This is a guide to the use of the most popular type of telescope in the world, the 20-cm (8-in) Schmidt–Cassegrain telescope. This compact instrument revolutionized amateur astronomy and astrophotography, and more than ten thousand are purchased each year. Peter Manly, a devotee and keen user of the Schmidt–Cassegrain, takes the telescope owner through all aspects of using the telescope in easy stages. It starts with techniques for viewing the Moon, then takes the observer through our planetary system, and on to the deep sky, where nebulae and galaxies are treated extensively. There are interesting projects to try, such as observing the nearest star and chasing eclipses. A full range of telescope accessories and detectors is described, together with advice on their use, and suggestions for projects. The 40-page appendix is packed with practical information that is hard to find elsewhere, arranged in ten separate sections.

Peter Manly designs astronomical instrumentation, as well as small computers and sensors for the aerospace, defense and astronomy industries. He is also a freelance astronomy, computer and aviation writer, and has contributed to dozens of books, journals and magazines.

The 20-cm Schmidt–Cassegrain Telescope

A practical observing guide

THE 20-CM SCHMIDT–CASSEGRAIN TELESCOPE

A practical observing guide

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Preface

When Simon Mitton of Cambridge University Press first suggested this book at the 1991 Riverside Telescope Maker's Conference, I didn't think he was talking to me. For years I'd been primarily concerned with all manner of odd-ball optical devices from satellite tracking systems to airborne telescopes as a professional astronomer. Then it finally sank in that after I'd finished my employer's work I'd go home and drag my trusty little 20-cm Schmidt–Cassegrain (S–C) out in the back yard just to have fun. For a decade and a half it has been part of our family, affording many hours of pleasure and not a little education for my children who have progressed from barely crawling to college entrance exams in the interim.

I believe I saw my first catadioptric telescope[1] during preparations for the International Geophysical Year in the late 1950s. In those days only professionals could own such a glorious and expensive machine. I was disappointed that we students would have to use smaller telescopes to track the yet-to-be-launched first artificial Earth satellite. But I did get to look through the shiny blue and white painted 'professional' telescope at times and I vowed that one day I would have one for my very own. Two decades would elapse before I could purchase a used 20-cm S–C.[2]

[1] Catadioptric telescopes use both mirrors and lenses as opposed to refractors which use lenses only and reflectors which use mirrors only. The corrector plate at the front end of a Schmidt–Cassegrain (S–C) acts as a lens and thus the type falls under the general heading of a catadioptric telescope which also includes Maksutov telescopes and Schmidt cameras.

[2] In astronomy there exists a rift between telescope designers/builders and telescope observers. Telescope makers have been known to sneer at those who use "store bought" instruments. Often it is said that the only mark of intelligence is the ability to grind and polish (manually) a quarter wave mirror. Indeed, I have done so and it is an exhausting educational experience. On the other hand, it has been quipped that the mark of stupidity is to grind and polish a second mirror.

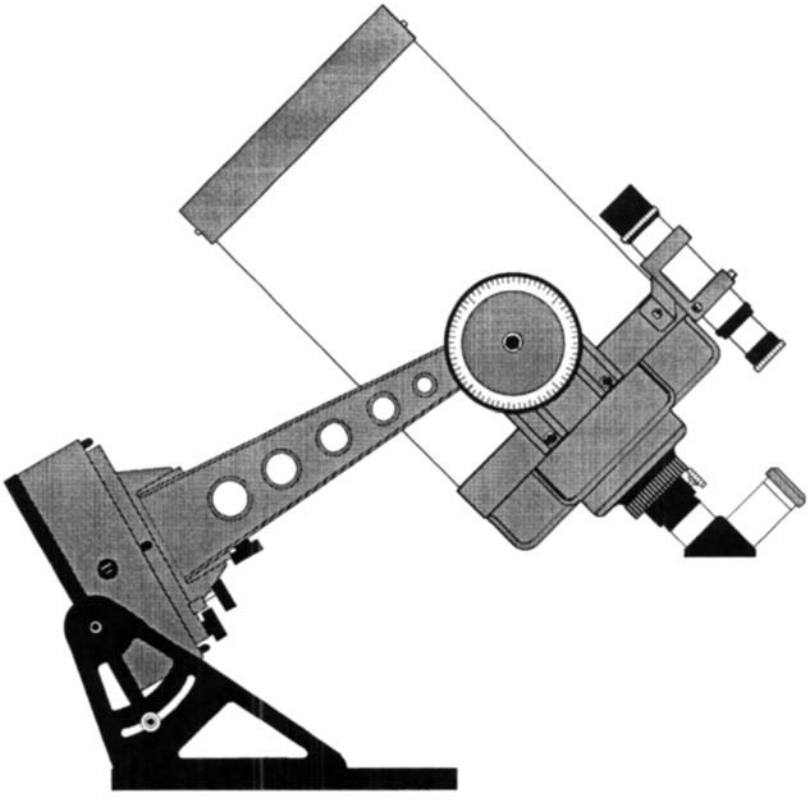

Figure 1. The classical Schmidt–Cassegrain

The aperture of a 20-cm diameter[3] telescope has an area of 314.16 cm². Any Schmidt–Cassegrain (S–C) telescope design, like all telescopes, is an engineering trade-off, applying sound design principles to the problem of observing the sky at a reasonable cost.[4] Newtonian telescopes generally have better wide-field performance at about half the price (per centimeter of aperture) of an S–C but they are physically bulky and not as easy to operate

[3] 20 cm equals just about 8 inches (7.874 015 748 inches, to be more exact) and for those readers who insist on using the archaic English measurement system, the aperture area is 4.87×10^{-9} square miles.

[4] The discussion of which telescope type is best has raged for many years. Typical is a set of articles by Harry D. Jamieson in the *Journal of the Association of Lunar and Planetary Observers* (ALPO) starting in Volume 35, Number 4, December, 1992, p. 181. Throughout the next four issues, letters debating the point appeared. At the time of writing I await the next issue which will probably continue the discussion.

as the S–C. Refractors are reputed to have better narrow field performance on planets and double stars (although a properly adjusted S–C usually challenges most refractors' performance at a fraction of the cost).

The S–C is a general purpose astronomical instrument, capable of superb views for amateur[5] observations and able to turn out professional results in the hands of an experienced astronomer. Like any optical and mechanical system, its design is a series of compromises between performance and costs. Commercial telescope manufacturers have the added pressures of maintaining high optical and mechanical quality while remaining competitive in price. The large commercial market for a good 20-cm S–C has forced the several manufacturers of the type to work hard at producing a high quality, affordable telescope.[6] Competition in the free market has thus reduced the cost of a 20-cm S–C from a 'professionals only' instrument to one which can be purchased by nearly any amateur.

This is not a comparison shopper's guide since I'm not going to tell you which manufacturer's telescope to buy for your observing program.[7] I haven't the foggiest idea of what your observing program is. And your program may shift emphasis as time passes. Don't worry that your astronomical interests may drift, causing you to buy some new type of telescope. The S–C is capable of handling a wide variety of observing programs. You can also modify your telescope and add accessories to handle may different types of observations. The second reason that I'm not going to recommend a specific telescope brand is that, with a little care, any competent manufacturer can make diffraction limited 20-cm diameter f/10 optics.[8] The

[5] The word amateur comes from the Latin 'amator' which means 'lover'. Reference *The Cambridge Astronomy Guide*, by Bill Liller and Ben Mayer, Cambridge University Press, 1985, p. 9. Thus, an amateur observes because he loves the experience. A professional, by definition, is one who is paid to work. It has often been quipped that only the most dedicated professional astronomers can ever achieve the status of amateur — one who truly loves astronomy and who would observe without remuneration.

[6] It is estimated that between 75 000 and 100 000 20-cm S–C telescopes have been made by the several manufacturers.

[7] Readers familiar with 20 cm S-C telescopes may note that one particular manufacturer's model is shown in most illustrations. It is neither better nor less expensive than any competitor's models. That one just happened to be handy when I needed illustrations.

[8] The diffraction limit of optical resolution is a function of the diameter of the aperture. Once the optical figure of the mirror is good enough that the glass is better than the diffraction limit, then any further polishing will not increase resolution. An increase in resolution will require an increase in the diameter of the whole telescope.

differences between scopes will be in the mounting, ruggedness, accessories, auxiliary fittings and, occasionally, optical coatings.

I will assume that you have read the telescope owner's manual. Maybe you haven't memorized it but you've run your eyes down the pages at least once. I'll assume you know the differences between planets, moons, asteroids, comets, stars and galaxies. Similarly, the system of measuring brightness in magnitudes and position in celestial coordinates should be understood, although they may be new and unfamiliar just now.[9]

The book is organized along the lines of learning something about your telescope and then applying it to a specific observation. While later chapters generally cover the finer points of telescope operation and more difficult observing tasks, you do not need to cover the chapters in numerical order, although it is recommended. The observing programs are designed to introduce the observer to many of the mundane objects in the Universe. In addition, special attention is paid to the more bizarre objects in the celestial zoo such as the brightest quasar, the star with the fastest proper motion[10] and (for Southern Hemisphere observers) the star which is closest to our own Solar system. We will examine a stellar nursery where stars are being born as we look at them and will look at a failed star which, if it had more of the right stuff, could shine like the Sun but as it is, just glows weakly in the infrared.

The book will discuss typical telescope performance with instruments operated by normal people at easily accessible observing sites. Occasionally, I will discuss the limit of performance but that refers to perhaps ten mountain peaks in the world on two or three nights of good seeing per year when operated by one of a handful of professional observers who are well

[9] There are various coordinate systems in use. This book shall concentrate on right ascension and declination, an Earth-oriented system, with an occasional excursion into altitude/azimuth coordinates when discussing mount alignment. Many astronomers use galactic coordinates, a spherical system oriented to the disk of our local galaxy. For those of you who intend to wander the galaxy while observing, write me and I can give you a handy little computer program to convert RA/Dec to galactic coordinates. If you intend to leave the home galaxy while observing, you're on your own.

[10] The proper motion of a star, asteroid or comet is its velocity North, South, East or West on the sky. It may also have an additional velocity component toward or away from us but that is referred to as its radial motion.

[11] Theoretically, a 20-cm telescope should allow an observer to see stars of Mv 14.2 according to *ASTRONOMY Magazine*, Nov. 1991, supplement, p. 9.

rested, breathing pure oxygen and have been dark adapted since last Tuesday.[11]

Just how faint an object can you expect to see with a 20-cm S–C? If your eyesight is average then maybe a twelfth or thirteenth magnitude star.[12] Galaxies, nebulae and comets are a little more difficult to estimate because their brightness is usually specified as the total amount of light which they emit but they're not point sources. Their visibility depends on their surface brightness and the eyepiece magnification which you use. It will also depend on the sky brightness at your observing site and your own visual acuity in discerning low surface brightness phenomena. You should at least be able to see all of the hundred or so objects in the Messier Catalogue with your 20-cm S–C telescope (providing, of course, that they rise above your local horizon).

If you've just purchased your 20-cm S–C and the sky is getting dark, I suspect you want to play with your new toy and you don't want to be sitting inside reading some book. Grab your owner's manual, review the parts about setting up your telescope and then head outdoors. Look at the Moon, find a planet. At least let the telescope see first light. Later, you'll learn some of the finer points of observing but for now, get out into the shadow of the telescope.

[12] The limiting sensitivity of a 20-cm telescope with one of the newer Charge Coupled Device (CCD) TV sensors is about Mv 17.5 although detection of Mv 20 stars has been reported. See the letter by Anthony Mallama in *Sky & Telescope Magazine*, February, 1993, p. 84.

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Many people have helped in the preparation of this book but because it draws upon a couple of decades of observing with a 20-cm S–C, almost every astronomer I have ever met has contributed some small bit of knowledge.[13] Several individuals, however, have taken an active interest in the book. They include Mark Coco, Alan Hale and Tom Johnson of Celestron International, John Diebel and Scott Roberts of Meade Instruments Corporation, Raul Espinoza, Bruce Hoult, Gene Lucas, Chris Marriott, Gary Mussar, Joe Perry and Chris Schur.

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[13] The first two astronomers I ever met were not professionals in the business. My Dad, a civil engineer by trade, dragged me out of bed one morning to observe a partial Solar eclipse and got me hooked on the sky. Mr Edwin Eide, a teacher, showed me that astronomy is an organized body of knowledge which is alive with researchers pushing at the frontiers of knowledge. He also taught me that this is a good working definition of Science.