Preface

There is now more interest in observing the Sun than ever before among amateur astronomers. Go to any major astronomical meeting or convention and you will see at least one solar telescope in action, and it is sure to draw a crowd. The Sun indeed has much to offer the amateur astronomer with modest equipment. On most days, it shows sunspots and other features that display a wealth of fine detail and change their appearance strikingly from day to day. But observing the Sun can be dangerous. *Never look at the sun through an ordinary telescope or other optical aid, even for a brief instant*. The Sun's intense radiation, amplified and focused by a telescope, will almost certainly cause eye injury and could well lead to complete blindness. Do not attempt *any* solar observing until you have read and understood the safety precautions and observing advice set out in Chap. 2 of this book – even if you think you have the correct equipment. Be especially wary about using filters to observe the Sun. If you have a filter that makes the Sun look dark, it is not necessarily safe, as it is largely the Sun's invisible radiation that is harmful to the eye. However, provided you use the correct techniques, such as projecting the solar image onto a screen or using a specially designed high-quality solar filter that fits over the telescope aperture, it is quite easy to observe the Sun safely.

One of the joys of solar observing is that useful observations are possible even with very small telescopes – such as the small refractors, Schmidt–Cassegrains, and Maksutov telescopes – that are readily available off the shelf. In fact, due in part to the fact that the Sun has more than enough light, a small telescope can actually give better results than a large one! Observing the Sun is also not affected by light pollution, a major advantage for the many amateur astronomers whose view of the night sky is obscured by the glow of streetlights and security lighting. The Sun can be observed from a busy town just as successfully as from the remote countryside.

Our nearest star is studied intensively by professional astronomers and is monitored around the clock, using space-based observatories as well as telescopes from the ground, and both the level of research and the equipment required to carry it out are far beyond the amateur's means. Therefore, solar observing does not offer the potential for discoveries or making major scientific contributions, like some other branches of amateur astronomy, such as supernova hunting or variable star observing. But monitoring solar features and keeping careful records of them is still important. Throughout the world, many amateur astronomers systematically monitor the Sun and send their observations to solar observing organizations for analysis. Monitoring levels of sunspot activity is particularly useful, as it continues a long series of observations made with small telescopes since the nineteenth century, which provide by far the best long-term record of solar activity that we have and is vital to our understanding of the Sun's behavior and any effects it might have on Earth's climate. More observers are always welcome in these sunspot counting programs. Solar photography is also useful, as it has considerable educational value. Professional solar images tend only to show small parts of the Sun or show our nearest star at invisible wavelengths, where its appearance is radically different from that in visible light. Amateur images, on the other hand, portray the Sun more realistically and so are more meaningful to the wider public. Indeed, as well as amateur astronomers, this book is also intended for those bringing astronomy to a wider audience, such as professional scientists engaged in public outreach activities, which are increasingly important in the present age of budget cutbacks, when scientists are under increasing pressure to bring their subject to the public and justify its value to the taxpayer.

The first edition of *How to Observe the Sun Safely* (Springer, 2003), was mostly written during 2001. But since that time, solar observing – and amateur astronomy as a whole – has undergone radical changes. The most fundamental of these has been the digital revolution and the almost complete substitution of digital imaging for film photography. The first edition had a chapter on digital photography, but the book's main emphasis was on 35-mm work. Digital cameras were still in their infancy: their resolution and exposure capabilities were modest, and they were difficult to use with telescopes.

Digital SLRs did exist, but they cost over $2,000, putting them out of the reach of most amateurs. And no one had thought of using a webcam, costing (and weighing) less than an eyepiece to take high-resolution images. All this has now changed. Digital SLRs now start at under $500 and take better images than their 35-mm predecessors, with all the benefits of digital imaging – the ability to see and evaluate your results on the spot, and no more waiting to finish a roll of film and have it developed.

At the same time, amateurs are routinely using webcams to take images of sunspots and H-alpha solar features with a resolution once reserved for professional observatories. Another revolution has taken place in the affordability, and availability, of telescopes and filters for observing the Sun in H-alpha. In 2001, the revolution was beginning, with the appearance of the Coronado SolarMax 40, the first "sub-angstrom" H-alpha filter to be available for under $1,000. And, since then, the

revolution has continued. Now, some solar telescopes costing as little as $500 can show spectacular solar features that before 2001 would have required instruments costing five to ten times as much. Two other companies – Lunt and Solarscope – have appeared and are producing high-quality H-alpha filters and telescopes, as has a revived DayStar (long the only source of sub-angstrom H-alpha filters for amateurs), with the result that the amateur now has a vast and potentially confusing array of equipment to choose from.

Therefore, there is all the more need for an up-to-date guide to show the amateur what to look for on the Sun, how to record observations, and what equipment to use. This second edition is aimed at the amateur who knows the basics of astronomy and wants to know how to go about observing the Sun. What is emphasized is what is possible using commercially available equipment that is easy to get hold of in most parts of the world. For this reason, I have deliberately eschewed some specialized topics, such as observing the Sun's radio emissions, which requires homemade equipment and a fair amount of technical know-how. Neither do I discuss in much detail the Sun-related topics of eclipses and the aurora. Both are major fields in astronomy by themselves, and some good books on them have already been published.

Throughout the book, the emphasis is on *practical* solar observing – what *you* can do with ordinary equipment, provided you take the proper safety precautions. I have tried to avoid unnecessary theory and have not attempted detailed scientific explanations, as these are available elsewhere. Rather, this book is intended as a basic guide to give the amateur a taste for observing our ever-changing nearest star, in the hope that he or she will explore further.

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