Galileo's Glassworks: The Telescope and the Mirror by Eileen Reeves

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Precisely when it occurred to someone to insert a convex lens into one end of a tube and a concave lens into the other to form the first refracting telescope is anyone's guess. We are considerably more certain about when the first attempt to patent such a device was made. On October 2 in 1608, the States-General of the Dutch Republic discussed and eventually denied the patent-application that Hans Lipperhey, a spectacle-maker from Middelburg in Zeeland, had previously submitted to his provincial council. Since this is the first documented evidence of the refracting—or 'Dutch'—telescope, Lipperhey has been credited with its invention, even though there are at least two, perhaps as many as four, competing claims from around the same time.

News of the device spread quickly, and so, evidently, did the device itself: a refracting telescope with a cracked lens was on offer at the Frankfurt Fair in autumn of 1608. By late November of the same year, Galileo's friend and supporter, Paolo Sarpi, had got wind of the invention at Venice; and within a matter of months the Dutch telescope had become fairly commonplace as more and more samples of the device were presented to various aristocrats by men seeking patronage or preferment. Indeed, by April of 1609, the Dutch telescope was commonplace enough to be commercially available in Paris. Anyone with a keen interest in optics and optical devices should therefore have known of the Dutch telescope by no later than the beginning of 1609.

Galileo was certainly among this group, yet in the introductory portion of his *Starry Messenger*, which was published in March, 1610, he claims that he had only learned of the device some 10 months earlier, presumably no earlier than May of 1609. Why it took him

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so long to get the news is puzzling for several reasons. First, there is good reason to believe that Galileo had become deeply interested in optics well before 1609 and that his interest was focused on how best to magnify distant objects for close scrutiny. Second, when it came to things scientific, Galileo had his ear continually to the ground through a network of correspondents and friends. Third, and most puzzling, one of those friends was none other than the Venetian, Paolo Sarpi, who already knew of the Dutch telescope by November of 1608. How could he not have shared that news with Galileo, who was ensconced in Padua, just a stone's throw from Venice and under Venetian rule at the time?

According to Reeves, the unaccountable lag between the invention of the Dutch telescope and Galileo's first intimation of its existence is not unaccountable at all. Galileo, she surmises, probably did hear of the device before May of 1609, but until that time he misunderstood what he had heard. That misunderstanding was based in part on the vagueness with which the instrument was initially described to Galileo and in part on his expectation that it would consist of some sort of mirror-lens combination. Galileo thus had no idea that the Dutch telescope consisted entirely of lenses until May or June of 1609; and only then, when he finally realized his mistake, was he able to embark on the path that led to the publication of the *Starry Messenger* in March, 1610.

Why was Galileo fixated on a mirror-lens telescopic device before learning of the actual composition of the Dutch telescope? The delightfully shandean story that Reeves offers in response takes us back to the legendary Pharos of Alexandria and the miraculous concave mirror mounted at its top. This mirror had such magnifying power that it could reveal ships at sea 500 miles away. Not only that, but it could focus sunlight on distant, hostile fleets with such concentration as to burn them long before they reached the harbor. With all its supernatural powers, this legendary mirror apparently served as the model for a host of subsequent fictional spy-mirrors, such as the one supposedly deployed by Caesar to scope out Britain from across the English Channel or the Chinese version described in the late 12th-century *Letter of Prester John*. Through the proliferation of such legends, the powerful spy-mirror, often given exotic origins and magical powers, had become a cultural trope in later Medieval and Renaissance Europe.

While late-Renaissance Europeans were lost in wonder at the marvelous capabilities of such legendary mirrors, the more mundane, yet still wondrous, capabilities of real concave spherical mirrors were capturing the interest of certain theorists and instrument-makers during the second half of the 16th century. Such interest may well have been piqued by improvements in the technology of mirror-making, although it is unclear that such improvements extended to the formation of concave mirrors. Whatever the case, by the second half of the 16th century, the optical focal properties of concave spherical mirrors had been recognized and exploited to enhance real images projected inside the *camera obscura*. Giambattista della Porta had even suggested the addition of a convex lens at the aperture. Moreover, plane mirrors had proved exceptionally useful in surveying devices, so it stood to reason that, if properly formed and deployed, concave mirrors might prove equally useful for surveying at great distances.

The chase was therefore on. Some researchers concentrated on formation, seeking to perfect the curvature of their mirrors while extending focal length as far as feasible in the hope of improving both magnification and image-clarity. Others concentrated on deployment, adding a convex sighting-lens to produce what is essentially a reflecting telescope. Although these efforts failed to yield satisfactory results, many researchers exaggerated the effectiveness of their particular device in the hope of attracting a wealthy patron, often publishing accounts extolling the merits of their invention while providing tantalizingly vague technical explanations of design and implementation. Perfection always seemed to be just around the corner. The long and short of it, according to Reeves, is that the mainstream of telescopic research at the beginning of 1609 was focused on concave spherical mirrors, either by themselves or in combination with convex lenses. And Galileo fell squarely within this mainstream until he finally learned in May or June of the actual composition of the Dutch telescope and reconfigured his research-program accordingly. Moreover, as Reeves points out in chapter 5 ('The Afterlife of a Legend'), Galileo's successful deployment of the Dutch telescope did not immediately put paid to the promise of an effective mirror-based telescope. After all, some, like Giovanni Magini, had a vested interest in such a device and were eager to protect that interest not only by extolling the merits of their alternative but also by deprecating Galileo's lens-based telescope and its observational results. Vicious priority-disputes also blossomed, as claims and counter-claims to originality were staked and defended, often on an *ad hominem* basis. Adding to the confusion were clashes over which 'nation' should get final credit for the invention.

I have no doubt that Reeves would be the first to admit that her explanation of why Galileo was so laggard in grasping the construction of the refracting telescope is plausible but not definitive. That, however, is somewhat beside the point. What makes this book so compelling (and so much fun) is the way Reeves embeds that explanation in her account of the social and cultural context of the refracting telescope's invention and dissemination. The result is a lively tale of seductive ideas, false hopes, serendipity, overweening ambition, partisan squabbling, astounding credulity, knaves, fools, and *agents provocateurs*—a story, in short, that is all too human.