The Telescope, Its History, Technology, and Future by Geoff Andersen

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The Telescope is a book of about 240 pages that was written for the general public rather than the historian of science. If this is the reader's first visit to the wonderful world of the telescope, this book is highly recommended as a good place to start, for one gains an appreciation of the importance of the telescope in the development of scientific ideas as well as of its diverse uses that include surveillance, mapping, and laser weaponry. The author takes the reader on a rapid journey from the time of the invention and application of the telescope in the early 1600s, to the time of Hubble. and up to the present with a discussion of future telescopes. The style is relaxed with digressions along the way that bring the human element to the subject. There is a lot of ground to cover in 240 pages; so some readers may find that their favorite subject within the 400 year old story, from the patent of the telescope in 1608 to the present time, does not receive enough attention or is not even mentioned. Hence, there are gaps in the story of telescope as told by the author; but if one is to keep the book to a manageable size, this is necessary. This book should whet one's appetite for further reading into the fascinating story of the telescope.

The author begins with a short chapter titled 'The Naked-Eye Universe' to lay the background for the introduction of the telescope. He ends the chapter with the understatement that the Dutch optician, Hans Lippershey, 'had invented a device which would dramatically increase the pace of inquiry into the physical universe and usher in the Enlightenment'. This point could have been given more emphasis. The author ends the main text of the book with the statement that the discoveries made with the aid of the telescope 'completely altered the way we view our universe and our place in it' [219].

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Chapter 2 describes the development of the telescope from its humble beginning, when Hans Lippershey, by chance, looked through two lenses separated by several inches and discovered that distant objects appeared larger. When Galileo heard about this new instrument, he quickly constructed one himself; and when he turned it to the heavens, he saw things that no one had seen before. He saw the moons of Jupiter, the phases of the planet Venus, and craters on the Moon— observations that were in various ways not compatible with the accepted doctrines of the day. There now was no turning back, for these findings truly altered how we view the universe and our place in it. Most of the chapter describes Galileo's work with an equal amount of space devoted to further developments up to the early 1800s. The contributions of giants such as Newton, Descartes, and Huygens are briefly discussed in the second half of the chapter.

The contributions of the many makers of telescopes (scientists, craftsmen, and opticians) from Galileo's time to the early 1800s are not even mentioned. There is no sense of the interplay and feedback between the many interacting, scientific, technical, and social forces associated with the telescope's development. There is the making of the telescope by the instrument makers, there are the many uses put to the telescope, and there are the results of that use. These three interrelated stories are important because they continue to be told today. There is no mention of developments in the 19th century.

In chapters 3, 4 and 5, the author describes how an ideal telescope works, the limitations of the telescope imposed by physical laws governing the interaction of light and matter, the wave nature of light, and the nature of the telescope design itself. For example, in a simple lens the focusing properties depend upon the color or wave length of the light. This is not a problem when the telescope uses mirrors instead of lenses. Additional external conditions, such as atmospheric turbulence, reduce the ideal design properties of the telescope and are discussed with sufficient detail that the reader will gain a real appreciation of why the Hubble telescope was developed and why most telescopes built today are on the tops of mountains. All of these requirements led to the current condition that virtually all telescopes made today for professional astronomical observations use mirrors for the main light collector rather than lenses.

Chapters 6 and 7 cover the subject of the measurement of the properties of the light that are collected by the telescope, as well as

the analysis and interpretation of these measurements. 'The next big thing for telescopes', according to the author, is combining the light waves of two or more telescopes in a coherent manner so that interference patterns are produced. One possible result of such a measurement technique would be the observation of objects very close to a star. Stay tuned.

Chapter 8 covers the many issues that must be considered when building a telescope observatory. The engineering process, along with the large number of issues that must be considered, would cause even a genius like Galileo, with his cardboard tubes, a difficult time with it all. Chapter 9 tells the intriguing story of the Hubble telescope, where things went wrong and how they were made right. The author also discusses some of the results obtained from the Hubble telescope, noting the tremendous growth of knowledge that has been added to our understanding of the universe. The Hubble dramatically reaffirms the impact of the discoveries of Galileo on our understanding of humankind's place in the expanding universe.

The book shines in the discussion of advanced telescope techniques in chapter 10 (and in chapter 15 which deals with future telescopes). Active optics, segmented primaries, adaptive optics, laser guide stars, terms we all read about but really do not completely understand, are subjects that the author covers with just the right amount of detail at just the right level. If you add the advances of detector technology and computers into the process, you have the necessary components for a 'renaissance' in telescope building.

Chapters 11 and 12 discuss applications of telescopes, such as surveillance and laser communication, areas one does not normally associate with telescopes. The word telescope has taken on a larger meaning than when it was introduced in 1611. The question may be asked, When is a telescope a camera, or a camera a telescope? One could argue that even the surveillance camera on the street corner is a telescope. If so, the telescope has become ubiquitous in our daily activities though we may not be aware of it.

This leads us to chapter 13 where some non-traditional observatories are described, principally to detect and measure energetic particles, light, and gravitational waves arriving from outer space. Clearly if one is to learn as much as possible about the universe, one must measure the emission of the various forms of energy from the

dynamical processes that occur in space. The author does a good job in discussing these issues.

The title of chapter 14 should be 'Recent Key Discoveries', for it will be hard to top the impact of the initial discoveries of Galileo. That said, the amount of new information we are obtaining about the universe is overwhelming and the pace will only quicken as new and bigger telescopes become operational.

The book ends with a very good discussion of future telescopes. Aperture fever sets in as we desire to see more distant objects with higher and higher resolution. As this reviewer pointed out earlier, the 17th-century story of the desire for bigger and better telescopes is repeated on a larger and more expensive scale. We now understand the physical laws that govern light behavior, which was of concern in the 17th century. Today it becomes an epic effort in engineering with the goal of understanding better the forces that mold our universe, a universe that almost defies comprehension because it appears to be beyond our everyday experiences and imagination.