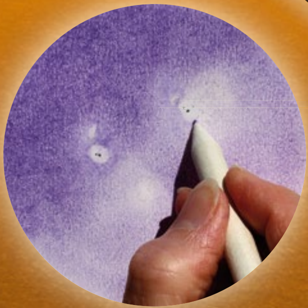
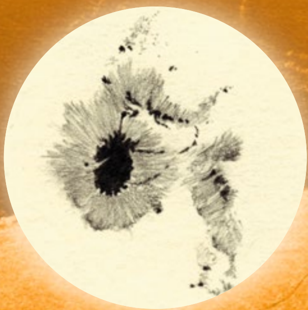
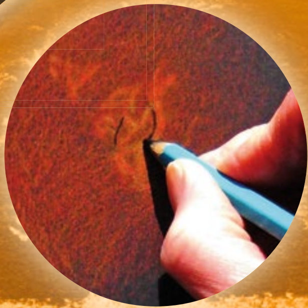
Erika Rix · Kim Hay
Sally Russell · Richard Handy

Solar Sketching

A Comprehensive Guide to Drawing the Sun

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To all who are drawn to the beauty and wonders of our nearest star, may the sunny days be plentiful and your pencils never dull. And to my mother, Suzanne, who shared her love of drawing with her children.

Erika Rix

To Linda, whose eternal light shone through the darkness to help illuminate my path. To Kim, whose heart in laughter restored my smile. To Sally, whose bright vision stayed true throughout. To Chas and the brothers, for the quiet courage to care for a brother when his path seemed uncertain. To Wendy and John, for the strength of spirit to help me hang in there. To Jeff, brother in my heart. To my dear family, for their love and understanding in the difficult times as this book came together. To Steve, for your ear in tough times. To Tim, may your path be in orbit of the Sun. To Tom, for quiet friendship and a common love. To David, your deep love permeates space-time. To Dee, your excitement and energy continue to feed my soul. To Frank, for enduring kindness, and a heart with a hand to match. To Erika, who never lost sight of me. To Sol, for being the genesis of my writing. To Rony, may your path wend through the stars. To Jeremy, when words fail to express it, your sketches do. To Linda and Roland, deepest love for hearts of compassion. To Rocky and Cathy, the faithful ones who provided me peace in moments of conflict. To Michael, who opened my eyes to astronomical sketching and opened my soul by your friendship. To Mom, whose spirit is embodied in the sacred stratigraphy and the ancient bird, now one with the living spirit. To Grandpa, on whose knee I am still listening, and to the Great Spirit of which he sung. Thanks and my best always.

Richard Handy

To Iris, with love and thanks for always being like a Mum to me.

Sally E. Russell

This book is dedicated to everyone who turns their face to the Sun, feels its warmth, and opens their mind to the wonder of the universe. To Kevin, my soul mate, your constant support and encouragement have kept me grounded and focused. And finally to Sara, my daughter, my Sunshine always.

Kim Hay

Preface

Less than 20 years have passed since the arrival of relatively low-cost, narrowband filters and dedicated solar telescopes to the marketplace. This affordability has opened a new window for solar observing and allows even casual amateur Sun gazers the opportunity to directly witness filaments, faculae, and active regions upon the face of our star as well as huge, arching prominences along its limb.

In conjunction with traditional white light-filtered, projection, and spectroscopic methods, amateur solar observing seems to have come of age. Two major approaches exist to document these phenomena—by utilizing cameras or by creating a sketch at the eyepiece. Both can produce superb results when skillfully applied, although a pencil and paper, along with an eye-hand-brain connection, are all that is needed to create a drawing. And that can be a very personalized experience. In addition, the more one engages in the act of sketching, the more refined one's observational abilities become. Subtle details, unnoticed with a quick inspection, can be recognized and recorded accurately using the straightforward procedures and simple techniques presented in this book. However, before we begin, a great benefit can be obtained by examining the past.

Beyond their artistic value, historical sketches of the Sun are a valuable resource for scientific studies of solar activity cycles and have been for the course of almost three centuries. As Randall Rosenfeld, RASC archivist attests:

"Observers have been sketching the Sun, its features, and phenomena through glass since nearly the dawn of the telescopic age. Thousands of historical solar sketches survive from the Enlightenment in the early seventeenth century, to the first age of astrophysics in the eighteenth century, and through (the modern age of astrophysics in) the twentieth century. Not only is this observational legacy of significance for those building astrophysical models of solar behavior through time, but it can also be a resource for modern astrosketchers endeavoring to refine and extend their craft.

"Earlier drawings present a range of techniques, some of which are relatively unfamiliar to contemporary astrosketchers (due to the astronomical conventions of the period)…past perceptions of solar phenomena may provoke an unanticipated glimpse of the Sun in a new light." This helps us understand how styles of historical solar sketches relate to the development of both the science and the technology available at the time. Rosenfeld continues, "It is useful to cultivate the habit of looking carefully and critically at observational art as a counterpart to patiently looking with discernment through an eyepiece."

Our modern understanding of past archival methods, coupled with a broad scientific insight into the materials that were used at the time, answers most questions relating to physical historical sketches. However, time spent exploring the digital archives of earlier sketchers' work, to witness *how* they were drawn in the past, will pay dividends when considering sketching techniques to record the modern Sun.

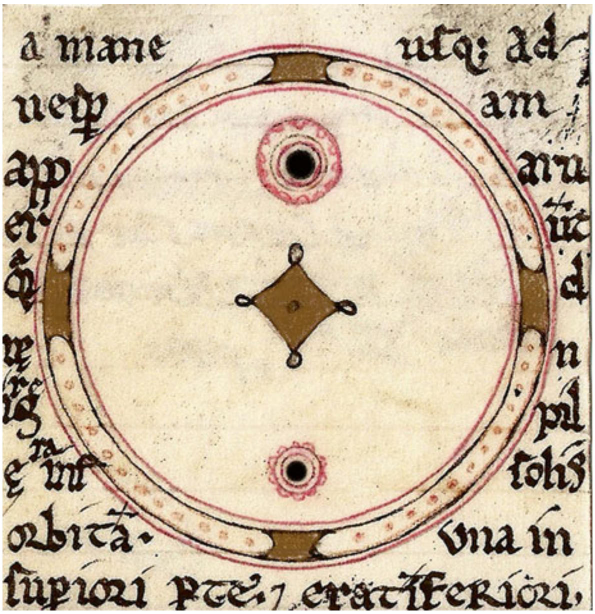

Fig. 0.1 Earliest known sunspot drawing, from *The Chronicle of John of Worcester*, circa 12th century. Prior to that, no actual drawings of sunspots were known to exist, and this illustration is thought to be the sole surviving sunspot drawing until the Chinese sunspot drawings in the 1400s. The naked-eye observation was December 8, 1128, Worcester, England. The description included, "...from morning to evening, appeared something like two black circles within the disk of the Sun, the one in the upper part being bigger, the other in the lower part smaller. As shown on the drawing." Sketch media consisted of ink, minium, and gold leaf on parchment, quill pen, and compass. For more information, see R.A. Rosenfeld, "Perception and Reflection: The Earliest Image of Sunspots?" in *JRASC* 108, 5 (2014 October), pp 211-213. (Image courtesy of *Specula astronomica minima*, image after Corpus Christi College, Oxford)

For more information on the history of astronomical sketching, an assortment of historical sketches is provided throughout this book with commentary from Rosenfeld. There is also a selection of references that we hope will be of use to you.

Liberty Hill, TX, USA — Erika Rix
Yarker, ON, Canada — Kim Hay
Wokingham, Berkshire, UK — Sally Russell
Jacumba, CA, USA — Richard Handy

Acknowledgments

Erika Rix

Rich, Kim, and Sally, thank you for embarking on this venture with me. Your expertise, hard work, and dedication were invaluable in seeing this project through to the end. I shall miss our numerous Skype meetings where business wasn't conducted without friendship and laughter thrown into the mix. For amateur astronomers involved in outreach or who gladly share their knowledge and techniques so that others may learn, thank you. You are the cornerstones of the astronomical community and appreciated beyond words. And to my husband, Paul, you'll once again start receiving your meals on time. Thank you for your everlasting support and patience during my astronomical endeavors.

Richard "Rich" Handy

Words do not convey the deep respect and admiration that I have for the principal coauthor and dear friend, Erika Rix. Her consistent and kind attitude of support and encouragement along the way made this book a possibility. Similarly, the dedicated and often exhaustive labors of my great friend and fellow astro artist, Sally Russell of the UK, gave me great heart to finish this book. Kim Hay has done a remarkable and tremendous job pulling together and expressing the science aspects of solar sketching, and besides that she is a hoot when she speaks of the Sun and Canadian weather and how it affects her observations.

There is a singular and remarkable website that has been the crucible of a number of new books on amateur astronomy. That website is Cloudy Nights. A number of us got our start there, and it has always been a comfortable place to lay our astronomical hats (and art tools, I suppose) while discussing our avocation. Without CN's support, there would be few opportunities to share our efforts. To the current amateur astronomy periodicals and magazines, thank you for extending the value of visual observation through wonderful astronomical sketching articles and columns.

There are two other individuals I would like to mention. Charles "Chuck" A. Wood has always encouraged sketchers to submit their work for inclusion on his website, LPOD (Lunar Photo of the Day). Thank you sir! And to my quietly spoken, yet deeply profound friend, Thomas Watson, thanks indeed.

To all contributors, the deepest respect for your techniques and your sketches.

Sally Russell

In my experience, solar astronomy is synonymous with *social* astronomy, as it's a pastime greatly enriched by sharing. So to start with, I must say a big thank you to Ian for enabling my first ever views of the Sun in Hydrogen-alpha, which ignited my passion for solar observing and started me on my solar sketching journey. My heartfelt thanks to my friends Erika, Rich, and Kim for working tirelessly to make sure that this project came to fruition. It has been an honor and a pleasure to work with you. To amateur astronomers everywhere who so generously share their time, expertise, and the fruits of their labors to inspire and encourage others, thank you. To my fellow astronomers with whom I've shared views of the Sun on so many happy occasions—Malcolm, John, Martin, and Peter, to name just a few—thank you for your splendid company, knowledge, and enthusiasm. Special thanks to my husband and son, Adam and Cameron, for supporting me in all my astronomical passions. And last but not least, for sheer exuberance and the generous sharing, and loan, of untold amounts of fabulous solar kit without which some of the tutorials in this book would not have been possible, my deepest thanks go to John, solar astronomer extraordinaire!

Kim Hay

Erika, Rich, and Sally, thank you for the honor and privilege to be able to share this wonderful opportunity to collaborate with you. Bringing solar sketching and science together, using your expertise in the various observing and sketching mediums, helps to show others how sketching can be fun, educational, and rewarding, and how this can contribute to solar science. I have truly enjoyed our Skype meetings and online discussions. Someday, hope to meet you all in person.

Thank you to all our contributors who, with their knowledge in specialized fields, helped to bring this book together. Also, thank you to many of my friends in solar astronomy circles who have provided answers to my many questions.

Thank you to the person reading this book. In your hands, you have a wealth of knowledge from many amateurs and professionals in the various fields, giving you an insight into solar sketching and observing techniques on how to capture the Sun. You have a piece of history in your sketching portfolio—welcome to data collection and science. Go observe the Sun, enjoy!

The four of us wish to thank the people and organizations whose contributions made this book possible. A special acknowledgment is for Randall Rosenfeld, RASC Archivist, for the use of the RASC historical solar sketches and excerpts from his terrific article, "Learning from the Past." Thanks to our sketch and tutorial contributors, Dr. Jean Barbeau, Lennart van Sluijs, Juanchin Perez, Peter Grego, André Vaillancourt, Jeremy Perez, Alan Strauss, Dr. Hannák Judit, Deirdre Kelleghan, Jeff Young, Maurice Toet, Roel Weijenberg, Michael Rosolina, Les Cowley, Stephen W. Ramsden, Stratos Tsanaktsidis, Cindy Krach, and Serge Vielliard. Thanks to Tara and Emily Krzywonski for their help with photos for the Sunspotter tutorial and for the use of their Sunspotter outreach photos. Thanks to Dragan Nikin for the solar hood image, to David Knisely for his prominence classification artwork, and to Tony Broxton for his sunspot sketches for science. Thanks to Rik Hill for his *Zürich/McIntosh* classification images and to Michael Boschat for assistance with the BAA sunspot formulas. Special thanks for the use of solar sketching templates to Lyn Smith and Hazel McGee of the British Astronomical Association, to the Association of Lunar and Planetary Observers, and to The Astronomical League.

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Contents

Chapter 1

Introduction to Solar Observing and Sketching

The Sun represents one of the most challenging and exciting astronomical objects to sketch. Noticeable changes can occur very rapidly, and the view is never the same twice. Regardless of where your interests lie, from the occasional view to daily sunspot tracking, or rendering the subtle complexity of prominences, the following techniques, hints and tips will help guide you to accurately sketch the Sun's ever-evolving features.

Warning!

Never look directly at the Sun with unaided eyes. While solar observing, do not use binoculars, finder scopes or telescopes unless they are dedicated solar telescopes or have been properly fitted with solar filters from reputable manufacturers. The consequences of even a brief view, particularly through an unfiltered telescope or finder scope, could result in severe eye damage or blindness.

Unless your finder scope is fitted with a solar filter, it should either be removed or covered to prevent both eyesight injury and damage to the instrument.

Before diving straight into sketching, it is worth reviewing the basics of solar equipment and observing. Also included are tips that we have picked up along the way.

E. Rix et al., *Solar Sketching*, The Patrick Moore Practical Astronomy Series 178, DOI 10.1007/978-1-4939-2901-6_1

1.1 Basic Equipment

Equipment should be tailored to the needs and preferences of each individual. So let's consider the essentials and how they may apply to you.

1.1.1 Filters

Sketching the Sun in white light can be completed using several types of solar wedges and thin film acetate filters. In the past, projection techniques were used predominantly, and this method is still going strong today, especially during outreach events. Nowadays, thanks to the advent of thin film depositing technologies, polyvinyl acetate sheets can easily be obtained to fit large telescopes that otherwise would be impractical to use for projection. These thin filters come mounted in a metal ring, or you can purchase a sheet of the film to construct your own.

Multi-coated glass white light filters and energy rejection filters (ERFs) are also available. An ERF is designed to filter ultraviolet and infrared light so that light from the visual spectrum can pass through.

Band pass filters selectively reject most of the continuous solar spectrum and only allow through the light that occurs in a defined range of frequencies. Hydrogen-alpha (H-alpha) is perhaps the most frequently used band pass filter because it permits light from the chromosphere, where ionization of the hydrogen gases above the photosphere is emitted, to be viewed. These types of filters can be obtained separately or in the form of dedicated H-alpha telescopes as seen in Fig. 1.1.

Some manufacturers offer Calcium (Ca) II band pass filters in the K and H lines, which are similar to the H-alpha filters, except that the frequency of the radiation they selectively filter allows light from the calcium absorption line of the solar spectrum to be viewed. Because the K-line is at the far end of the visual frequencies, the light is more difficult to see visually. The H-line, however, is closer to the visible spectrum. As a result, it produces a brighter image at the eyepiece and is often the filter of choice for that range of frequencies.

Finally, a Sodium (Na) D-line filter is also available. It can be used to study super granulation and flare eruption kernels in the surface layers of the Sun.

Warning!

NEVER USE EYEPIECE SOLAR FILTERS! Some telescopes still come with solar filters that either screw into or are fitted over the eyepiece. The intense heat of the focused sunlight could cause them to crack during use, resulting in possible blindness. We recommend that the eyepiece filter be destroyed and thrown away to prevent anyone from using it.

Fig. 1.1 Internally double-stacked Coronado Maxscope 60 mm, 400 mm focal length, Hydrogen-alpha dedicated solar telescope. (By Erika Rix)

1.1.2 Telescopes

White light solar observing can now be done with just about any telescope type or design. Some designs are easier to use due to their portability, ease of set-up, and viewing comfort. Because of their size, refractors are the clear favorite, along with small reflectors. Refractors can be easily transported, the set up time is minimal, and the height of a typical mount can be adjusted to allow for either a standing or sitting position for viewing comfort. Because atmospheric turbulence, which is associated with daytime observing, is rarely good enough to allow full useful magnification with even modest-sized telescopes, large telescopes can seldom be used to their potential for solar observing.

1.1.3 Mounts

Mount choice for solar sketching is often dependent on the telescope's field of view (FOV) and your ability to keep the Sun, or its observed features, within that field for the duration of your observation. For example, short focal length, wide-field refractors often have a wide enough FOV that the observer can see the entire solar disk with plenty of room to allow for a slow drift, with only the occasional nudge to bring it back into view. As such, a manual-adjusting alt-azimuth mount will work just fine, with only a few corrections of its position required during a sketch.

Warning! ALWAYS use a suitable filter when directly observing the Sun

Keep in mind, however, that as the magnification increases, the FOV shrinks. The power required to discriminate fine details within the solar structures means that the Sun will appear to move quite rapidly across the FOV. Therefore, unless you are willing to make constant bumps in its position, following these features will prove difficult. And if you are making these adjustments, it will distract your concentration.

Consequently, equatorial mounts, or computer tracking mounts, are an ideal solution for sketching within a small FOV at high power. Equatorial mounts are designed to align one of the rotation axes of the telescope to the Earth's axis of rotation. By rotating with the axis, this motion through the field is eliminated and the feature will stay centered in the FOV throughout the course of the observation. Computerized tracking telescopes are basically computer driven motorized alt-azimuth mounts that make use of tiny movements of stepper motors to keep the telescope on target.

1.1.4 Eyepieces

Most eyepieces are interchangeable between nighttime and daytime observing. There are, however, eyepieces made specifically with solar observing in mind. Lunt Solar Systems manufactures flat-field eyepieces with 0.1 % anti-reflective coatings that reduce the ghosting and glow often seen around the Sun through an eyepiece. Similarly, Coronado CEMAX eyepieces have multiple-coating materials to enhance contrast in the H-alpha band pass region and eliminate internal reflections and scattered light. They also offer a 2x CEMAX Barlow.

Zoom eyepieces are handy when seeing is turbulent; adjustments for best magnification can be made quickly without the need to swap eyepieces. For the projection method of solar observing, use an inexpensive, simple eyepiece. Avoid those with plastic parts or cemented lenses, as they can become hot and melt while using.

1.1.5 Observing Chairs

Muscular strain can be a serious distraction while sketching. A good observing chair will help mitigate this stress during the course of your observation, allowing increased concentration at the eyepiece. There are several manufacturers and each have their pros and cons, but we recommend that the chair be variable in height with a relatively quick and secure adjustment. Be aware that some observing chairs require a hard, level surface for stability, so consider the ground where you frequently observe.

If you are seated high above the ground, try using a short step stool to raise your legs to a more comfortable position. Your lap can double as a sketching platform.

1.1.6 Media

No two media are the same. Each has unique qualities that should be taken into account when choosing the materials for a specific type of sketch. What archival qualities does it have? Will the drawing bleed or remain crisp? Will it tolerate erasures or combined media? Think about its blending characteristics, textures, colors, and messiness.

Consider the varieties of paper available for sketching the Sun. For instance, the texture (tooth) of the paper can be used for photospheric granulation or the mottled appearance of the chromosphere. Black paper preserves the dark adaptation necessary for H-alpha observing. White printer paper is inexpensive and readily available in most homes.

1.1.7 Templates

Plotting sunspots and other solar features within a blank sketch circle is very similar to plotting a star field. Visualizing a clock face, gridlines, or even cross hairs in both the field of view and the sketch circle helps. Using a template is even better.

The Sun has heliographic coordinates for longitude (L_o), latitude (B_o), and the position angle (P_o) of the solar rotation axis. Because sunspot locations are measured in degrees from these coordinates, using a template featuring gridlines or degree markings can help observers plot sunspots with higher accuracy. When using a template, it is important to match its orientation to that of your telescope. Also keep in mind that sunspots rotate onto the Sun from the east and rotate out of view to the west.

Three common templates are the Stonyhurst disk, the Porter disk, and a solar grid. Each is a guide tool that can be placed under your sketch paper. If you prefer to sketch directly on the template, simply create a photocopy for that purpose. A selection of templates is available for your use in Appendix A.

The angle of Earth's orbit varies just over 7° north and south of the Sun's equator throughout the year. This is represented by the heliographic latitude of the center of the Sun's disk. If the Sun's north pole is tilted toward Earth, B_o will be in positive degrees; tilted away from Earth, B_o will be negative. There are eight Stonyhurst disk templates, one to represent each ± degree variant, including 0°. Latitude of ±40° and longitude are included in grid format.

The range of dates associated with the Sun's apparent tilt is printed on the templates. Choose the template that corresponds with the date of your observation. Likewise, you could refer to the B_o value on an ephemeris.

For example, when observing at 13:00 UT on February 9, 2014, B_o is –6.57 from the Lat/Long coordinates inputted on the *TiltingSun* freeware program by Les Cowley (Fig. 1.2). The correct Stonyhurst disk to use for that observing date, time and location is the date range of February 9 through April 1 at –7°. The template will need to be rotated so that the correct date range is at the top (Fig. 1.3).

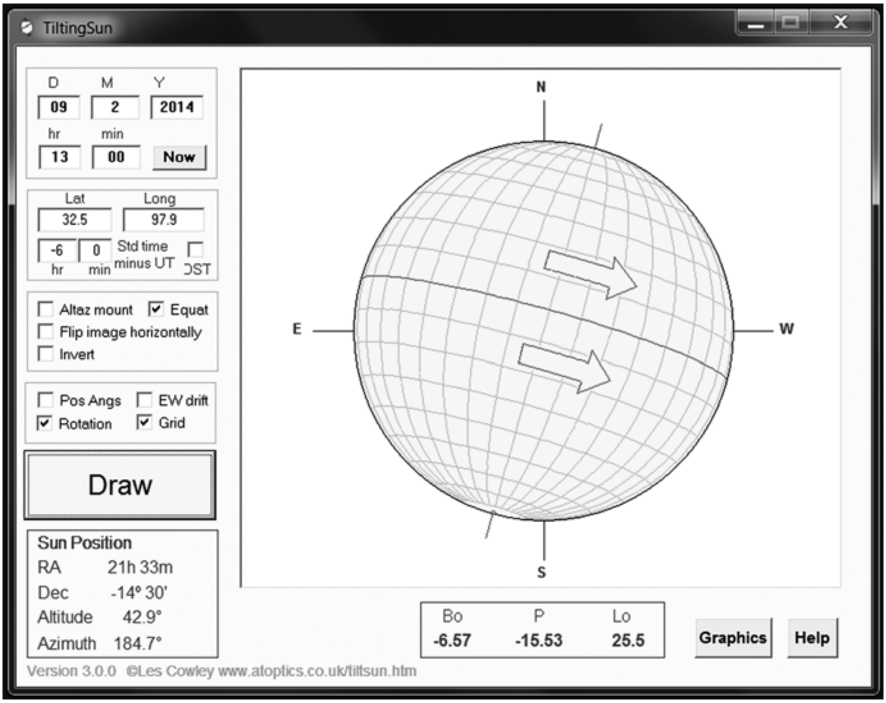

Fig. 1.2 Screenshot of *TiltingSun* freeware program by Les Cowley demonstrating heliographic coordinates for longitude (L_o), latitude (B_o), and the position angle (P_o). www.atoptics.co.uk/tiltsun.htm

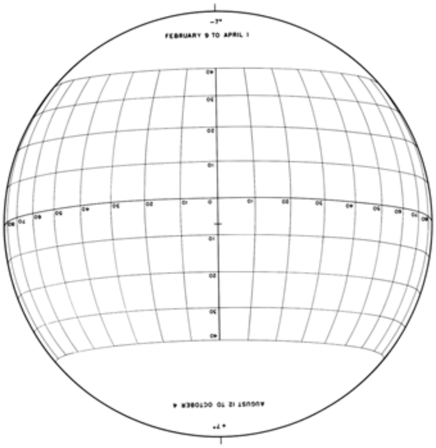

Fig. 1.3 Stonyhurst Disk 7°. (Shown by kind permission of the British Astronomical Association. www.britastro.org)

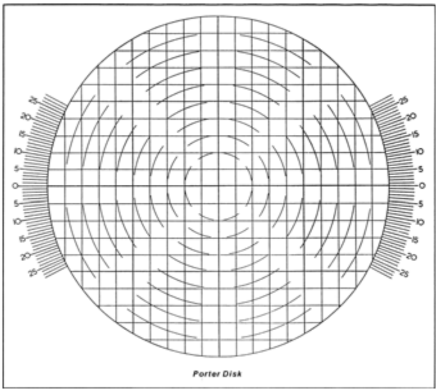

Fig. 1.4 Porter Disk. (Shown by kind permission of the British Astronomical Association. www.britastro.org)

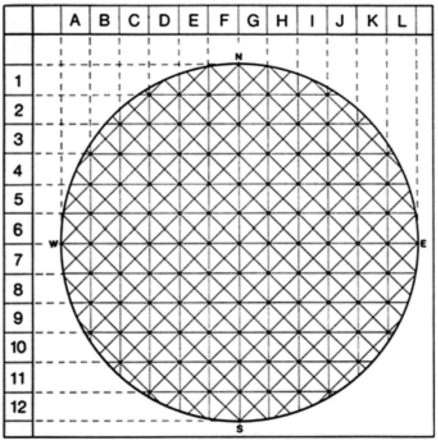

Fig. 1.5 BAA Solar Grid. (Shown by kind permission of the British Astronomical Association. www.britastro.org)

The Porter disk uses concentric circles for the locations of sunspots with degree markings on the western and eastern edges (Fig. 1.4).

The solar grid is marked in a graph arrangement with numbers down the *Y*-axis and letters across the *X*-axis (Fig. 1.5).

Creating daily sunspot sketches provides you with a first-hand view of the Sun's immense power and sunspot morphology. You will gain an understanding of how the upper layers of the Sun move with respect to its rotation and may even witness re-emergences of large sunspot groups!

Warning! ALWAYS use a suitable filter when directly observing the Sun

1.1.8 Solar Cloths

You are probably familiar with the idea of dark adaptation when observing at night—keeping extraneous light to a minimum to help with image contrast—but you might not have realized that it is also useful to keep the glare of the Sun to a minimum when solar observing to achieve similar benefits. The use of a cloth over your head when at the eyepiece, particularly when observing in H-alpha and CaK, will make a big difference to your observing experience and allow you to see finer detail in the image.

When using a solar cloth it helps to hold its edges together under your chin to block any glare from the ground, and if your cloth is big enough, you might be able to carry out your sketch while underneath it!

Making a solar cloth is straightforward, particularly if you have access to a sewing machine. The finished cloth needs to be black on one side (the *inside*) and white on the other (the *outside*) when the cloth is in use. The white surface will reflect the Sun's heat and light, not only reducing glare but also correspondingly making solar observing a cooler, more comfortable experience. Extra weight can be added to the cloth's corners so that it won't blow around in windy conditions.

Black and white double-sided fabric (where the white side is actually a blackout layer) is usually available from curtain fabric outlets and manufacturers. If commercial double-sided fabric cannot be obtained, then use white "blackout" curtain lining fabric stitched back-to-back onto a medium-weight black fabric instead.

Suggested Materials

- A piece of black/white double-sided fabric, approx.1 yard squared
- Black thread
- Four small curtain weights

(Note: In the figures, the dotted lines indicate the position of the *first* fold made along each edge.)

Step 1

Lay out the fabric with the white side facing upward and turn a ½-in. hem along one edge. Press with a warm iron to reinforce the fold, and then pin to hold (Fig. 1.6). Repeat for the remaining three edges. At each corner, unfold the fabric and snip out the triangle of excess fabric as shown (Fig. 1.7).

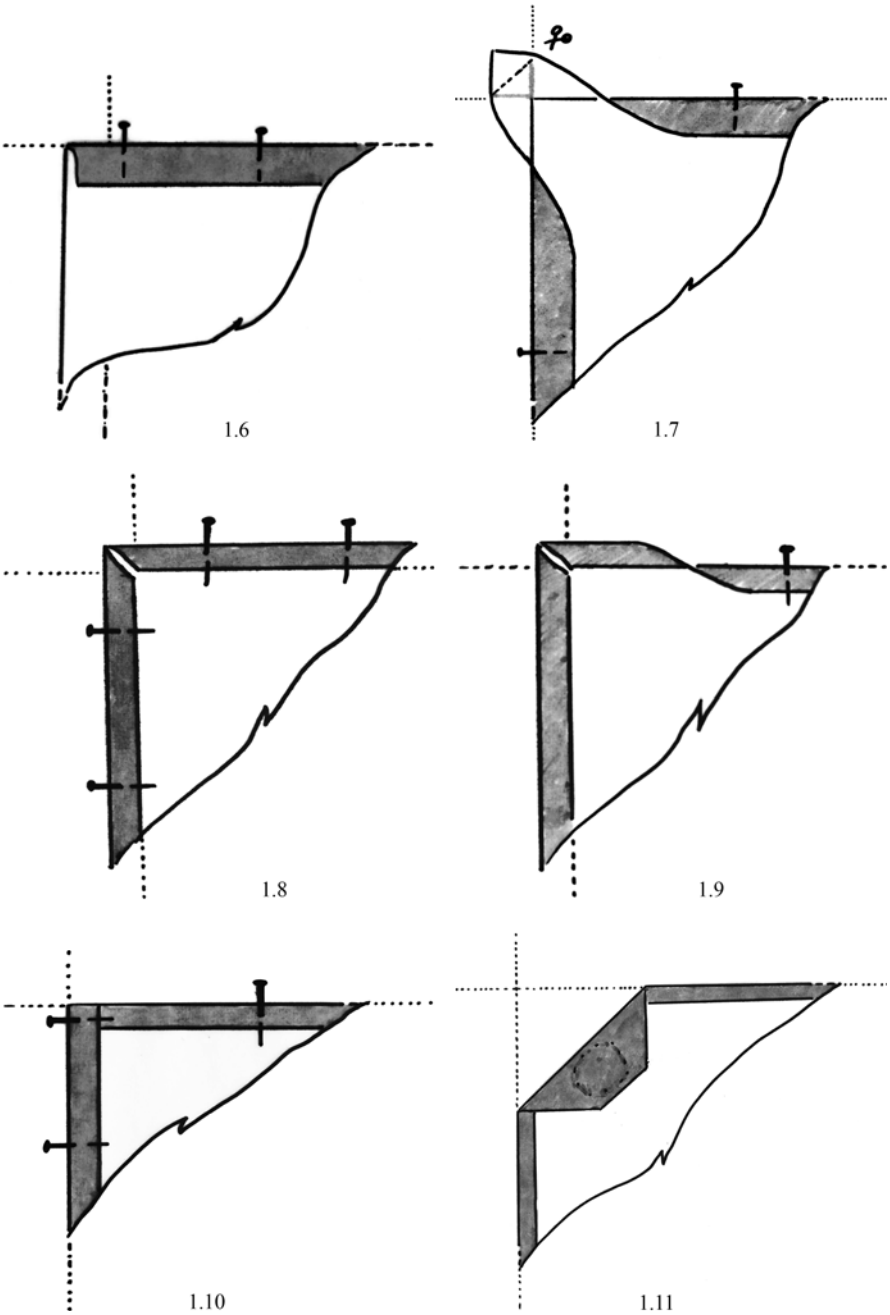

Fig. 1.6–1.11

Warning! ALWAYS use a suitable filter when directly observing the Sun

Step 2

Remove the pins and unfold the hems, then re-fold the fabric along each edge so that the raw fabric edge now touches the first fold line. Pin to hold. The hem will now be half its original width and the corners should lie flat, as they will be mitered (Fig. 1.8).

Step 3

Now fold the fabric along the original fold line again so that the raw edge of the fabric gets tucked underneath for a ¼-in. wide double-thickness hem (Figs. 1.9 and 1.10). Press with a warm iron and pin in place. Repeat for each edge.

Step 4

Using a medium-length stitch size (approx. 1/16–1/8 in.), machine stitch centrally along the length of each hem. Sew in any loose ends of thread.

Step 5

With the white side uppermost, place a small curtain weight approximately 1 in. from a corner, and then fold the cloth over to enclose it, tucking the point of the fabric underneath the weight. Stitch around the edges of the folded area containing the weight so as to hold it in place (Fig. 1.11). Repeat for each corner.

Figure 1.12 demonstrates how a drawing board can be placed under the solar cloth while rendering the Sun. Very little light is allowed through the opening above it so that the drawing can be seen while still preserving the dark adaptation needed to observe in H-alpha.

If sewing doesn't appeal to you, Dark Skies Apparel manufactures unique, quality observing hoods and vests that are designed with pockets to hold spare eyepieces, pencils and glasses. They offer versions specifically made for solar observing! (Fig. 1.13) (www.darkskiesapparel.com).

Another option is the TeleGizmos TGSO solar observing hood. It also uses a dual-layer design. The outer layer's aluminized surface reflects the Sun's light to keep you cooler. The opaque inner layer shuts out the daylight to improve the views. The hood is large enough that it slips over the rear end of the telescope in front of the focuser and forms a tent over the eyepiece holder to shield you from the Sun. It is equipped with Velcro closures to keep the cloth in place (www.telegizmos.com).

Fig. 1.12 Combining the use of a solar cloth with a sun shield preserves dark adaptation for sketching the faintest prominences. The sketch board is easily placed under the cloth with enough ambient light to sketch by. (By Erika Rix)

Fig. 1.13 Solar observing hood by Dark Skies Apparel. Solar observing vests are also available for purchase. http://www.darkskiesapparel.com/ (Courtesy of Dragan Nikin, Illinois, USA)

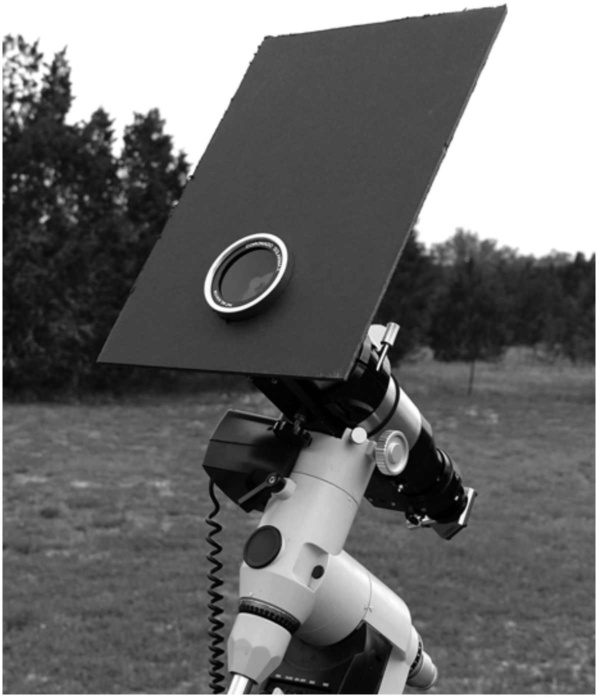

Fig. 1.14 Homemade sun shield fitted over a 60 mm Coronado Maxscope. (By Erika Rix)

1.1.9 Sun Shields

Sun shields block direct sunlight from the eyepiece. They are easily made and fit snug over the optical tube assembly (OTA) (Fig. 1.14).

Suggested Materials

- Black foam board, 20″ × 30″ × 3/16″
- White color pencil and graphite pencil
- Compass
- Tailor's tape measure