To: AAVSO Solar Section

From: John W. Briggs
john.w.briggs@gmail.com
970-343-0618

Regarding: Svalgaard Project to Re-calibrate 17th Century Sunspot Records

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Hello Friends--

As I described in an email last November 17, I've been involved in an unusually simple sunspot observation project using a reproduction 18th century telescope. The project was conceived by solar physicist Dr. Leif Svalgaard of Stanford University. The goal is to better interpret a particularly important record of sunspot observations by an 18th century German amateur astronomer, the 1,130 sunspot drawings of Johann Caspar Staudach that were made between 1749 and 1799.

The project has drawn surprising attention in the solar physics community. After I described the project to Kristine, she contacted Solar Section leaders about it and encouraged me to produce an article for the March issue of *Reflector.* Sara suggested she could make a web page about it encouraging observers to participate. This document is my effort to supply content for that web page.

I attach a copy of the two-page article from *Reflector.* I was pleased how it came out. It did not go into details, but instead, it was meant to simply engage interest. For observers, the project could not be more simple (if they can make a very simple telescope). Here's a draft of what I envision for the text of the web page. I welcome suggestions from everyone how to improve it:

A Simple but Very Interesting Project in Sunspot Observation

Understanding our Sun's long-term magnetic cycle is among the central concerns of solar physics. While modern observations have become very sophisticated, the simplest historical records of solar activity remain significant. Solar physicist Dr. Leif Svalgaard is among the world's leaders in the field of solar records. A concern, however, was how it might prove necessary to adjust interpretation of a key series of 1,130 sunspot drawings recorded by German amateur astronomer Johann Caspar Staudach that were made between 1749 and 1799.

To better interpret Staudach's drawings, it occurred to Svalgaard that current solar activity could be observed with telescopes similar to the 18th century one used by Staudach. To that end, Svalgaard appealed to the Antique Telescope Society in 2015 to recruit observers able to use 18th century telescopes or simple reproductions of what such instruments were.

As it turned out, very few ATS members had early telescopes available. But it proved easy to make reasonable reproductions of what Staudach used. The German amateur did not record details of his telescope. In fact, he said nothing more about it than referring to it as a *"three-foot sky tube."* But we can reasonably assume it used a single-element objective having a focal length of about a meter, and the drawings were made using eyepiece projection. Compared to modern standard sunspot counts, only

a fraction of the actual spots are recorded with such simple equipment. Understanding that fraction is key to a correct interpretation of Staudach's record!

Dr. Svalgaard describes the project in the following outline:

> • Find telescopes (from the 18th century if possible) with characteristics similar to Staudach's
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> • Find people willing to observe, *i.e.* make drawings of what they see (high precision of positions is not needed)
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> • Make systematic observations over some time (months, or as long as possible) even if only one drawing per week
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> • If we can find several people or more, they can share the load, and also make it possible to assess the "error bar"
>
> • Observers can scan the drawings and communicate them to me (Leif Svalgaard, leif@leif.org). Website: http://www.leif.org/research
>
> • I'll process the drawings and produce a scientific paper with the observers as co-authors, publishing the result
>
> • Benefits: Exposure for everyone participating, while building an important calibration point for the Sunspot Series (real science!)

Initial observers in the project included John W. Briggs, Ken Spencer, and Walter Stephani, all with homemade reproduction telescopes. Briggs described his experience making his telescope as follows:

> The outline for a suitable telescope for the reenactments is necessarily vague. While I still hope to get my hands on an original 18th century "three-foot sky tube," I decided to begin by building something simple from scratch. Perhaps too hasty in my prejudice toward old-time standards, my goal was to build something appropriately rude & despicable. Surplus Shed sold "PL1107," a 30-mm uncoated plano-convex lens, 1,000-mm focal length, for $5. That seemed like a reasonable choice for my re-creation objective glass.
>
> I took my objective and glued it unceremoniously into the middle of a large steel washer. I then glued the washer to one end of a reasonably stout mailing tube of good length. I considered all this a fine start toward an appropriately rude 18th century sky-tube approximation.
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> I then chose an anonymous and undistinguished eyepiece from my optical *junque* catacomb -- an old, small, uncoated two-element ocular of about 1/2-inch focal length. I did not bother to clean it well, in part because I can't open it easily. Another step in the right direction, I thought. After gluing, the clear aperture of my sky tube became about 3/4-inch, so the focal ratio became about f/52.

I was briefly confounded by the problem of a drawtube. I resorted to borrowing a brass one from the Allegheny College 7-inch Clark, circa 1865, the most convenient thing at hand. With quite a number of layers of taped paper to form a collar adapter, the instrument took form, and I got first light through a living room window. The weather was poor, but the telescope worked!

Soon I got a bright clear day and was surprised how well the telescope showed basic sunspots by eyepiece projection. My final step, before I started making solar drawings about 3 inches in diameter, was to attach the tube to a tiny equatorial and devise something to hold paper behind the eyepiece.

At that point in my project, we were hit with a major snowstorm. Snowed-in with 20 inches, we woke early to a very bright morning. The view though our westward window offered countless fantastic artificial stars, glinting from up close to hundreds, if not thousands, of feet away, across a valley. I devised a loop of string to hold the telescope's front end near the window, and I hand-held the other end. The air outside was evidently very still.

I guess I shouldn't have been so surprised to be rewarded by the sight of hundreds of Airy disks. No matter that it was a non-achromatic single-lens telescope and a dirty old eyepiece (and through a window) -- the disks & first-order diffraction rings looked great! My "rude and despicable" telescope was thus a failure. It worked great!

I hope other people will consider building similar "sky tube" replicas.

Unfortunately the inexpensive $5 lens used by Briggs is no longer available. But any simple lens of about 1-meter focal length would be fine. Ideally it should be uncoated. "One diopter" lenses (meaning a focal length of one meter), as used in eyeglasses, would be fine. Edmund Optics has a 750-mm focal length lens (stock #45-282) that would be a good focal length to add to the reproduction telescopes involved in this project. If the lens has a large diameter, as likely the case if made for optometry, it should be stopped down with a mask to about a 1/2- to 3/4-inch aperture. The eyepiece should not matter much, but a very simple one would be best, such as any older 2-element type of about 12- to 26-mm focal length. A draw-tube focuser, possibly using PVC plumbing parts, should allow a projected image of the Sun to be made with about a 3-inch diameter.

Ideally, new observers participating in this project will have telescopes slightly different from the reproductions already in use. Briggs chose a standard 3-inch diameter for his drawing size. Staudach made only 2-inch-diameter drawings. There is no need to record positions with great accuracy, as Dr. Svalgaard is interested in only approximate position and intensity of what's seen. Barely perceived details of penumbral structure, for example, are not necessary to record. Note also that it is wise to pursue this project *ignorant* of what larger modern telescopes are showing of the sunspot distribution! (This point may make the project difficult for people involved in other solar observations, as they'll be forewarned what to expect.)

Anyone interested to pursue this project can contact Leif Svalgaard for general information & encouragement and John W. Briggs for suggestions on the technical aspects of building a reproduction 18th century telescope. John's article describing the considerable scientific interest Leif has generated is in the March, 2021, issue of the Astronomical League's quarterly magazine, *Reflector*, pages 24-25, "A Funny Thing Happened in Solar Physics." A great deal of additional information can be found on Leif's research website, mentioned above.

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A Funny Thing Happened in Solar Physics

(AND A NEW OPPORTUNITY FOR BACKYARD OBSERVERS)

—By John Briggs

Twenty years ago, it was my privilege to serve as a site survey engineer for what became the Daniel K. Inouye Solar Telescope on the island of Maui in Hawaii. The three-year survey gave my family and me the opportunity to live and work at the National Solar Observatory in Sunspot, New Mexico. My daughter, Anna, thus came into this world as a "Sunspot baby." We now look back fondly on our time in that remarkable scientific community high in the Sacramento Mountains. My friend at nearby Apache Point Observatory, Bruce Gillespie, had a background in hands-on solar physics. He said, "everyone should do a site survey once in his life," and I agreed with him.

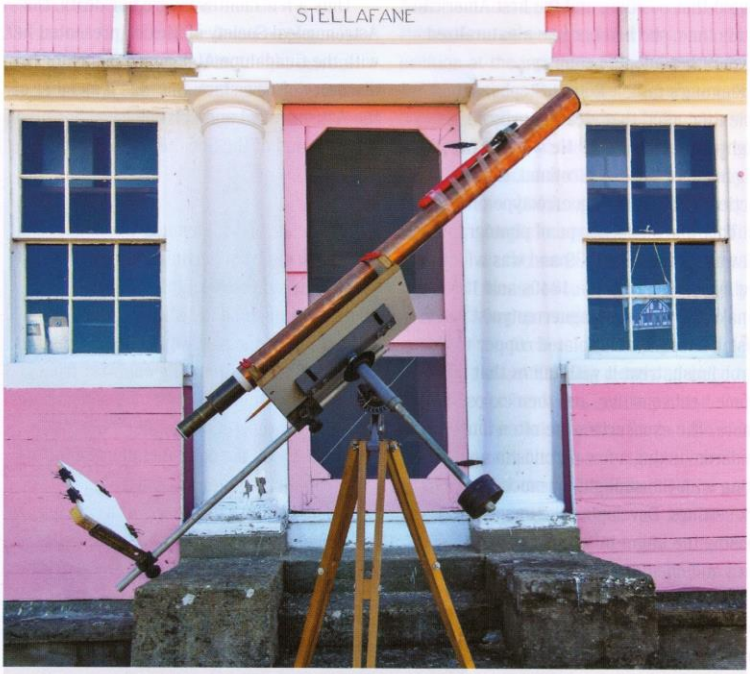
Maui was chosen for the mighty new telescope, an awesome 4-meter clear-aperture reflector that now leads the world in ground-based solar astronomy. Its design and construction were done by a large team of specialists over many years at a cost of over $340 million. Having played "cog in a wheel" early and briefly in this big-science project, I followed its progress with the insight and appreciation that my flirtation with the solar community allowed me. The magnitude of the effort – in cost, time, and talent – always left me in awe.

Flash forward to 2016, and a meeting of the American Astronomical Society's Solar Physics Division in Boulder, Colorado. This was the professional forum where the final construction progress for the amazing new telescope could be reported and celebrated. In a press conference on June 1, 2016, four of the "hottest topics in solar physics at the moment" were selected for special presentation to journalists. Naturally, recent progress of the multimillion-dollar Inouye telescope was included. But, in an evolution beyond anything I could have dreamed, another of the four reports featured an instrument in my own backyard, using an objective lens that had cost me about $5! It was just a fleeting event, but, to me, it was a little surreal.

Credit for the moment was due entirely to solar specialist Dr. Leif Svalgaard of Stanford University. In brief, Dr. Svalgaard had recognized that important eighteenth-century solar sunspot records needed to be better calibrated. A way to do this was to re-observe the Sun now using eighteenth-century instruments or reasonable reproductions of them, and then compare those observations with modern standard sunspot counts.

The matter is important because sunspots are an index of the underlying magnetic activity cycle of the Sun that relates in many ways to the "space weather" experienced by Earth. Proper interpretation of the historical record is very important, and initial results based on data from a small team from the Antique Telescope Society allowed Dr. Svalgaard to propose a significant correction factor. The other observers in our team included Ken Spencer and Walter Stephani.

The observations are simple daily sunspot drawings using a single-element refractor via eyepiece projection. The focal length of the lens can be 20 to 40 inches or so, with a clear aperture of 0.5 to perhaps 1 inch. My own replica of an eighteenth-century telescope uses a 1-meter focal length simple lens stopped to about 15 millimeters aperture. It's glued to a large steel washer that, in turn, is glued to a cardboard mailing tube. To make my tube appear distinguished, I gave it a spiral wrap of copper tape that I had handy. That flourish was unnecessary, but in my case it set the stage for a taped-on Crescent wrench that facilitated balance in declination on a microscopic old Edmund equatorial mount. The mounting might just as well have



This simple homemade single-element refractor with a $5 objective purchased from Surplus Shed was one of three telescopes used by members of the Antique Telescope Society to collect simple sunspot data. The project allowed specialist Dr. Leif Svalgaard to propose a significant correction in the interpretation of eighteenth-century sunspot records. As solar activity now increases, additional observers are especially welcome in the project. Photo at the Stellafane Clubhouse by J. W. Briggs.

been a very simple altazimuth.

The eyepiece for solar projection onto a small sheet of white paper is not critical, but I chose the simplest and most primitive one in my optical junk pile. In fact, heat could damage a fancy multi-element eyepiece. The key is to devise a projected solar diameter of about three inches. The images will then be similar in scale to ones recorded in the 1700s. I prepare sheets of paper ahead of time with a circle drawn using a particular jar lid. Recording the exact positions of sunspots is not required – it's simply a matter of recording the approximate positions of ones clearly seen. Experience teaches that only a few major spots are typically seen with such primitive telescopes.

As solar activity is now increasing, recording spots is becoming more interesting, and Dr. Svalgaard would greatly appreciate additional observers. Some observations have been recorded with true eighteenth-century telescopes, but most potential observers just commit to using homemade reproductions. What is truly surprising is how *engaging and enjoyable* the simple ritual of basic observation becomes, even in this modern world of $340 million solar telescopes! With additional data, solar specialists can become more confident that the historical correction factor now suggested by Dr. Svalgaard should indeed be applied to the early solar records. And in so doing, the project and its observers may again be amused to find themselves attracting attention – even shoulder-to-shoulder with those building and running the grandest instruments of our modern time.

A related web page describing the project with instructions and encouragement will be online at the AAVSO's Solar Section as this article goes to press. See also Dr. Svalgaard's most recent presentation for the Antique Telescope Society, linked here: *leif.org/research/Sunspots-with-Ancient-Telescopes-for-SC25.ppt.* ✷

John Briggs is a member of the Springfield Telescope Makers, and is associated with the FOAH Observatory and The Astronomical Lyceum in Magdalena, New Mexico.

NEVER LOOK AT THE SUN DIRECTLY WITH THE NAKED EYE OR THROUGH ANY UNFILTERED OPTICAL DEVICE!