CHAPTER SIX

Catadioptric Telescopes

Maksutov–Cassegrain

While the inventions of the refractor and reflector occurred within a scant 60 years of each other, no new form of astronomical telescope appeared on the scene for nearly another three centuries. The idea then dawned on telescope designers 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. A decade later, Dimitri Maksutov combined a thick meniscus lens with a Cassegrain reflector to greatly improve both its visual and its photographic performance, resulting in the *Maksutov–Cassegrain*.

In this system, light entering through the meniscus lens is corrected for the inherent errors resulting from 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* and 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 Maksutov–Cassegrains actually use this system and are, therefore, technically Gregory–Maksutovs.

Introduced by Lawrence Braymer in 1954 after more than a decade of development and testing, the Questar 3.5-inch 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 over half a century!) This exquisite instrument is as much admired

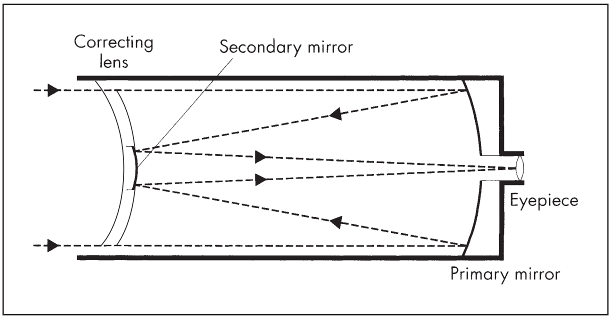

Figure 6.1. The optical configuration and light-path of a catadioptric telescope. The form seen here is the Maksutov–Cassegrain, which uses a thick, steeply-curved meniscus lens to eliminate the aberrations of the steep spherical primary mirror.

Figure 6.2. The legendary Questar 3.5-inch Maksutov–Cassegrain catadioptric, long considered 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 tabletop 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.

for its beautiful precision-machined tube assembly and tabletop fork mounting as for its unsurpassed optics. Originally priced at about $900, the basic 3.5-inch Questar today goes for over $4,000, making it a telescope mainly for the affluent stargazer and collector. (It can also be found from time to time on the used market for about half this amount.) A 7-inch version and a 12-inch 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-inch f/13.8 Maksutov–Cassegrain for around $500! This was soon followed by 4-inch f/14 and 5-inch f/15 models. A 7-inch f/15 was eventually added to the line in their LX200 series. The three smaller scopes are all priced under $1,000, while the 7-inch goes 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).

Figure 6.3. The standard Questar's big brother – a 7-inch 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.

Figure 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-inch) 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 2001, Orion entered the field with its StarMax 90-mm f/14 Maksutov–Cassegrain priced at about $300, followed by 102-mm, 127-mm, and 150-mm models running up to about $700. Among other companies offering these highly popular compact instruments (in apertures all the way up to 16 inches and with prices in excess of $4,000) 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 on 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-inch f/10 on a sturdy but lightweight field tripod, which eventually replaced the 2.4-inch (60-mm) refractor as the best-selling type of telescope in the world. (There were earlier versions of the Celestron SCT in 10-inch and 16-inch apertures, but these were soon replaced by the C8. They are occasionally still found offered on the used-telescope market today.)

Besides the C8 itself, 5-inch, 9.25-inch, 11-inch, and 14-inch apertures (known as the C5, C9.25, C11, and C14, respectively) were added to the line. (Celestron also made a limited number of 22-inch SCTs for private observatories. The author once spent several nights at a mountaintop observatory stargazing with one of these gems – the views of deep-sky objects through it were nothing short of astounding!) A variety of unique 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-inch, while the 8-inch computerized NexStar goes for around $1,400. The advanced 8-inch GPS model is priced at $2,000 and the 11-inch at under $3,000. Prices for both the 11-inch and 14-inch SCTs mounted on hefty German equatorials begin at well over $3,000, with the top-of-the-line C14 going for nearly $6,000.

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

Following on the immense popularity of Celestron's 8-inch SCT, Criterion introduced its own 8-inch version called the Dynamax, at a lower price than the

Figure 6.5. Today's reincarnated version of the original classic orange-tubed 8-inch Celestron Schmidt–Cassegrain catadioptric, which 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.

C8. Bausch and Lomb/Bushnell continued producing this instrument, along with 4- and 6-inch models, when they took over Criterion. Unfortunately, the Dynamax series never gave quite the optical and mechanical performance levels 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 reflectors having a short focal length, the *Schmidt–Newtonian* form was introduced several years ago by Meade in apertures of 6-, 8-, and 10-inch. 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-inch and $1,000 for the 10-inch. A few Newtonians that have also appeared on the market over the years employ an *optical window* to seal the tube and support the secondary, but these have flat (plane-parallel) surfaces and do not provide the optical correction of a Schmidt plate. With the exception of Edmund's Astroscan rich-field telescope (discussed in Chapter 5), there is currently no reflector with an optical window commercially available.

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, this form of catadioptric is offered by several companies – three of them from Russia. One of these is LOMO, whose line runs from a 4-inch f/4.5 to an 8-inch f/4.6, with prices ranging from $1,000 to nearly $4,000. Another is Intes, which offers a 6-inch f/6 and a 7-inch f/6 at prices of over $1,000 and more than $2,000, respectively. Intes Micro has a 5-inch f/6 for under $1,000 and a 6-inch f/6 for less than $2,000. Larger models are available in 8-, 10-, 12-, and 16-inch 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-inch f/6 and an 8-inch f/3.5 in the $2,000 to $4,000 price range. (In the 1980s, the Canadian firm Ceravolo Optics briefly offered a superb, essentially custom-made, 8.5-inch Maksutov–Newtonian, but did not stay in business for long. These fine instruments had exquisite optics and are 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 extra. You may opt to purchase just the OTA and place it on an existing mount – or perhaps make one, or 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 Chapter 9, for specific details on what they are actually offering, availability, current prices, shipping charges, and, of course, delivery time.