Chapter 6

Catadioptric Telescopes

Maksutov-Cassegrain

While the invention of the refractor and reflector occurred within roughly half a century of each other, there was no new form of astronomical telescope to appear on the scene for nearly another three centuries. The idea then dawned on telescope designers/makers of combining the attributes of both the refractor and the reflector into a single system, which became known as the *catadioptric* (or compound) *telescope*. In 1930 Bernhard Schmidt used a thin aspheric corrector plate on a fast Newtonian reflector to flatten and sharpen the field for wide-angle photography, giving birth to the Schmidt camera. Then a decade later, Dimitri Maksutov combined a thick meniscus lens with a Cassegrain reflector to greatly improve both visual and photographic performance, resulting in the *Maksutov-Cassegrain*.

In this system, light entering through the meniscus lens is corrected for the inherent errors of the steep spherical primary mirror. The converging light cone from the primary is then reflected up the tube to a secondary mirror mounted to the back side of the meniscus. In a modification of this scheme known as the *Gregory-Maksutov* invented by John Gregory in 1957, the secondary mirror is actually an aluminized central spot on the back surface of the meniscus itself. Many instruments marketed today as a Maksutov-Cassegrain actually use this system and are, therefore, technically a Gregory-Maksutov (Figs. 6.1 and 6.2).

Introduced by Lawrence Braymer in 1954 after more than a decade of development and testing, the Questar 3.5-in. f/14 Maksutov-Cassegrain became the world's first commercially available catadioptric telescope. (It also holds the record for having the longest continuous production of any telescope in the world—now well over

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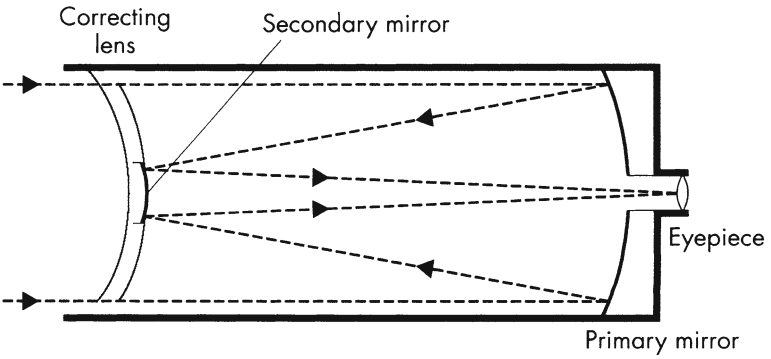

Fig. 6.1 The optical configuration and light-path of a catadioptric telescope. One form is the popular and widely-used Schmidt-Cassegrain, which employs a thin aspheric corrector plate or "lens" to eliminate the aberrations of the spherical primary mirror. The other main type of compound telescope in use today is the Maksutov-Cassegrain, which substitutes a thick steeply-curved meniscus lens for the corrector plate as shown here

Fig. 6.2 The legendary Questar 3.5-in. Maksutov-Cassegrain catadioptric, long considered to be the finest small telescope ever made. This beautiful instrument is truly a work of art, both optically and mechanically. It's seen here in its table-top altazimuth mode, but it also has legs to tip it into an equatorial position. An engraved star chart (which rotates) on the outer barrel slides forward, serving as a dew cap and revealing an engraved map of the Moon on the telescope's actual barrel. A flip-mirror finder that works through the main eyepiece and a flip-in/out Barlow lens are some of its other unique features. Courtesy of Questar Corporation

half a century!) This exquisite instrument is as much admired for its beautiful precision-machined tube assembly and table-top fork mounting as for its unsurpassed optics. Originally priced at about $900, the basic 3.5-in. Questar today goes for over $4,000, making it a telescope mainly for the affluent stargazer and collector. (It can also be found occasionally on the used market for about half that amount.) A 7-in. version and a 12-in. custom-made observatory model are also available at significantly higher prices.

In the 1990s, Meade introduced what is essentially an affordable version of the Questar with its ETX-90 3.5-in. f/13.8 Maksutov-Cassegrain for around $500! This was soon followed by 4-in. f/14 and 5-in. f/15 models, and a 7-in. f/15 was eventually added to the line. The three smaller scopes were all priced under $1,000, and the 7-in. for around $3,000. Such economy of pricing for what had traditionally been very costly instruments is a result of Meade's pioneering mass-production of precision-quality optics. The ETX has become so popular that two entire books devoted to its use were published in 2002: *Using the Meade ETX* by Mike Weasner (Springer) and *The ETX Telescope Guide* by Lilian Hobbs (Broadhurst Clarkson & Fuller) (Figs. 6.3 and 6.4).

In 2001, Orion entered the field with its StarMax 3.5-in. f/14 Maksutov-Cassegrain priced at about $300, plus 4- and 5-in. models running around $400 and $600, respectively. Among other companies offering these highly popular compact instruments (in apertures all the way up to 16-in.) are Astro-Physics, Orion UK, TEC (Telescope Engineering Company), LOMO (Lenigrad Optical and Mechanical Enterprise), Intes, and Intes Micro. The last three are Russian manufacturers, which seems most appropriate since the Maksutov was originally invented there!

Schmidt-Cassegrain

The most popular and best-known catadioptric system is the *Schmidt-Cassegrain* telescope (or SCT, as it's often referred to). It combines a thin aspheric Schmidt corrector plate to compensate for the aberrations of a fast spherical primary mirror in a Cassegrain-style instrument, with the secondary mirror mounted to the back side of the plate itself. Celestron's founder Tom Johnson introduced the first commercial version to the market in 1970. This was the Classic C8 fork-mounted 8-in. f/10 on a sturdy but light-weight field tripod, which eventually replaced the 2.4-in. (60 mm) refractor as the best-selling type of telescope in the world. (There were earlier versions of the Celestron SCT in 10- and 16-in. apertures, but these were quickly replaced by the C8. They are occasionally still found offered on the used telescope market today.)

In addition to the C8 itself, 5-, 9.25-, 11- and 14-in. apertures (known as the C5, C9.25, C11, C14, respectively) were added to the line. (Celestron also made a limited number of 22-in. SCTs for private observatories. The author once spent several nights at a mountaintop site looking through one of these gems—the views of deep-sky objects through it were nothing short of astounding!) A variety of unique

Fig. 6.3 The standard Questar's big brother—a 7-in. Maksutov-Cassegrain. At double the aperture, it has twice the resolution and four times the light-grasp of the smaller instrument, but also much greater cost and weight. Courtesy of Questar Corporation

computer-driven altazimuth single-arm fork and traditional German equatorial mountings are offered, from basic Go-To systems known as "NexStar" to state-of-the-art GPS systems. Prices today begin under $1,000 for the basic 5-in., while the 8-in. computerized NexStar goes for around $1,400. The advanced GPS model 8-in. is priced at $2,000 and the 11-in. at under $3,000. Prices for both the 11-in. and 14-in. SCTs mounted on hefty German equatorials begin at well over $3,000, with the top of the line C14 going for nearly $6,000. Celestron's newest offering at the time of writing is its line of SkyProdigy telescopes. Its 6-in. SCT model has many advanced features including self-aligning to initialize its Go-To system and is priced at $1,000. (The line also includes a 90mm Maksutov-Cassegrain, for $600—plus a 130mm Newtonian reflector for $700, and 70mm and 102mm refractors priced at $500 and $700, respectively.)

Fig. 6.4 Both Meade and Orion have introduced their own affordable versions of the pricey Questar Maksutov-Cassegrains at just a fraction of their costs. Seen here is Orion's 127 mm (5-in.) equatorially-mounted StarMax catadioptric (which can be purchased as an optical tube assembly with tripod adapter). It's also available in apertures of 90 mm (the size of the smaller Questar) and 102 mm. Courtesy of Orion Telescopes & Binoculars

In 1980, Meade introduced its own extensive line of Schmidt-Cassegrain telescopes, beginning with an 8-in. and eventually followed by 10-, 12- 14- and 16-in. models. As with Celestron, these LX200-series instruments are offered with Go-To and GPS capability on computer driven altazimuth fork mounts. They also now offer "Advanced Coma-Free" models that start at $6,000 for a 12-in. Their "Autostar" system was actually the very first computerized Go-To system for commercial telescopes. Prices are around $2,300 for the 8-in., $2,900 for the 10-in., $3,800 for the 12-in., $5,300 for the 14-in. The 16-in. observatory model is offered on either the altazimuth or traditional German equatorial fork mount and starts at over $15,000 (Fig. 6.5).

Fig. 6.5 Today's reincarnated version of the original classic oranged-tubed 8-in. Celestron Schmidt-Cassegrain catadioptric that started the explosive popularity of compound telescopes. It now has such modern features as a sleek single-arm "fork" altazimuth mount and computerized Go-To acquisition of targets and tracking. Courtesy of Celestron

Following on the immense popularity of Celestron's 8-in. SCT, Criterion introduced its own 8-in. version called the Dynamax at a lower price than the C8. Bausch and Lomb/Bushnell continued producing this instrument along with 4- and 6-in. models when they took over Criterion. Unfortunately, the Dynamax series never gave quite the optical or mechanical performance level achieved by Celestron (and later Meade) and it was eventually discontinued. These scopes are still to be found today on the used telescope market, typically at prices far below used Celestron and Meade SCTs. An excellent reference for those considering the purchase of any SCT is *Choosing and Using a Schmidt-Cassegrain Telescope* by Rod Mollise (Springer, 2004).

Schmidt-Newtonian

In an effort to correct for coma in short focal length reflectors, the *Schmidt-Newtonian* form was introduced several years ago by Meade in apertures of 6-, 8- and 10-in. A Schmidt corrector plate is located at the top of the tube, providing essentially round images right to the edge of the eyepiece field. This plate also seals the telescope tube against dust and thermal currents, and eliminates the need for a secondary mirror support, the mirror being attached to the back side of the corrector itself. These fast systems (f/4 to f/5) give wide, nearly coma-free fields for both visual observing and astroimaging, with prices around $700 for the 6-in. and $1,000 for the 10-in. A few Newtonians have also appeared on the market over the years employing an *optical window* to seal the tube and support the secondary, but these have flat (plane-parallel) surfaces and provide no optical correction as does a Schmidt plate. With the exception of Edmund Scientifics' Astroscan-Plus rich-field telescope (see Chap. 5), there is currently no commercially available reflector with an optical window.

Maksutov-Newtonian

This form of Maksutov combines a steeply curved meniscus instead of a Schmidt corrector plate with a fast (typically f/4 to f/6) Newtonian reflector to give superb image quality across a wide field. And unlike the Schmidt-Newtonian, these instruments can also provide detailed views of the Moon and planets. While not nearly as well-known as a standard Maksutov-Cassegrain, a number of companies do offer this form of catadioptric—three of them from Russia. One of these is LOMO, whose line runs from a 4-in. f/4.5 to an 8-in. f/4.6, with prices ranging from $1,000 to nearly $4,000. Another is Intes, which offers a 6-in. f/6 and a 7-in. f/6 at prices of over $1,000 and more than $2,000, respectively. Intes Micro has a 5-in. f/6 for under $1,000 and a 6-in. f/6 for less than $2,000. Larger models are available in 8-, 10-, 12- and 16-in. apertures, with prices for the larger sizes running well in excess of $4,000. A fourth, domestic, source of Maksutov-Newtonians is TEC, which offers a 7-in. f/6 and an 8-in. f/3.5 in the $2,000–$4,000 price range. (In the 1980s, the Canadian firm Ceravolo Optics briefly offered a superb, essentially custom-made, 8.5-in. Maksutov-Newtonian, but did not keep it on the market for long. This fine instrument had exquisite optics and is much sought after today by observers and collectors.)

Note that many of the prices quoted here are for *optical tube assemblies* (OTAs) *only*, with the mountings themselves costing additional. You may opt to purchase just the OTA and place it on an existing mount—or perhaps buy one from another source at a more affordable price (particularly in the case of the three overseas manufacturers). In any and all cases no matter what make and type of telescope you're interested in, you should contact the companies directly using the resource information provided in Chap. 9 for specific details on what models they are actually now offering, availability, current prices, shipping charges and, of course, delivery time.