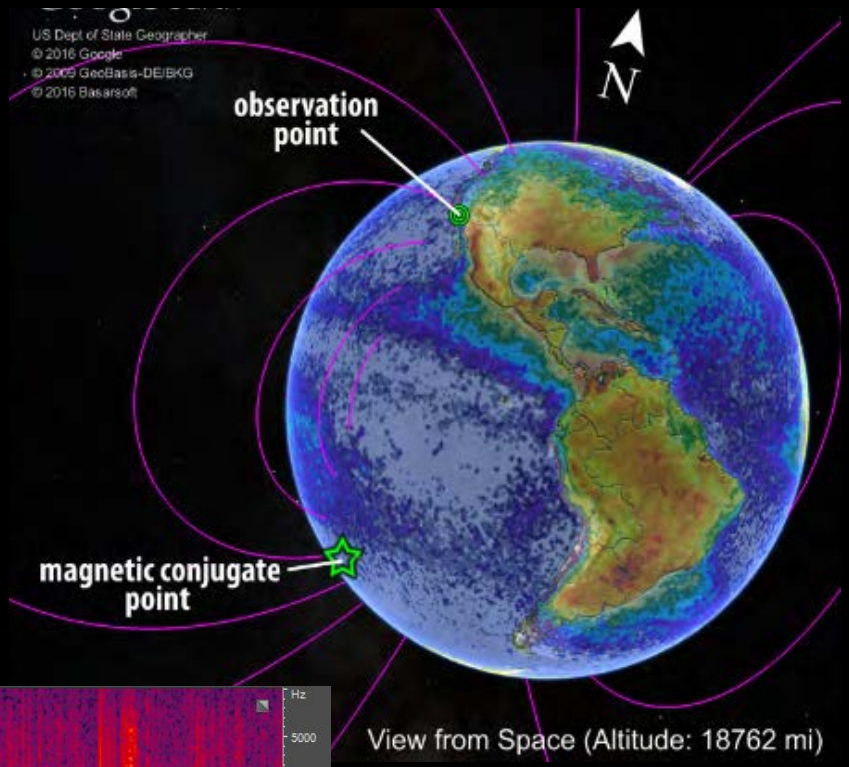
Radio Noise from Lightning

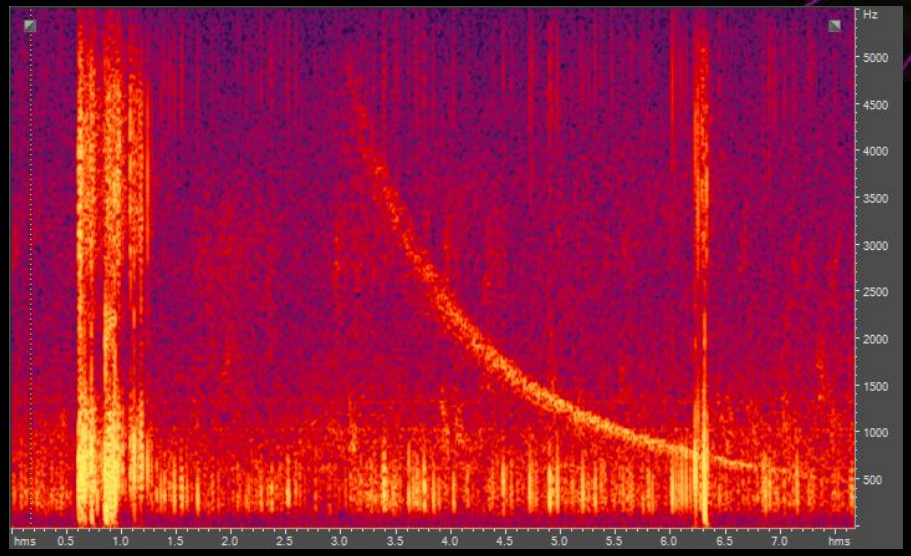
Lightning produces a broad spectrum of radio waves. Most of the wave energy is usually confined between Earth's surface and the ionosphere.

- Spherics is the crashing sound you may have heard while listening to AM radio.
- Tweeks sounds a little like a plucked string and can come from anywhere in the world, traveling between the ground and ionosphere.
- Whistlers have been in space, nearly following magnetic field lines in the ionized gas of Earth's magnetic environment.

Radio Noise from Lightning

- Sometimes lightning wave energy goes through the ionosphere.
- The low frequency part is guided by the magnetic field.
- Where somewhat higher frequencies move faster than lower frequencies.

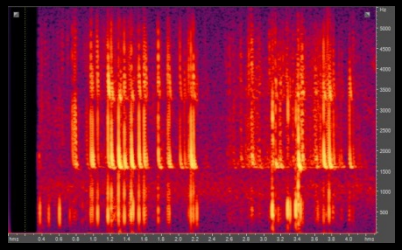




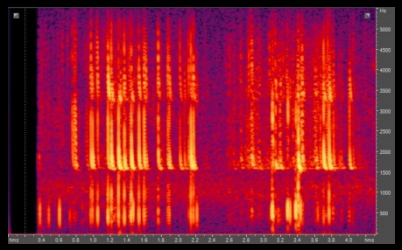
So What is to Be Done with VLF Waves?

Answer the question: “Does the eclipse shadow change the ionosphere enough to cause VLF waves to behave like they do at dawn/dusk on normal days or will VLF radio noise be like it is at mid-day without an eclipse?”

Dawn/Dusk



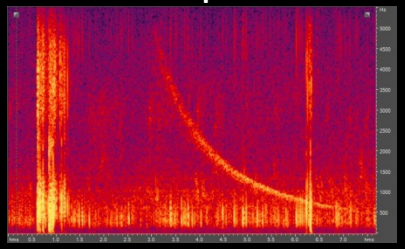
Mid-Day



What are VLF waves like at these times without an eclipse?

What are VLF waves like during this eclipse?

Mid-Day Eclipse



Do what with the answer? Publish in the INSPIRE Journal!
Other VLF enthusiasts may also submit their observations from elsewhere along the path of totality that can be used to answer the question.

2017 Solar Eclipse VLF Site

Between bean fields near Guthrie, KY

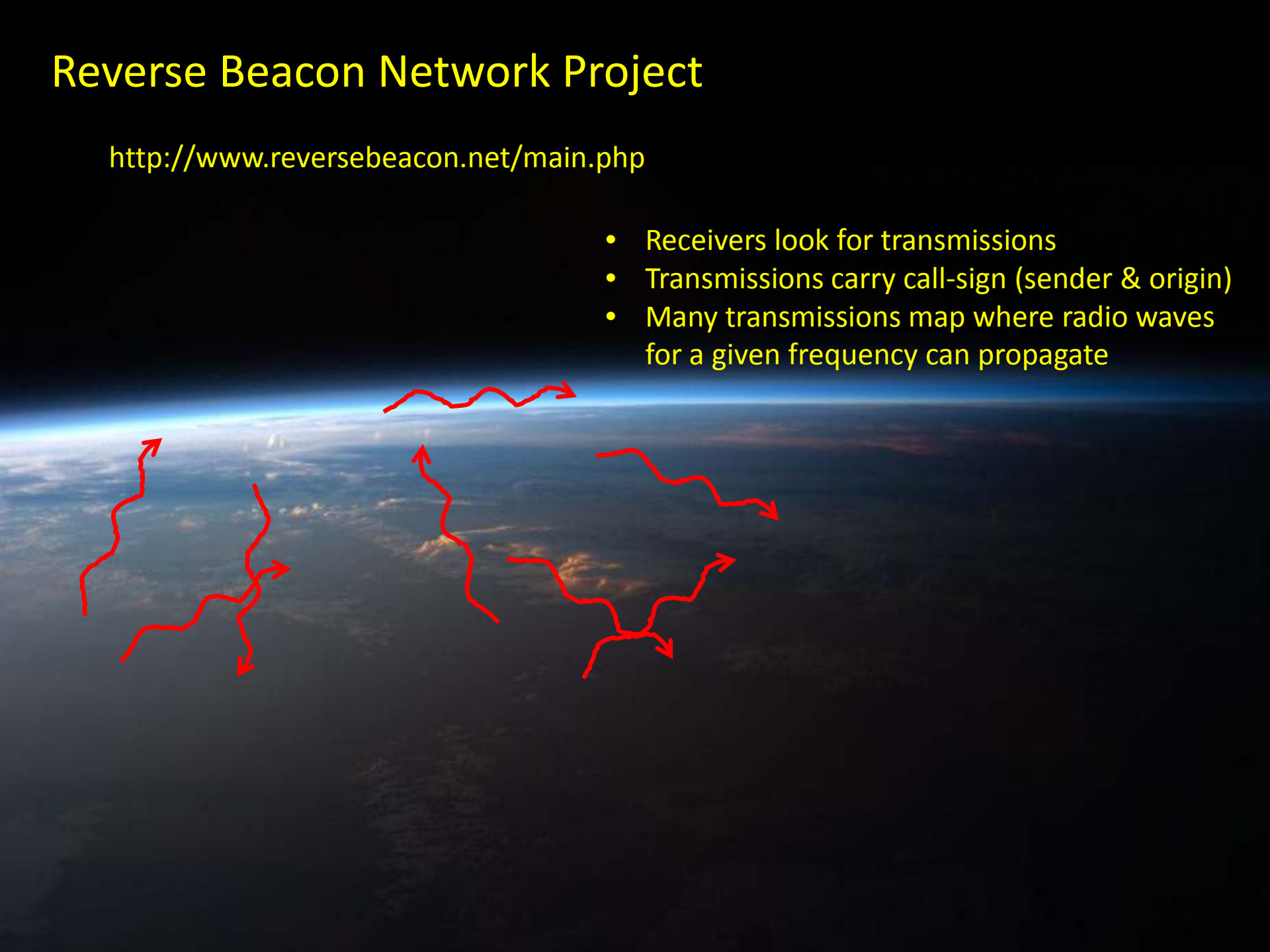
INSPIRE
INTERACTIVE NASA SPACE PHYSICS
IONOSPHERE RADIO EXPERIMENTS

http://theinspireproject.org/

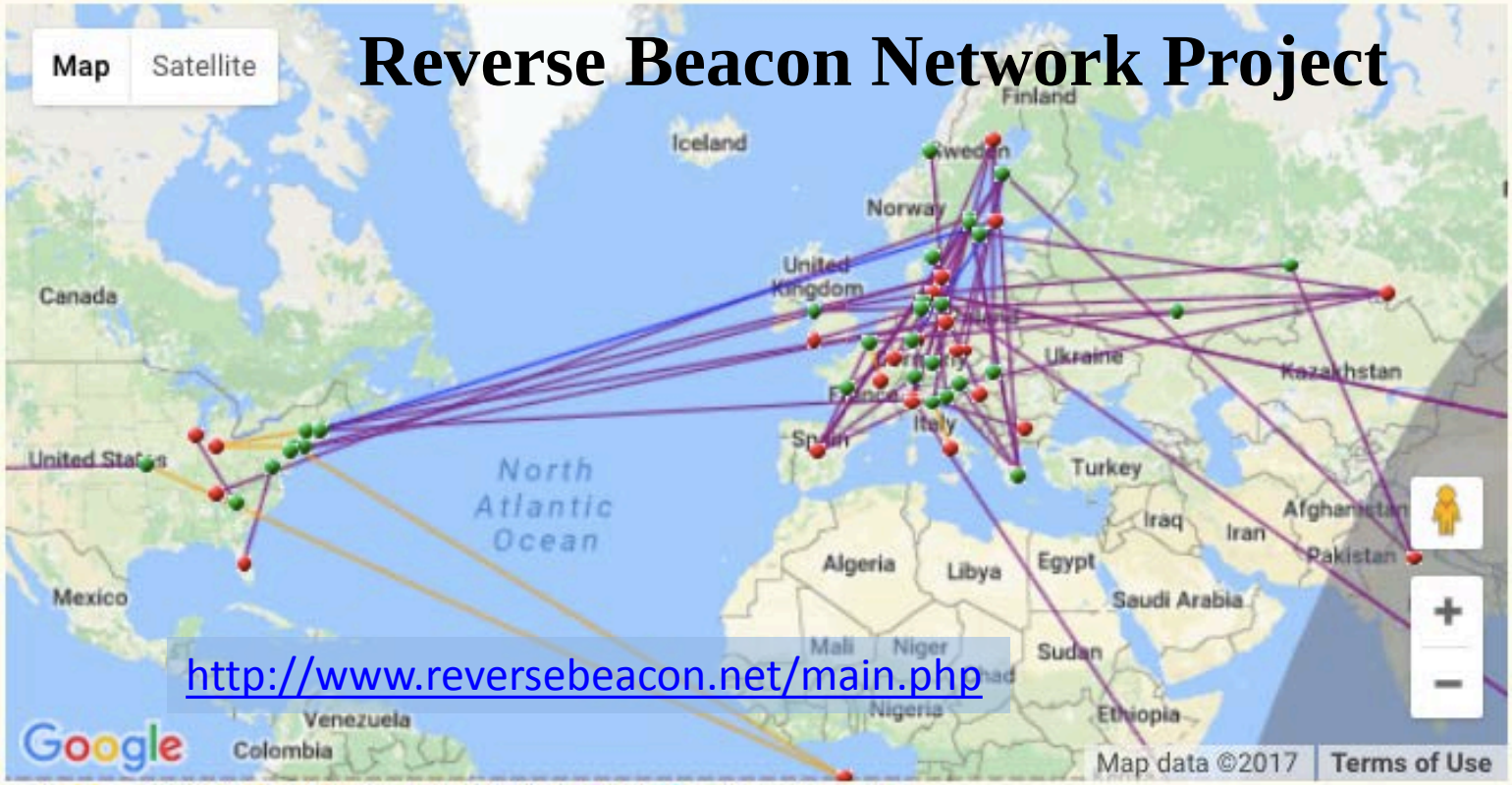
Reverse Beacon Network Project

http://www.reversebeacon.net/main.php

- Receivers look for transmissions
- Transmissions carry call-sign (sender & origin)
- Many transmissions map where radio waves for a given frequency can propagate



Reverse Beacon Network Project



http://www.reversebeacon.net/main.php

/ 160m / 80m / 40m / 30m / 20m / 17m / 15m / 12m / 10m / 6m / 2m

world wide / zoom to US / zoom to Europe / zoom to North Atlantic

show/hide my last filters

no filter selected, showing all spots

search spot by callsign

rows to show: 10

de	dx	freq	cq/dx	snr	speed	time
DL6ZB	SM2YIZ	14014.4	CW CQ [LoTW]	27 dB	25 wpm	1430z 12 Jul
K2MFF-3	W3P	7026.0	CW CQ	8 dB	25 wpm	1430z 12 Jul
HA6PX	SM2YIZ	14014.4	CW CQ [LoTW]	24 dB	26 wpm	1430z 12 Jul
DF4XX	SM2YIZ	14014.4	CW CQ [LoTW]	9 dB	26 wpm	1430z 12 Jul
SV1CDN	SM2YIZ	14014.5	CW CQ [LoTW]	17 dB	25 wpm	1430z 12 Jul
SK3W	I2WEQ	14050.0	CW CQ [LoTW]	11 dB	16 wpm	1430z 12 Jul

options:

show/hide

news

RBN blog: stay tu

we have 132 skimm

skimmers online

3B8CW - 20m
7L4IOU - no spot la
9M2CNC - 20m
9M2ZAK - no spot
9V1RM - no spot la
AA4VV - 40m, 30m
AC0C - 40m, 30m,
BD4WN - no spot la
BG8NUD - 20m
BH4RRG - no spot
DF4XX - 20m
DJ9IE - 40m, 30m,
DK0TE - 40m, 30m
DK3UA - 40m, 30m
DK8NE - no spot la
DK9IP - 40m, 20m
DL3KR - 40m, 20m
DL6ZB - 20m
DL8LAS - 40m, 20
DL9GTB - 80m, 40
DO4DXA - 40m, 30
10m
DQ8Z - 40m, 30m,
EA5WU - 30m, 20
EA6VQ - no spot la

Finally, Let's Talk About Photography

This is a composite image taken by Dr. Alphonse Sterling, NASA/MSFC, on August 1, 2008 in the Gansu Province, China

Images like this don't just happen. Just ask Dr. Sterling sometime. Or better yet, watch "Black Suns: An Astrophysics Adventure"

Until then, how can you take your own pictures?

Review Of These Crucial Steps – 1 and 2

Determine Your Gear - focal length (800 to 1200 mm / f-stop / meter setting / solar filter type

What's your camera sensor's format? Mine is Nikon DX at 1.5x

Camera Tripod or Motor Drive - affects ISO selection a little. Make sure your tripod can point to 63 degrees without obstruction

Practice Now - Take a Range of Exposures By Varying the Shutter Speed of a Full Sun Disk Image with Your Exact Gear Set-up After You Have Selected an ISO

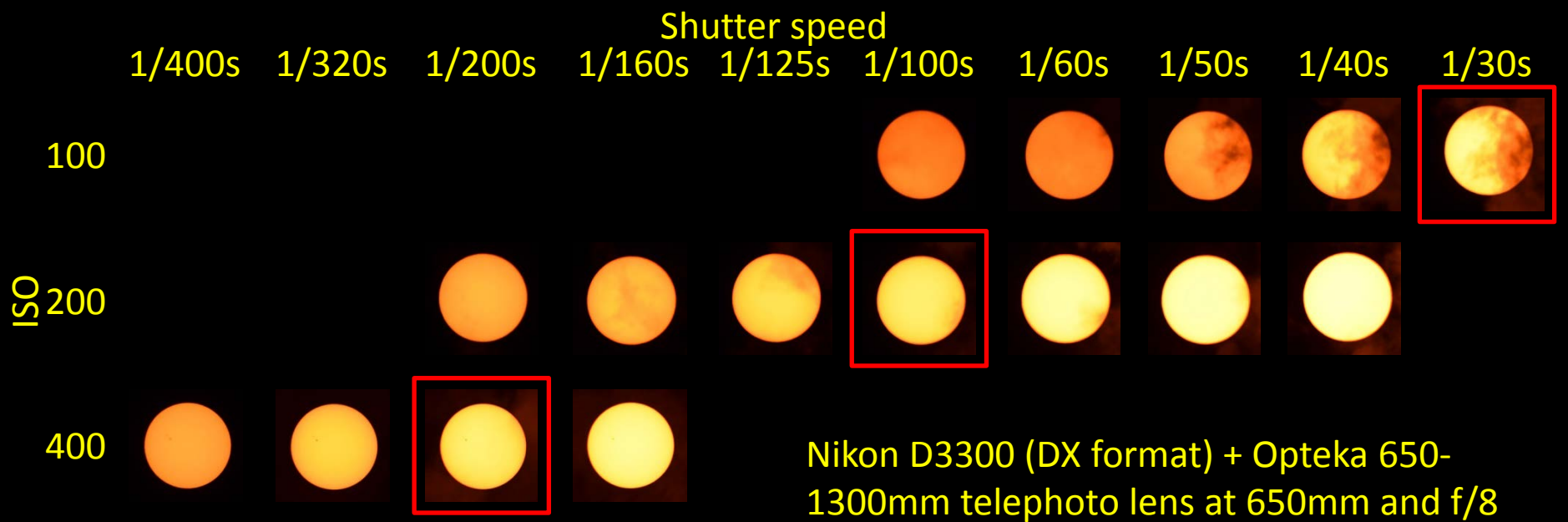
Pick a Shutter Speed of a Nice Exposure of the Full Disk That is Yellow

Your final crescents will need a slightly Slower Shutter Speed to Stay the Same Tone Yellow.

Your Yellow Full Sun Disk Image Exposure Will Be An Exposure That Will Be Good For the Inner Corona in Totality (you have the ability to bracket)

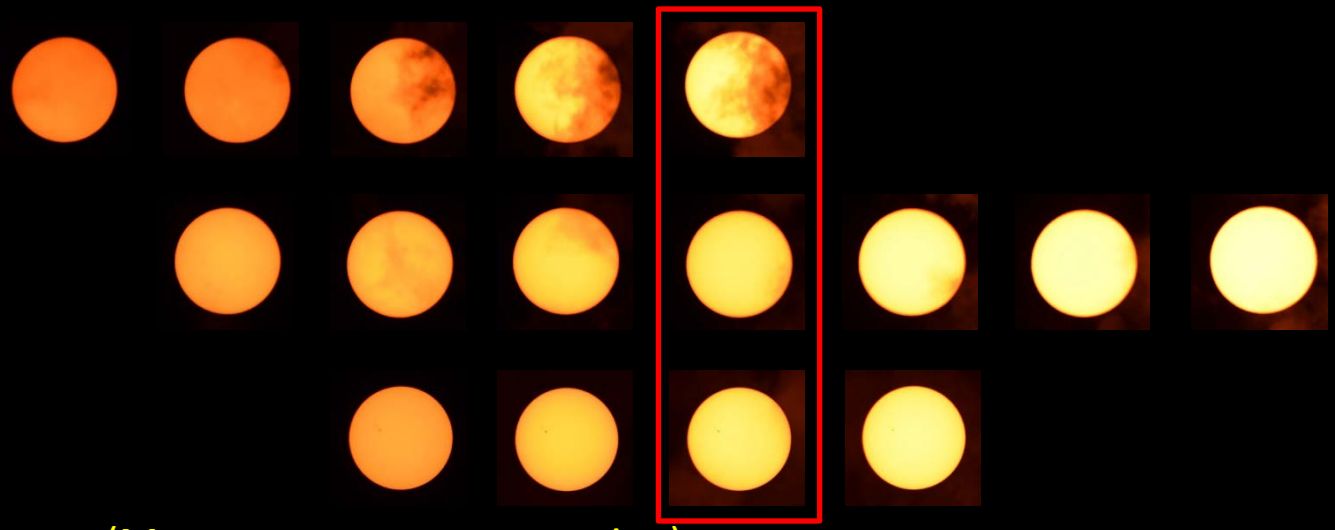
Slides About Eclipse Photography
Curtesy of Dr. Gordon Telepun,
More information can be found at http://www.solareclipsetimer.com

Finding the Full Disk Exposure and Starting Exposure During Totality



Nikon D3300 (DX format) + Opteka 650-1300mm telephoto lens at 650mm and f/8

A direct comparison of effective exposure can be made by sliding each ISO series of exposures until the best vertical correspondence is reached.



(My camera exposure testing)

Review Of These Crucial Steps – 3 and 4

at 2 min before

Prepare For the Diamond Ring Effect and Baley's beads Before 2nd Contact - After your final crescent phase picture set you camera to the faster shutter speed (range 1/500 to 1/2000; depends on your set-up)

Longer exposures were as crescent narrowed

Have a Plan For Removing Your Solar Filters and Where You Are Going To Lay Them Down! Don't bump your tripod!

Timing Is Absolutely Critical! *Our 2nd Contact Time Will Now Be So Much Better Than What I had In Africa*

- 20s before 2nd contact; hands on solar filters
- Remove filters, not later than 10s before 2nd contact; CAREFUL, NOT FOR BARE EYES YET
- Start repeat exposures; Bailey's beads change second to second
- Auto bracket exposures if you can do it

4th Thing: Totality Exposures (2001)

During Totality You Will Take Range Of Exposures. (1000mm, f 12.6, ISO 200)

Then Look With Your Eyes! Let Yourself Experience this Wonder.

1/2 s (un-guided, no motion blur)

Review Of The Crucial Steps

1st Figure out your Sun disk image size, 1.5 disk diameters of padding, 800mm to 1200mm (lock/tape focus and zoom)

2nd Determine your shutter speed for a nice yellow full Sun disk

(final crescent (1 or 2) will need a longer shutter speed) (this is an inner corona exposure also)

3rd Understand that your Baley's beads and diamond ring shutter speed will be 3 to 4 times faster than your yellow Sun disk image

(Know how you are going to handle the removal of your solar filters) (have exact timing)

4th Take a range of shutter speeds for totality

(after totality exposures change setting back ready for Baley's beads and diamond ring) (enjoy totality with your eyes and/or binoculars) (check the horizon, take wide angle shots, NO FLASH)

However You Do It, View the Eclipse 2017!

SAFELY observing THE SUN

WARNING! Never look directly at the sun without proper eye protection. You can ***seriously*** injure your eyes.

Check with local science museums, schools and astronomy clubs for eclipse glasses—or purchase an ISO 12312-2 compliant pair of these special shades!

View the eclipse with special eclipse glasses.

Regular sunglasses are not safe to view the eclipse.

SUN FUNNEL

Inexpensive and easy to build, the sun funnel is a device that completely encloses the light coming from a telescope and projects a magnified image of the sun, large enough for many people to view at once.
http://eclipse2017.nasa.gov/make-sun-funnel