Sunspots with Ancient Telescopes for the New Solar Cycle 25

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Solar Storms and Consequences

The energy stored in Sunspot Active Regions can be released explosively causing dangerous radiation and plasma hurled into space. If Earth-directed, this ‘debris’ from the explosions can have damaging and disturbing effects on our technological infrastructure.
Where Does the Magnetized Solar Wind Come From?

To find out we build Solar Magnetic Field Observatories!

So, we go to sunny California to study the Magnetic Sun

“All the sun, all the time”
Where Does the Magnetized Solar Wind Come From?

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Wildfire look 09/09/2020

Mount Wilson Observatory
Near Los Angeles California

1912

Observer

Solar Magnetogram

Bigger underground than above ground

Solar Dynamics Observatory 2010

“All the sun, all the time”
The 11-yr Solar Cycle

An ‘Active Region’ = Lots of Magnetic Fields

First drawn up by Rudolf Wolf

Magnetic Fields

Sunspot Group

Cycle

Approx. size of Earth
Stars have Spots too

Largest starspot known

Sonne  HD 12545

Ca II light

Some other stars

Sun in Ca II light 393 nm
Centuries of Sunspot Observing

We have observed sunspots with telescopes for 400 years

Galileo Galilei
June 23, 1613

Galileo’s Telescope

Thomas Hariott
1610

Groups

Galileo Galilei

Wolf’s Telescope

Rudolf Wolf
1816-1893

Minimum
January 7, 2005

Sunspots observed by Spacecraft

Maximum
March 29, 2001

‘Compiler’ of Sunspot Number
Still used today

The sunspot number is always determined using small telescopes
Christoph Scheiner
Rosa Ursina, Anno 1630

Helioscope: Projecting the Solar Image
Our Knowledge of Sunspots in the 18th Century is
Based on J.C. Staudach’s Drawings 1749-1799

1134 drawings

13th & 15th February 1760

Early Reconstruction of Number of Groups
The Project

• Find telescopes (from the 18th century or build replicas) with similar characteristics as Staudach’s
• Find people willing to observe, i.e. make drawings of what they see (high precision of positions not needed)
• Make systematic observations over some time (many months) perhaps at least one drawing per week, better daily
• If we can find several people, they can share the load (and also make it possible to assess the ‘error bar’)
• Scan the drawings and communicate them to me (leif@leif.org). Website: https://leif.org/research
• I’ll process the drawings and produce a scientific paper with the observers as co-authors publishing the result
• Benefits: Exposure of ATS (Antique Telescope Society) and providing an important calibration point for the Sunspot Series (real science)
• First observation 14 January, 2016
Optical Flaws in Early Telescopes

Amateurs could not afford achromatic telescopes with composite lenses

(Cost a years salary)

Chromatic aberration

Spherical aberration
Briggs, and (importantly) Staudach simply could not see the tiny groups (in blue circles) with their inferior telescopes.
Reconstructions of the Telescopes

John W. Briggs, Magdalena, NM

2016-03-11

Locarno
Modern Observers See Three Times as Many Spots as The Old Telescopes Show

So, there is no long-term steady increase of solar activity
Our Project has Confirmed the ‘New Sunspot Number Series’

A recent revision (Clette et al. 2014) of the Sunspot Number is nicely validated by our observations.

Factor of three

Comparison J. C. Staudach (by Svalgaard) and SILSO.V2 Relative Sunspot Numbers

$r^2 = 0.93$

$R_{SILO.V2} / 3.15$
Why Is This Important?

1. The Total Solar Irradiance (output of heat) in the past before satellite measurements is reconstructed from the sunspot numbers and is used as input to climate models.

2. Predictions of future solar activity, damaging solar storms, and our general understanding of the sun rely on knowledge about its past behavior.
The Sun is a magnetic star. Its magnetic field affects Earth, by causing space weather that affects our technology. Understanding its formation and effects gives rise to some of the most challenging scientific problems of our time. We present four different exciting advances in the search to understand the consequences and origin of the Sun’s magnetic field.

First, an exciting new result about the origins of hard-to-predict “Stealth CMEs” that can launch from the Sun and impact Earth without an obvious signature at the surface.

Next new insights into the formation of sunspots, produced via strikingly beautiful simulations of the flows inside the star.

Third, understanding the long-term evolution of the Sun’s magnetic field drove one team of scientists to recreate 18th century telescopes in the modern era.

Finally, in the 21st century the titanic four-meter-diameter solar telescope DKIST is nearing completion and will enable new observation of solar magnetism at the very finest scales.

Boulder, June 2016
Conclusions

• Observations with telescopes suffering from the same spherical and chromatic aberrations as we think Staudach’s ‘sky tube’ did, validate the factor of about three that we previously found was needed to normalize the 18th century amateur observations to the modern scale, and hence that there has been no steady increase of solar activity

• When sunspots disappeared at the end of the previous sunspot cycle, my observers got bored and stopped observing

• Now that a new cycle (#25) has started it is time to begin again!

The end