# Chapter 2

# A Yorkshireman Makes Good

The ancient English city of York has enjoyed a long and illustrious history spanning two millennia. Founded by the Roman governor of Britain, Quintus Petillius Cerialis, in A. D. 71, it lies at the junction of two great rivers – the Ouse and Foss – and quickly grew from a garrison town into a major northern city of the Roman Empire. The second century Spanish emperors, Trajan and Hadrian, knew the place. The third century African *Princeps*, Septimius Severus, died there, and in the fourth century, Constantine the Great was proclaimed the western Augustus by his troops within its walls.

Fortified and expanded by the Vikings and Normans who followed them, York also basked in the noon day brightness of the Industrial Revolution, attracting all manner of skilled artisans to its bustling streets. And it is here that our story begins, when and where a young man named Thomas Cooke founded a telescope- making dynasty that restored Britain's talent for scientific innovation throughout the Victorian Era and beyond.

Cooke was born on March 8, 1807, in Allerthorpe, Yorkshire. The son of a shoemaker, he received only the briefest of formal education, when after 2 years at an elementary school, he was put into his father's trade. But it soon became evident that such an occupation was not for the dreamy boy who pined for maritime adventures. Bright and curious, Cooke soon resumed his learning, teaching himself mathematics, navigation and astronomy. Fortunately for us hopeless telescope junkies, Cooke never did set sail on the high seas, his mother having persuaded him (insisted?) to seek local employment instead. From 1829 to 1836, he pursued a teaching career as an assistant schoolmaster and private tutor. And it was during this time that he met his future wife, Hannah Milner.

Cooke's interest in practical optics impelled him to begin work on his first telescope, one of the lenses of which he ground from the bottom of a whiskey tumbler and mounted the objective inside a tin tube that he soldered together from scrap

N. English, *Classic Telescopes: A Guide to Collecting, Restoring, and Using Telescopes of Yesteryear*, Patrick Moore's Practical Astronomy Series,
DOI 10.1007/978-1-4614-4424-4_2, 

metal. That same telescope was bought by a one John Philips, then Curator of the Yorkshire Museum but who later became an active member of the British Association for the Advancement of Science. Philips was to prove a powerful ally in the advancement of Cooke's subsequent career.

His marriage to Hannah was bountiful, too. She bore him seven children in all. Two of his sons, Charles (1836–98) and Thomas (1839–1919) subsequently joined him in the business he founded in 1837, at 50 Stonegate, York, with a loan of £100 from his wife's uncle. From this unassuming, rented premises, Cooke began work repairing and making instruments to order.

Throughout the eighteenth century, Britain had established a solid lead in optical glass manufacture, attributed no doubt to the extraordinary success of the Dollond dynasty and the many artisans who grew up around them. Yet, by the second decade of the nineteenth century, England's optical glass industry was crippled. In a penetrating modern analysis, historian Myles Jackson referred to the affair as "the British Crisis," in which the government maintained a stranglehold on the glass furnaces by enforcing heavy taxes on the manufacture of crown and flint glasses, while domestic types were exempt from duty. The motivations of Her Majesty's government lay with the large quantities of wood and (later) coal, consumed to produce the melts. Those raw materials – the energy resources of Empire – were to be prioritized for other purposes. Indeed, although at the beginning of the eighteenth century 13 optical glass works were in operation across the country, only three remained by 1833 and with them a drastic loss of skilled artisans. It was to be another 12 years before Parliament repealed these heavy tax levies.

In the early 1820s, though, in Bavaria, Germany, optical glass working was undergoing a bit of a Renaissance. A Swiss bell maker turned glass worker Pierre Guinand, under the aegis of Joseph Fraunhofer, hit upon a way of making larger blanks of both flint and crown using a new and improved stirring process.

Fraunhofer was born in the small Bavarian town of Straubing, Germany on March 6, 1787. The eleventh and last child of Franz Xavier Fraunhofer, a glazier to trade, the boy was plunged into misfortune from an early age when he lost his mother at 11 and his father just a year later. Thereafter, Fraunhofer was apprenticed to the mirror maker and ornamental glass cutter P.A. Weichselberger based in Munich. But after serving just 2 years of apprenticeship, disaster once again struck when Weichselberger's house collapsed. Luckily, Fraunhofer was protected by a cross-beam and escaped serious injury. Traveling to the scene of the debacle, Prince Elector Maximillian Joseph IV of Bavaria was apparently so moved by the fate dealt to the young Fraunhofer that he invited him to stay at his castle at Nymphenburg, ordering his privy councillor, a one Joseph von Utzsheneider, an influential politician and entrepreneur, to look after the youth.

In 1806 Fraunhofer was offered a junior post at the Munich Institute by Utzschneider, making fine optical instruments, where his extraordinary abilities were soon realised. Within a year, he was grinding and polishing lenses and soon after took charge of a workshop and several apprentices. Utzschneider moved his business to Benediktbeuern, where he had founded a glass melting workshop. It was here that Fraunhofer met the Swiss Pierre Louis Guinand, a specialist in melting high quality crown and flint glass. Utzschneider instructed Guinand to introduce Fraunhofer to the secrets of glass melting. After 1809, Fraunhofer was already a partner of the firm and in charge of building optical instruments: microscopes, opera glasses and astronomical telescopes. The firm produced everything in house; the optical parts, mountings, clockwork mechanisms, precision shafts, tube and the young man rapidly gained a reputation for producing achromatic doublets of excellent quality. Fraunhofer eschewed the trial and error processes used by his predecessors. He firmly understood the relationship between the refractive index of the glasses he employed, their curvature and resulting dispersive powers. These new techniques enabled Fraunhofer to design and build a giant 9.5-in. refractor, the largest aperture refractor the world had ever seen, which was installed at the Dorpat Observatory, Russia, and entrusted to F.G. Wilhelm Struve on November 10, 1824. Upon its arrival, Struve inspected the instrument and recorded his memories of its arrival for posterity:

> *On opening the boxes, it was found that the land carriage of more than 3000 German miles (close to 1500 English miles), had not produced the smallest injury to the instrument, the parts of which were most excellently secured. All the bolts and stops, for instance, which served to secure the different parts, were lined or covered with velvet; and the most expensive part (the object-glass) occupied a large box itself; in the center of which it was so sustained by springs, that even a fall of the box from considerable height could not have injured it. Considering the great number of small pieces, the putting together again of the instrument seemed to be no easy task, and the difficulty was increased by the great weight of some of them; and unfortunately the maker had forgotten to send the direction for doing it. However, after some consideration of the parts, and guided by a drawing in my possession, I set to work on the 11th, and was so fortunate as to accomplish the putting up of the instrument by the 15th; and on the 16th (being a clear morning) I had the satisfaction of having the first look through it at the Moon and some double stars. I stood astonished before this beautiful instrument, undetermined which to admire most, the beauty and elegance of the workmanship in its minute parts, the propriety of its construction, the ingenious mechanism for moving it, or the incomparable optical power of the telescope and the precision with which objects are defined.*

The German furnaces, unlike those in England, were still fueled by wood but didn't generate the same kind of heat as coal, rendering the homogenization of the melt more problematic unless a more effective way of stirring it were achieved. Guinand's technique involved constant stirring of the molten glass using a cylinder of fire clay, bringing bubbles to the surface and ensuring the melt was thoroughly mixed from its complete fusion until, after very slow cooling, it became too viscous to stir longer. Guinand succeeded in that goal where many others failed, employing a precise combination of time, temperature and stirring. Fraunhofer however, was a paranoid soul, and, as a result, went to great lengths to keep Guinand's pioneering new technique a closely guarded secret.

Nonetheless, a letter written by a certain Reynier of Neuchatel, Switzerland, to the Council of the newly founded Astronomical Society of London in 1821, stated that Guinand could deliver high quality optical glass blanks up to 12 in. in aperture. Intrigued, the Council invited Guinand to submit samples for inspection. The largest flint blanks were disappointingly small, just 2 in. in diameter and were given to the very capable London optician Charles Tulley (active 1780–1824), who combined it with fine English crown glass to produce a telescope that was described as "trifling" in size but excellent in performance.

Indeed, Tulley apparently received even larger flint disks from Guinand. One was a very respectable 7.25 in. in aperture which he attempted to achromatize with a similar-sized plate glass. The resulting mating was poor. Tulley then combined it with English crown glass and produced an instrument of 6.8 in. clear aperture and 12 ft focus. He then invited George Dollond and Sir John Hershel, among others, to observe Saturn, Jupiter, the Virgo 'nebulae' and a variety of difficult double stars through it. The unanimous verdict was impressive and helped to consolidate Tulley's optical reputation both at home and abroad. Perhaps one of his finest instruments – a 5.9 in. achromatic – went to the noted English double star observer, Sir James South (1785–1857), who entrusted Tulley with the task of grinding it and which South himself considered to be the finest in the world. Many choice antique instruments bearing the name of Charles Tulley are considered highly collectible today, some of which have commanded five-figure sums.

## The Admirable Admiral

The early Victorian period represented an exceptionally changeable time for astronomy. On the continent, the French, Russians and Germans had established large observatories with professionals at the helm. The United States, still a sleeping giant, had not yet realised her latent talent for producing some of the finest refracting telescopes in the world. But as John Weale reported in an account of London's observatories in 1851, privately owned establishments, run by wealthy amateurs, were all the rage across England and indeed had become 'fashionable'. Immersed in this 'gentleman astronomer' culture, William Henry Smyth, a retired sea captain and later admiral in the Royal Navy, flourished.

Smyth's childhood was, by all accounts, a happy one, with long days filled with adventure and romance in equal measure. But for us amateur astronomers, it is his last forty years that we cherish most. The son of an American loyalist who had returned to Britain after the Revolution, Smyth fancied himself as a bit of a Captain Cook. After climbing on board a merchant ship that had docked in the Thames, he had run away to sea as a lad. And there he stayed, joining the Royal Navy during the height of the Napoleonic Wars, when Lord Nelson had risen to become the hero of 'Free Europe'. Much of his early naval career was spent in the Mediterranean, assigned to the pro-British naval base at the Kingdom of Naples and Sicily. By his early twenties, he had been promoted to his first command of a small squadron in the Straits of Messina, where he helped keep the anarchy of the Barbary Pirates at bay.

And it was during these years that Smyth, invited to the Court of King Ferdinand IV of Naples, met the illustrious Italian astronomer, Father Giuseppe Piazzi, who had already earned a piece of immortality by discovering the first asteroid, Ceres, back in 1800. Despite his fervent Protestantism, Smyth found a kindred spirit in the Italian Catholic who was to make a lasting impression on the upwardly mobile Englishman, by opening the young man's eyes to the possibilities a scientific career might bring. Smyth soon sought out the great observatories of Europe, learning how to use the astronomical instruments at their Royal Observatory, Greenwich, as well as those established at Palermo, Sicily.

Curiously, in the same way that Lord Nelson had met his future wife, the Lady Hamilton, while at the Neapolitan Court, so too did Captain Smyth become acquainted with Miss Annarella Warrington, the daughter of a future British Consul, at the same court. They subsequently married, and unlike Nelson's, the matrimonial union proved a long and happy one. As father to three daughters – Henrietta, Ellen and Rosetta – he cultivated their passion for civilised learning, instructing them in practical astronomy, navigation and mathematics. Their son, Charles Piazzi Smyth, was later to become one of the most notable figures in the Victorian scientific movement and indeed later became Astronomer Royal for Scotland.

After the fall of Napolean and the liberation of Europe, Smyth served out his time in the eastern Mediterranean, undertaking hydrographic surveys. Supporting a young family, he remained in Naples until 1825 but thereafter 'retired' to England, living out the life of a country Laird in Bedford, where he soon assumed the mantle of the Gentleman Astronomer, a persona that subsequent generations would hold in great affection.

From his opulent, country home, Smyth constructed an elegant observatory, equipping it with a transit instrument and an accurate timepiece with which he could measure both the right ascension and declination of stars as they trundled across the meridian. He also had in his possession a small refracting telescope astride a solid mounting, which he could move round his estate. Charging it with high-quality micrometer eyepieces, he undertook measurements that would better quantify the refractive index of the air, by accurately recording stellar positions.

Some time later, Smyth acquired a 5.9″ equatorial refractor from Sir James South. Though probably average by modern standards, it nonetheless represented one of the largest and most sophisticated refractors in Britain. With this telescope, Smyth began a long programme of original research on double and variable stars, as well as kinematic studies on the proper motions of nearby stars.

Smyth's new-found passion for advancing the cause of visual astronomy blossomed in the fertile soils of the British Empire, where his contemporaries – men of the ilk of Sir John Herschel, William Rutter Dawes and Sir James South – were carrying out exciting new researches from the comfort of their grand estates. It was during these seminal years that Smyth first made his acquaintance with the wealthy barrister and squire of the great Hartwell Estate, Aylesbury, a one Dr. John Lee. Passing through Bedford whilst travelling to the County Quarter Sessions Courts, Lee often stopped off at Smyth's house, where he enjoyed the use of the Admiral's fine instruments. Indeed, under Smyth's aegis, Lee constructed his very own observatory (Hartwell), equipping it with the finest astronomical contraptions money could buy. And though they remained firm friends, kindred astronomers as it were, their personalities couldn't have been more different.

Dr. Lee, the embodiment of Victorian idealism, was a teetotaller, eschewing the activities of gambling and the pleasures of hunting – the time-honoured pastimes of many of his peers. Smyth, on the other hand, had acquired many of the habits of his seafaring comrades, indulging in the culinary delights of good food and the various libations his social station had accustomed itself to, as well as expressing a decidedly more conservative political worldview. Yet, each man thrived in each other's company, hosting numerous astronomical gatherings. Indeed, rumour has it that while Dr. Lee was constructing his lavish observatory, he would issue a certificate of merit to anyone who would lay a commemorative brick towards its completion. But his brick layers were no ordinary plebs; indeed they were the *nobilitas* of the *Imperium Britannicum* and future presidents of the prestigious Royal Society, including names like Airy, Brewster, Struve, Herschel and Rumker. Wealthy 'commoners' were also welcomed with open arms, including the tycoon landowner-brewer, Samuel Whitbread, who had himself built private observatories at his pallatial London home, at Eaton Square.

Both Dr. Lee and Captain Smyth, as active Fellows of the Royal Astronomical Society (FRAS), began to publish numerous papers on various astronomical topics. But it is arguably Smyth's 1844 work, *A Cycle of Celestial Objects*, that he became more generally known. Distilling some twenty years of experience in matters of practical astronomy and astrometry, which greatly aided Smyth's rise to notoriety, even among upwardly mobile nobodies. In this beefy, two-volume work, Smyth published many useful tables (which the American poet Walt Whitman would later write about with derision) of the celestial real estate he had visited, together with invaluable advice on their location and study. It is here that one will also find a treatise on Gamma Virginis, the first double star, the orbital aspects of which had just been established through careful study.

Yet, seen through the lens of modernity, *Cycles in the Heavens* could certainly not be considered to be an easy tome to digest. Indeed, Smyth presupposes that his readers possess quite a sophisticated background in trigonometry, optics and linguistics. But as terse as it sometimes seems, Smyth's *magnum opus* need not be construed as being deliberately elitist.

Smyth was a man of his time, classically trained for the Age of Empire. If anything, it just illustrates the sheer gulf between the haves and have nots of the day, as well as the circles within which the good Admiral and his chums moved. For Smyth, the squalor of a London slum was a distant and unthinkable possibility.

In the *Cycle*, Smyth described in great detail, the constitution of his own observatory at Bedford. The 'truncated dome,' ran on wooden balls, where, on a favourable evening, his beautiful, 5.9″ Tulley refractor peered out. In addition to the main circular space, Smyth also had constructed ancillary 'transit' and 'computing' rooms, where his rough numbers, derived from the micrometer, could be reduced.

The cost of building such a grand observatory must have been prohibitive to all but the most well to do folk, and while Smyth never alludes to its cost, another Gentleman astronomer, the wealthy surgeon, William McClear does. Indeed, in 1882 McClear commissioned a local carpenter to erect a six foot diameter wooden dome, which, at £50, he deemed 'economical'. The reality however, is that this sum of money would have kept a working class family, with several dependants, sweet for an entire year!

In retrospect, we only know so much about the activities of the Victorian Grand Amateur culture because Dr. Lee's *Albums* of the Hartwell Estate have been so well preserved. Another issue that needs to be clarified is the role of women in such a society, with the common misconception that the fairer sexes were really second class citizens in Victorian society holding sway. Yet, the *Albums* clearly record the attendances of ladies and children who appear to have been warmly welcomed into these grandiose Victorian 'mancaves,' drinking up the views through the magnificent refractors erected therein, or perhaps weighing up the latest theories of cosmogeny with their spouses and other male acquaintances.

Captain Smyth had his place in the pecking order too. He was not as wealthy as Dr. Lee. Indeed, the good Admiral once described himself as a 'half pay naval officer' implying that he lacked the true, landed wealth of his magesterial friend at Hartwell. By 1853, he had acquired the rank of rear-, followed shortly afterwards by vice-admiral. Only in 1863 was Smyth promoted to full Admiral, though by that time, he was nothing more than a beached officer.

Indeed, the publication of Smyth's *Cycles* in the 1840s may have reflected an underlying financial crisis in his life. Diligent research carried out by the distinguished historian of astronomy based at Oxford University, Dr. Allan Chapman, has shown that the early 1840s were characterised by a volatile financial market, both at home and overseas, with many banks and mercantile companies crashing out. Indeed, this may well have been the motivation behind the sale of Smyth's 5.9″ refractor to Dr. Lee and its re-housing at Hartwell House.

In the autumn of his life, Admiral Smyth's conviviality was known the length and breadth of the country. We now know of many correspondences he made with gentlemen in Liverpool and Nottingham in the 1850's. Indeed, by the 1860's, there would have been few places in the British Isles that did not have an Astronomical Society of sorts, equipped with ever more impressive instruments donated by the euergetism of wealthy patrons. When Smyth started his astronomical adventures, a 5.9″ object glass was considered world class. Thirty years on, refractors as large as 10 inches were being used by gentlemen amateurs continuing in the good Admiral's footsteps.

After 70 trips round the Sun, Smyth bade farewell to active observing but lived a further seven years. His life-long friend, Dr. Lee, survived him by only a year and with their passing, much of the instrumentation became entrusted to the RAS. The famous 5.9″ equatorial is now in safe keeping at the Science Museum in South Kensington, London.

Tulley's obtaining of large glass blanks from Guinand proved to be the exception rather than the rule, though. Some of the greatest British scientists of the age tried everything to get their hands on the details of the new German technology. Traditional diplomacy quickly descended into bribery (Fraunhofer was offered £25,000 for information), but without success. Circumstances changed, though, as they invariably do. In the summer of 1826, the Mozart of practical optics died prematurely, opening the way for glass makers to sell their secrets to the highest bidder. It marked the end of Fraunhoferian hegemony and the beginning of a new age in British optical glass making.

Cooke learned of these new techniques and applied them to build his first 'serious' telescope, a 4.5-in. equatorial, for a well-to-do lawyer, William Gray. McConnell describes the process of preparing the glass in her book, *Instrument Makers to the World*:

*Glass for optical purposes was not blown or rolled, but allowed to cool slowly in its pot, then removed and broken up. Flawed pieces were discarded and the remaining blocks cut into disks. These were sent to the optician who ground them into the shape of a lens with perfectly spherical surfaces. The convex shape was ground in a saucer shaped iron plate covered with pitch, hatched by cross grooves to take away the waste material. The pitch was warmed and covered with rouge – a fine abrasive. The lens was then rubbed and turned by hand or machine to achieve the desired curve.*

Beyond that, little else is known about the precise techniques Cooke employed to figure his object glasses. But what we do know is that the prescription of the early Cooke objectives differed a little from the standard Fraunhofer template, with the latter usually (although there are apparently some variations) having a more strongly curving outer crown element than its Fraunhoferian counterpart. What's more, the fourth (innermost) element of the Cooke object glass was flat and so didn't require figuring.

The 4.5-in. equatorial was apparently a great success, for news of its quality spread far and wide. Cooke made more instruments and built his reputation. His second large commission was for a 7.5-in. equatorial for a Mr. Hugh Pattinson. When his friend, the noted astronomer Isaac Fletcher had a chance to evaluate its optical and mechanical performance, he was so duly impressed that he wrote to Sir George Bidell Airy, then the Astronomer Royal (the man who, quite literally, divided the world in two, by establishing the new Prime Meridian at Greenwich), suggesting that Cooke be commissioned to make the lens for the Cape Observatory in South Africa. And although that job had already been contracted out to another party, it certainly helped Cooke's reputation and finally enter the conversations of the inner sanctum of the astronomical elite (Fig. 2.1).

The Victorian Era was no Antonine Age. Indeed the *Imperium Britannicum* had not seen a year free of the ravages of war in all the days of Victoria's reign. And while the construction of large equatorially mounted refractors were statements of scientific prestige, Cooke & Sons played their dutiful part in helping to sustain the machinery of the Empire – theodolites for surveying, spyglasses for naval officers, range sights for more accurate killing machines, and magnetometers for mining geologists in their ever more efficient plunder of colonial resources. With the railway coming to York in 1839, many new opportunities appeared across the country, and Cooke's goods found their way into every major optician's premises from Sutherland in the north to Cornwall in the south. Cooke also displayed a penchant for practical horology and set his considerable mechanical abilities to good use, manufacturing turret clocks for church towers.

In 1855, Cooke moved to bigger premises, the Buckingham Works, at Bishop Hill in York, where factory methods of production were first applied to optical instruments. Employing six workmen and one apprentice, everything, with the exception of the glass blanks, were made in situ – workshops for glass, brass and wood and a foundry where all but the largest castings were made. In the same year, Cooke decided to bring his new wares to the continent, exhibiting his instruments at the Universal Exhibition in Paris – the NEAF of its day. His gamble paid off, for he came away from the event with a First Class Medal for his clock-driven equatorial mounting and a ringing endorsement from the chattering classes (Fig. 2.2).

**Fig. 2.1** Thomas Cooke (1807–1868)

Cooke received commissions for several more large refractors (from 5- to 10-in. apertures), but perhaps the most prestigious of all came from an order by Prince Albert, who, in 1860, summoned Cooke to Osborne House, on the picturesque Isle of Wight, to discuss the construction of a telescope for the viewing pleasure of the royal family. They chose a fine equatorial refractor of 5.25-in. aperture.

Arguably one of Thomas Cooke's greatest achievements was the construction of the 25 in. 'Newall' refractor. Built for Robert Stirling Newall, the story behind the completion of this great telescope is a particularly somber one. After accepting the commission for the giant lens, Cooke greatly underestimated the length of time it would take to complete it. Indeed, he surmised that it would take no more than a year. What is more, in an attempt to undercut a quote from his rival, Sir Howard Grubb, he charged too little for the work.

These realities conspired in such a way that Cooke failed to meet several new deadlines he agreed to with Newall. What is more, Newall accused Cooke of 'taking his eye off the ball' as it were, and even threatened to withhold further down payments on the project. The probable reality, as McConnell convincingly argues, is that Cooke was under enormous pressure to complete other sizable commissions on time. Thomas spent his twilight years a sickly man, finally giving up the ghost on October 19, 1868, aged 61.

In his will, Cooke bequeathed 'everything' to his wife, who immediately instructed her sons to see the Newall project to completion and the telescope trans-

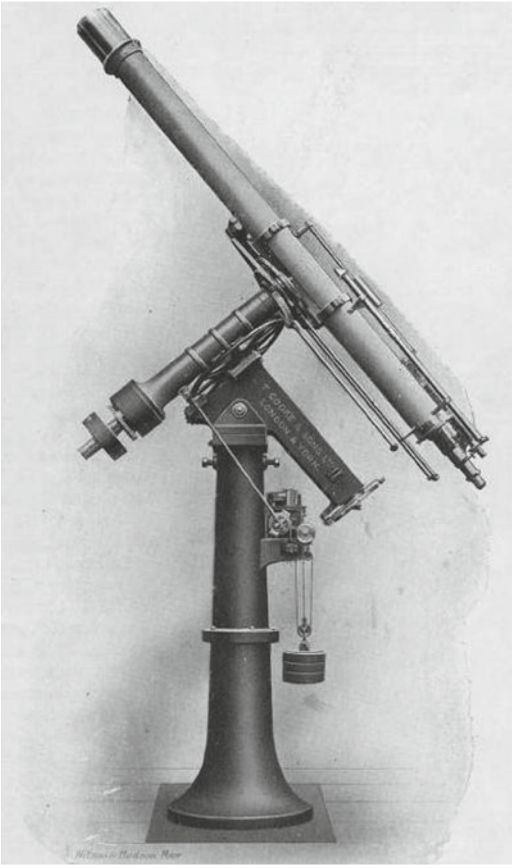

**Fig. 2.2** An instrument for a well-heeled amateur c. 1899 (Image credit: Doug Daniels)

ferred to his estate in Ferndean, Northumberland. It arrived in 1870 and became fully operational a year later.

The Newall telescope enjoyed the distinction of being the largest refractor in the world for only a year, when Alvan Clark's latest monster refractor, erected at the U.S. Naval Observatory, Washington, D. C., literally inched it out of first place in 1872. After Newall's death, the instrument was donated to Cambridge University and lauded for its fine optics. By the 1950s, however, the Golden Age of Astrophysics having come and gone, the telescope fell into disuse. Finally, in November 1958, the decision was made to sell it to the Greek National Observatory, which housed it in a magnificent dome atop Penteli Mountain, just a day's walk north of Athens.

Messrs. Cooke continued to secure enough orders to keep the business (which now had grown to a workforce in excess of 100) ticking, and in the decades ahead, it continued to provide both private individuals and public observatories scattered

**Fig. 2.3** A 4-in. F/15 Cooke branded A. Ross. c. 1860 (Image credit: Richard Day)

across the world with large instruments, including an 18-in. refractor for the Brazilian National Observatory.

Several optical firms in the United States and in Germany were employing new and more sophisticated lenses, using techniques that rivaled or exceeded the quality produced by the Cooke brothers. To add insult to injury, many other, smaller firms were beginning to compete with the British optical giant, undercutting their powerful rival.

T Cooke & Sons evolved and adapted to their changing circumstances as best it could. For example, the company was known to supply telescopes for re-branding, such as the fine 4-in. F/15 refractor supplied to Ross of London (shown below), or the elegant astronomical instruments of Negretti & Zambra (active 1850–1999), which often employed high quality Cooke objectives (Fig. 2.3).

It is difficult to assess how well T. Cooke & Sons penetrated the European market. Interestingly, a study of the origin of the wealthy Hungarian astronomer Miklós Konkoly-Thege's (1842–1916) instrumentation from 1870 to 1910, conducted at his private Budapest Observatory, shows that 66% of the instruments derived from German manufacturers, with only 17% from other foreign countries, mostly England. An interesting trend emerges if one looks more closely at the individual decades. Throughout the 1870s, there were apparently more English than German instruments, due, no doubt, to Konkoly's earlier trip to the English workshops. In the 1880s, the number of German instruments increased, but also the number of instruments made in Hungary. That said, by the turn of the century, German instrumentation dominated.

The decline in British optical ingenuity was well underway by the end of the nineteenth century. But that wasn't the end of the story, for the company was about to be restored to an even greater level of prestige, when Messrs. Cooke took an extraordinary young man under their wing. His name was Harold Dennis Taylor (1862–1943), and his ingenuity became the brain and glory of T. Cooke & Sons in the post-Victorian era.

Beginning his professional career as a trainee architect, Taylor soon became bored and disillusioned with it. He was offered an apprenticeship – which he enthusiastically accepted – with the Cookes at the Buckingham Works. McConnell describes the culture of his new work setting upon the young man's arrival:

> *At the time of his arrival, optical design was, as it had been since the time of Thomas Cooke senior, a matter of trial and error based on experience and practice, with only a token nod to theoretical formulae.*

The elder Cooke, like all other opticians of his time, probably relied heavily on visual inspection of images through his objectives in the assessment of optical quality. Dr. Jackson describes the 'litmus test for achromaticity' as was then employed by telescope makers:

> *The examination of a bright object on a dark background, as a card by daylight, or Jupiter by night, which high magnification powers affords as is well known, the severest test of the perfect achromaticity of a telescope, by the production of green and purple borders about their borders in the contrary case.*

Judging by their many happy customers, the Cookes must have done extremely well in their task. That said, Taylor was a different kettle of fish to the elder Cooke. He quickly absorbed the work on diffraction set out by G. B. Airy and established new and higher standards of optical testing and evaluation. Within a year, he had designed a novel kind of photographic exposure meter. Several other patents followed – mainly camera lenses – some of which he sold to Messrs. Cooke outright, and others he received a royalty from.

By 1893, aged just 30, Taylor was placed in charge of all optical projects, followed 2 years later by a seat on the Board of Directors. For the next two decades, Taylor dedicated himself to the advancement of optical knowledge. In 1891, he published a new treatise on refractor optics, *The Adjustment and Testing of Telescope Objectives*, followed in 1906 by a *System of Applied Optics*, which still serve as invaluable resources today. Arguably Taylor's crowning technical achievement was the design and construction of a new kind of refractor objective – an instrument that could be used both photographically as well as visually. Enter the remarkable photo-visual triplet.

By the end of the nineteenth century, the overwhelming majority of public observatories were equipped with large equatorial refractors. The larger instruments, of course, produced a noticeable color fringe around bright objects. Experienced astronomers just learned to ignore it, but the secondary spectrum proved disastrous in long exposure photographic applications. Taylor's new triplet, first produced in 1892, consisted of an outer light baryta flint lens, a middle borosilicate flint element and a light silicate crown comprising the innermost element. An air space was placed between the second and third element. Designed to be used in an F/18 format, the lens produced a wonderfully flat, aberration-free image with color correction an order of magnitude lower than anything seen before. Needless to say, these telescopes proved hugely popular as the new bulwarks of astrophotography, finding their way into observatories on every continent.

Like all dynastic businesses, the end came slowly and unpredictably for Cooke & Sons. In the twentieth century, the firm amalgamated with Troughton & Simms (London) in 1922 to become Cooke, Troughton & Simms. By 1915, however, Vickers had acquired a 70% stake in the business and by 1924, it became a wholly owned subsidiary of the same company.

In the aftermath of the Second World War, Vickers continued to thrive, selling microscopes, surveying equipment and a variety of high precision scientific instruments. Finally, in 1989, the business was purchased by the California-based company Bio-Rad Micromeasurements. Vickers decided to deposit the firm's archives and collection of scientific instruments with the University of York. The instruments are now on display in the Department of Physics, and the archives are cared for by the Borthwick Institute for Archives. The collection also includes a number of printed books, which embody a special collection in York University Library (Fig. 2.4).

## Voices from the Grave

Is it possible to divine information regarding the general optical quality of the Cooke refractors that found their way into the private observatories and homes of Victorian gentlemen scattered across the world? One way forward is to explore the comments of historical observers who had used Cooke refractors during the course of their careers.

We shall begin with William Rutter Dawes (1799–1868), revered among double star observers for bringing us his empirical (though as yet unsurpassed by any pseudo-theory) formula used to work out the minimum aperture needed to resolve double stars of a given angular separation. What is less well known is that the reverend was also a first rate planetary observer, apparently possessing extraordinary visual acuity (despite his extreme myopia) at the eyepiece. And he had an interesting purchasing history, having used refractors crafted by Dollond, Merz & Mahler,

**Fig. 2.4** The author's 1960s Vickers binocular microscope

Cooke and even the shining light of American optics, a portrait painter turned telescope maker, Alvan Clark.

Dawes took an interest in Clark's meteoric rise from early on in his career. Naturally, being an unknown in the industry, Clark at first found it hard to sell his instruments. What he needed was someone with great astronomical *gravitas* to champion his cause. If the astronomers didn't come to his telescopes, then he'd have to bring his telescopes to the astronomers.

And so it was in 1851 Clark wrote to Dawes, describing to him the close double stars he had observed with his newly-crafted 7.5-in. refractor. Impressed, the reverend sent Clark a more extensive list of close binary stars for him to split, together with an order for the same objective!

Yet, in the autumn of his life, old 'Eagle Eyes' returned to a Cooke refractor. Dawes had already made some drawings of Mars in 1862 and at earlier oppositions. In 1864, he used an 8-in. Cooke (that later became known as the Thorrowgood), usually with a magnifying power of 258×. His drawings, wrote Richard Anthony Proctor, "are far better than any others…. The views by Beer and Mädler are good, as are some of Secchi's (though they appear badly drawn). Nasmyth's and Phillips', De La Rue's two views are also admirable; and Lockyer has given a better set of views than any of the others. But there is an amount of detail in Mr. Dawes' views which renders them superior to any yet taken." Camille Flammarion concurred: "The drawings by … Dawes brought a new precision to studies of Mars."

And across the Irish Sea, to a beautiful, windswept rural estate near Milltown, County Galway, John Birmingham (1814–1884) used a 4.5-in. Cooke refractor to embark on a special study of red stars, in which he set out to undertake a revision and extension of the best resource of its day on such objects, *Schjellerup's Catalogue of Red Stars.* In all, he included 658 such objects. This work was presented to the Royal Irish Academy in 1876, and its merit was acknowledged by the award of the Cunningham Medal. In 1881 Birmingham discovered a deep red star in Cygnus, which is named after him. He published articles on the transit of Venus and sunspot morphology made with the same telescope, corresponding regularly with the leading astronomers of his day. A lunar crater is named in his honor, too.

Moving next to the Far East of the Empire, at Bankura, India, Chandrasekhar Venkata Raman (subsequently knighted), the recipient of the 1930 Nobel Prize in Physics for his contributions to optical science, was fond of using a 53 Cooke refractor. There is one curious account Raman made while using this telescope to observe Saturn:

> *[N]ot only was the Crepe ring an easy object," he says, "but for nearly one hour while the definition was perfect, I made out Encke's marking in the A ring and held it steadily for practically the whole period.*

Now, the Crepe ring is quite a difficult target for a 6-in. scope, and for many, 8″ seems to the smallest aperture they'd be happy with. The Enke division (marking) is typically regarded today as a good target for a 10-in. instrument. So, was it fine optics Raman had in his 5-in. Cooke or exceptional eyes – or both? Maybe we'll never know for sure! (Fig. 2.5).

We return, once again, to England, and to the fondly remembered British actor and comedian Will Hay (1888–1949). Though playing the consummate idiot on stage, behind the scenes, Hay was a gentleman of encyclopedic knowledge, with a predilection for astronomical adventure. He set up a fine 6-in. Cooke refractor in a private observatory established at his home in Norbury, London, to study the planets. On the fateful night of August 3 1933, Hay used this instrument and an eyepiece delivering a power of 175× to detect a prominent white spot on Saturn. The spot, located in the planet's equatorial zone, remained prominent for a few days before mysteriously fading away. And although similar phenomena were recorded by earlier observers (Asaph Hall in 1877 and E.E. Barnard in 1903), Hay is credited with the official discovery. Curiously, Hay's beloved 6-in. Cooke, like the spot he discovered, inexplicably disappeared after his death, and, despite diligent attempts to locate it, we are still none the wiser concerning its current whereabouts! (Fig. 2.6).

Hay wrote a wonderful, non-technical book for the newly minted amateur astronomer, *Through My Telescope*, in which his great charm and insight still shines through. A timeless classic if ever there was one! (Fig. 2.7).

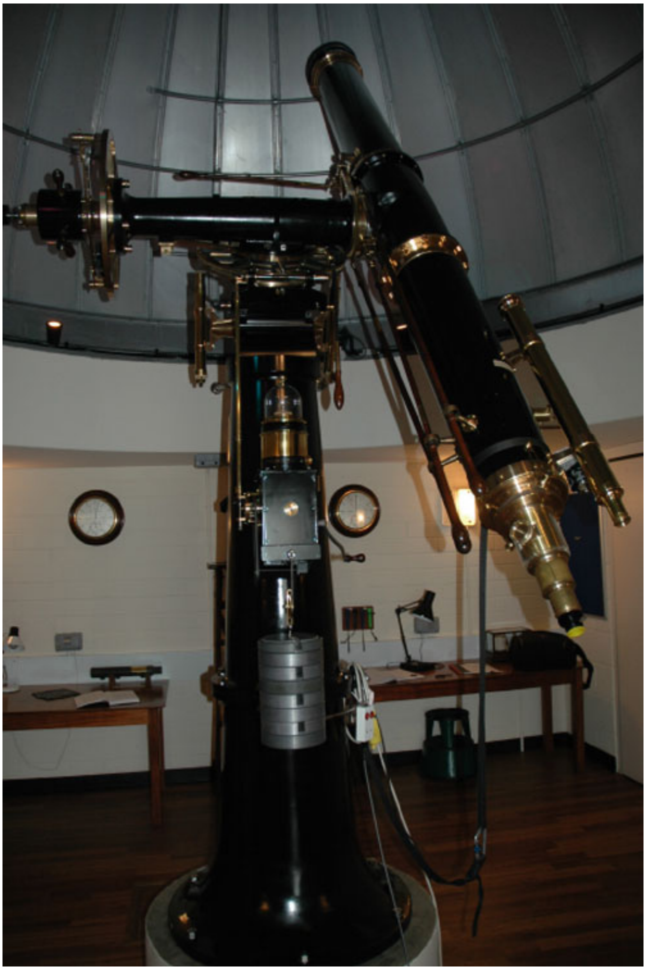

**Fig. 2.5** The fully restored 8-in. f/16 Fry telescope, at Mill Hill Observatory, London

## Modern Perceptions

I have spoken elsewhere of experiences with a couple of Cooke refractors, particularly the 10-in. at Mills Observatory, Dundee, Scotland, which I have peeped through on many occasions during my time in graduate school, and a superlative 4-in. F/18 Cooke-Taylor photovisual instrument. The sharp, contrasty views they both served up were very impressive. But was this representative of what others have experienced? How did these refractors of old settle with folk who have had the pleasure of using them over years and decades? First, Douglas Daniels was contacted, president of the Hampstead Scientific Society, England, who has had the immense good fortune of using the observatory's 6-in. F/15 Cooke since 1967.


**Fig. 2.6** The second drawing of Saturn by Will Hay showing the great white spot 6 days after his discovery sketch (Image credit: Martin Mobberley)

Doug spoke about his background and how he became acquainted with Cooke refractors (Figs. 2.8, 2.9, and 2.10).

*I have always been a keen lunar and planetary observer and telescope maker since I first became seduced by astronomy at the age of 13 in 1953. I joined the BAA in 1956, which was the year of a very close opposition of Mars. At that time, I had built a 6-inch Newtonian reflector using a mirror made by the late Henry Wildey. I was quite impressed by the performance of this instrument, both on Mars and Jupiter, but I was soon to meet another young BAA member – Terry Pearce. Terry and I became good friends (and still are!). Terry had managed to borrow a 4.5-inch Cooke from the BAA that he had set up in his garden at Chingford in Essex. I was amazed at the sheer size of it. It was an unusual Cooke, two part cast iron column and the equatorial mount was massive for an instrument of that size. But I was even more amazed when I looked through it. The detail on both Mars and Jupiter was astounding – far more contrast than with my 6-inch reflector. That was my first taste of a Cooke.*

How and when had Doug first became acquainted with the Hampstead 6-in. Cooke?

*In 1967, I joined the Hampstead Scientific Society and was able to use the 6-inch Cooke at the Hampstead Observatory. Again, 1967 was a year with a good opposition of Mars, and the detail observed with the Cooke was so good that I began to attempt photography. I built a special planetary camera with a flip mirror system to keep the planet under close surveillance, waiting for clear moments to make exposures – it was a sort of single lens reflex job but without the lens!* (N.B. This was 1967!) *My photographs came to the attention of an American student Ron Wells, who was doing a PhD on Martian topography at University College London. Ron was working at the University of London Observatory at Mill Hill – just 15 minutes from my home. I was introduced to the director, Professor Allen, and was allowed to use the 18-inch Grubb – I had the key to the big dome for 6 months. On the same site, there were two smaller domes. One contained the Fry Telescope - an 8-inch Cooke.*

**Fig. 2.7** A portable 3-in. f/15 Cooke refractor c. 1900 (Image credit: Richard Day)

*Once again the Cooke was the instrument that impressed most. On most nights of average seeing, it could easily outperform the 18-inch Grubb. Only when the seeing was excellent could the Grubb show slightly more detail.*

Doug was more than happy to recount the telescope's long history.

*The Cooke was once owned by a member – George Avenell, and we know that it was in use at the observatory in 1923. It was finally presented to the Society in 1928. Prior to this we have no information. The optical tube appears to have been manufactured around 1900, but we have no hard evidence for this date. When I began using it in 1967, it was mounted on an old Cooke equatorial from a 4.5-inch instrument that was too small. It had the old Cooke falling weight drive and a worm sector – not a complete wheel that was always getting jammed. In the end we built our own heavy duty mount in 1976, driven by a stepper*


**Fig. 2.8** Image credit: Doug Daniels


**Fig. 2.9** Image credit: Doug Daniels

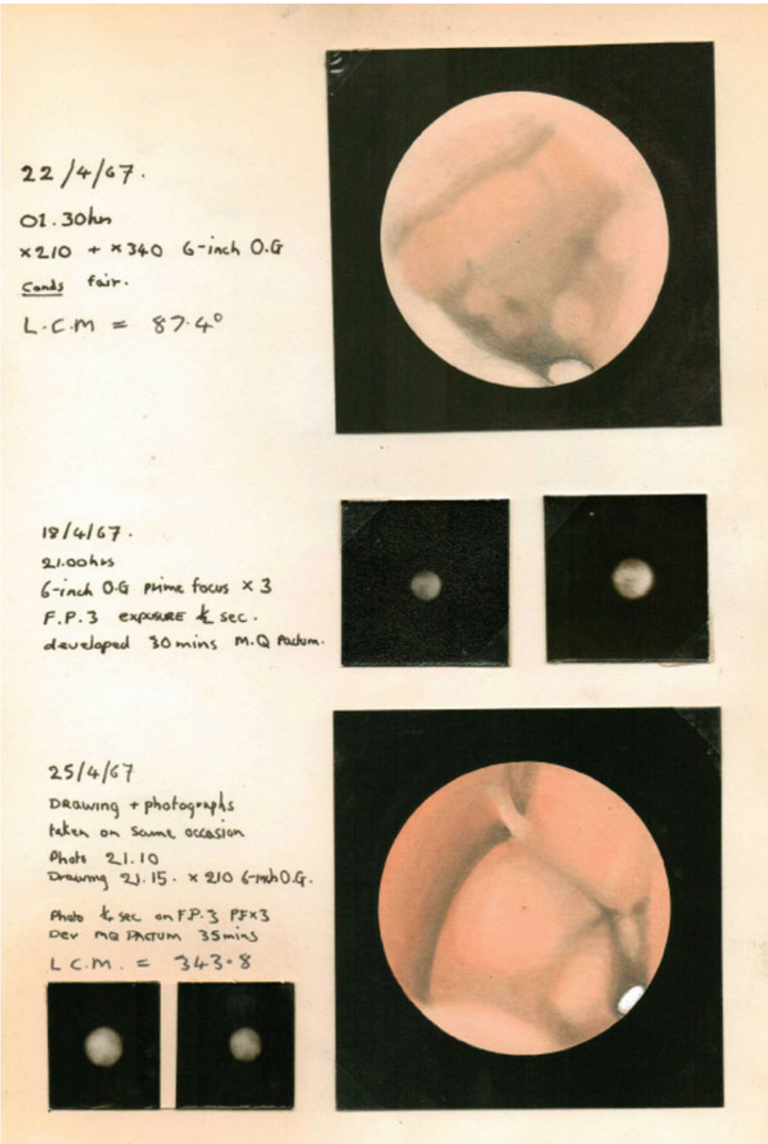


**Fig. 2.10** Some of Doug Daniel's recorded details of the Martian opposition of 1967 (Image credit: Doug Daniels)

*motor. A couple of years ago, I was in correspondence with Martin Mobberley, who was researching the 6-inch Cooke once owned by Will Hay. I was able to confirm that the Hampstead Cooke was not Hay's instrument.*

What about the telescope's maintenance? Is it, in any sense, fastidious in its requirements?

*No, not at all. The objective is best left well alone. It gets an annual wipe over with meths and a lint free cloth and every few years is checked for squaring on, which hardly needs any adjustment for long time periods other than that I discourage anyone from touching it. That's another nice aspect of refractors, they are virtually maintenance free, unlike reflectors, which are constantly going out of square and need re-coating every few years.*

Doug is no stranger either to the current proliferation of telescope types, each having their advantages and disadvantages. He was asked how he thought the old Cooke faired in the scheme of things:

*As a long standing lunar and planetary observer, I have, over the last half century, been able to compare the performance of many different instruments. Given average seeing conditions, I have found that the images produced by the 6-inch Cooke f/15 refractor at the Hampstead Observatory will surpass most if not all other instruments of equal aperture. It will outperform Schmidt-Cassegrains and Maksutov-Cassegrains of 8-inches aperture, and on occasions, it has provided better images of Mars obtained with my own 16.5-inch Dall-Kirkham Cassegrain. It is only on the rare apparitions of excellent seeing that large aperture reflectors can outperform it. I put this down to the absence of a central obstruction that reduces image contrast in all compact reflectors. The current popularity of short focal ratio apochromats is no doubt due to their portability and the need to travel to dark observing sites. But they take longer to acquire thermal equilibrium and require expensive highly corrected short focal length eyepieces to produce sufficiently high magnifications.*

Next, we sought the opinion of Dr. Richard McKim, director of the Mars section of the BAA, who has used some of the Cooke refractors in his extensive studies of the Red Planet over the last few decades:

*I have used many refractors on a regular basis since the 1970s, 4 cm, 7 cm, 7.5 cm, 15 cm (Cooke, my own), 20 cm (Cooke, Cambridge), 30 cm (Cooke apochromat, Cambridge) and 83 cm (Meudon Observatory). The problem is, I have no basis of comparison with other makes. Until 1988, the Northumberland telescope at Cambridge had a 30 cm Cooke apochromat, as the old lens from the c. 19th had worn so much it was too small to safely fit in the original cell. After the devitrification of one component, Jim Hysom made a new lens for that year, 1988. Equally sharp in definition to my eye, but of course an unfair comparison with an apochromat. Both gave marvelous, sharp images. All I can say is that Cooke achromats and apochromats give marvelous results.*

Privately owned Cooke Photovisual refractors, as you might expect, are as rare as hens' teeth. Having looked through a 4-in. f/18 sample, this author can tell you the images of Mars it served up in a recent opposition were nothing short of breathtaking, easiest the finest view of this small planet I have seen through any telescope. Colin Shepherd, an amateur astronomer based in Jervis Bay, Australia, is the lucky owner of a 5-in. F/17 Cooke Photo-visual (c. 1902) but also enjoys observing through his modern ultra-premium 5-in. Astro Physics refractor. So how did he reconcile the old with the new? (Fig. 2.11).

*My recollection of its performance is that it delivers images on a par with my 5-inch Astro Physics Starfire (AP130-EFS). I discussed it with my friend, Steven Lee, of the Anglo Australian Observatory, and we both agreed that the performance was similar other than maybe a slight light loss, which is probably due to the lack of coatings on the Cooke PV objective. I have an adapter to permit use of a 2-inch diagonal in place of the original prism, so I can use the Cooke with modern eyepieces. The biggest difficulty with using the 'scope other than its weight is the long tube.*

**Fig. 2.11** A pristine Cooke lens that saw first light over 150 years ago (Image courtesy of Richard Day)

These telescopes, of course, have long been considered choice instruments for measuring double stars. Curious to see what a contemporary double star observer thought of a big Cooke, Bob Argyle, based at the Institute of Astronomy, in Cambridge, England, is a highly skilled binary star astronomer and author of an influential book on the subject. He has used the 8-in. Thorrowgood (also at Cambridge) refractor for measuring the orbital elements of hundreds of pairs (Fig. 2.12). He said:

*I'm happy to confirm that this lens is a good as you can expect for the aperture. It was specified for double star work by its original owner, Dawes, and needless to say it fulfills the Dawes limit admirably, separating pairs as close as 0''.55 or possibly a little less. On the best nights here, which would not necessarily be regarded as such elsewhere, the disks are perfectly round. In 2004, when Gamma Virginis passed through apastron at 0''.37, I was still able to measure the position angle of the elongated image. I gather that J. C. Adams once tried to acquire the telescope from Dawes, and he was of the opinion that it was of better optical quality than the 9.6-inch Dorpat refractor of Struve.*

## *Animum Debes Mutare, Non Caelum!*

What are we to make of all these opinions – both contemporary and historical? For one thing, these are not the words of egregious rogues with hidden agendas! The Cooke refractors clearly delivered and continue to deliver quality views. But, in this age of the Roddier test and interferometer, how well do the 'fine' achromatic Victorian Cooke lenses really stack up? Alas, hard data is not available to answer this question. Prizing one away for laboratory analysis would be rather like trying to acquire a piece of the Constitution! That said, there has been a tendency in

**Fig. 2.12** The 8-in. Thorrowgood refractor at Cambridge (Image courtesy of Martin Mobberley)

contemporary amateur culture to assess optical quality using the Strehl ratio interpretation, based on laboratory bench tests.

Based on the sample of testaments, many of the larger Cooke refractor object glasses would most probably not be figured to an accuracy much beyond a smooth ¼ wave level at the eyepiece, corresponding to a Strehl ratio not much greater than 0.8 (their peak Strehl at green wavelengths being higher). Contrast that to contemporary, top-of-the-range apochromatic triplets, which can exhibit Strehl ratios higher than 0.95. Yet, as we have seen, many seasoned observers are, and continue to be, more than satisfied with the views these classical refractors of yore deliver. How can these significantly different quantitative assessments of optical quality be reconciled?

One explanation is that we are looking at this question far too simplistically. Doubtless, it is not how well the scope performs in laboratory tests that is at issue here. What counts is how well those quality images are *attained* and *maintained* under typical conditions *in the field*. In previous correspondences with optics authority Vladimir Sacek (www.telescope-optics.net), this author is reminded that, at least in terms of perceived image quality, under field conditions, there's not much difference between a true 1/8 wave and 1/4 wave p-v level optic. Indeed, all the optical greats – Rayleigh, Conrady and Marechal, to name but a few – concluded much the same. What is paramount, however, is the added error, from a number of other sources, and as has been described elsewhere, many of these sources are close to home and may have more to do with the design of the telescope and its thermal management than has previously been acknowledged.

Es Reid, a highly experienced optical engineer based in Cambridge, England, gave his take on this matter:

> *I reckon that, although glass prescriptions and anti-reflection coatings have improved over the years, the methods of final polishing and figuring have not changed to any great extent. A long, heavily mounted refractor should outperform a short one on a lighter, modern mounting. Eyepieces can always be simpler for the same power, and glass will behave thermally as glass always has. Eyes plus brain can select the best wavelength to some extent to give highest acuity in colored images, so I think all of these factors let the old instruments compare very well indeed with modern equipment. It is also interesting that glass companies nowadays have to knock out toxic chemicals, for safety reasons, that can restrict color correction. The inherent and continual smoothness of a refractor wave-front and the high entrance both help a lot in keeping an image sweet!*

Sweet indeed! It seems that quality views delivered by these antiquated telescopes are the result of many things coming together in one package – their unobstructed optics, their simplicity of design, a doublet objective made from thin lenses that acclimate rapidly and completely, their greater elevation off the ground, well away from any sources of ground turbulence and anthropogenic heat and their great depth of focus, making accurate focusing easier and, of course, their generous image scale (1/f). Couple that to the ruthless genius of the human eye to 'filter' the signal from the noise, introduced by the purplish unfocused light of the standard achromatic prescription, and you can easily understand why they would delight a patient or experienced observer.

Such attributes, of course, make them ideal as measuring instruments and that's precisely why, it is likely, they were built with such enthusiasm. Indeed, J.B. Sidgwick, writing in his influential book from 1971, reminds us yet once again of the advantages of these long focus refractors. They enjoy, he says, "greater independence of temperature variations, with steadier images and higher possible magnifications than with a reflector of the same aperture," (pp. 420–21). Seen in this light, these telescopes are not the 'extinct dinosaurs' contemporary astronomical culture would have us believe. As we have seen, there is every indication that these instruments are 'highly adapted specialists', supremely useful in the noble art of astronomical mensuration.

In retrospect, it seems daft (it really does!) that these instruments should ever fall out of favor with amateur astronomers. But that, sadly, is the reality on the ground. Doug Daniels thinks he knows why.

*At the end of the day, I think the reason that the long focal length refractor has 'fallen out of favor' is simply due to the 'long focal length.' It was (is) an instrument ideally suited for a permanent observatory and to be used for visual observation. Both of these applications seem to be out of favor today. Because of the proliferation of light pollution, users want portable equipment to drag to dark locations, some going as far afield as Bermuda or the Canary Isles. Because of the comparative ease afforded by digital imaging, users demand faster focal ratios. Because of the 'competition' amongst enthusiasts to produce ever more astounding images of 'deep sky' subjects and the relatively small size of CCD chips, users demand wider fields of view. None of these requirements can be met with an f/15 refractor. BUT, if you are interested in observing and drawing planetary detail, or observing and measuring double stars, and you have the space to build a 10-foot diameter dome in an unobstructed pollution free location, then the 'old fashioned' achromatic refractor is hard to beat. If my astronomical 'fairy godmother' could wave her wand and grant my wish, it would be for an 8-inch f/15 Cooke refractor made at the end of the nineteenth century at Bishop Hill in Yorkshire.*

Although the Sun has long since set on both the Roman and British Empires, the legacy of Thomas Cooke lives on in the people who have had the pleasure of using these fine telescopes, whether a gentleman's 3-in. glass or a large observatory class instrument. Small wonder that Cooke's erudite obituarist was compelled to write in 1868, "[To] our English Fraunhofer…. Whose science and skill had restored to England the pre-eminent position she held a century ago in the time of Dollond (Fig. 2.13)."

The ancient Greek philosopher, Socrates, once remarked that all learning consists of that which is pre-existing in memory. Having recounted the allegory of Thomas Cooke & Sons to you and extolled the virtues of some of their optical wares, we hope that this will all seem familiar to you, too!

**Fig. 2.13** *In Amatam Memoriam*: The author's fine 4-in. f/15 refractor, inspired by the workshops of T. Cooke & Sons (Image by the author)

Springer
http://www.springer.com/978-1-4614-4423-7

Classic Telescopes
A Guide to Collecting, Restoring, and Using Telescopes of Yesteryear
English, N.
2013, XV, 239 p. 171 illus., 83 illus. in color., Softcover
ISBN: 978-1-4614-4423-7