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A BRIEF HISTORY OF TELESCOPES

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ABSTRACT

We provide a brief historical introduction to telescopes and descriptions of refractors, reflectors, and the most common type of modern (amateur) telescope, the hybrid catadioptric Schmidt–Cassegrains. We then describe the activities for our first session, which will allow you to explore the properties of these telescopes (and of the different types of telescope mounts), to experiment with magnification, to use an optics bench to build your own telescope, and to practice assembling, balancing, and aligning your 6" Schmidt–Cassegrain.

Subject headings: telescopes: reflectors, refractor — telescopes: Schmidt–Cassegrain, Newtonian/Dobsonian — eyepieces

1. INTRODUCTION (THANK YOU WIKIPEDIA!)

A telescope is an instrument designed for the observation of remote objects and for the collection of electromagnetic radiation. The first known functioning telescopes were invented in the Netherlands at the beginning of the 17$^{\text{th}}$ century. The name "telescope" was derived from the Greek "tele," meaning far, and "skopein," to look or see, and was coined by the Greek mathematician Giovanni Demisiani for one of Galileo's instruments. "Telescope" is now used to refer to a range of instruments operating in most regions of the electromagnetic spectrum.

In the 10$^{\text{th}}$ and 11$^{\text{th}}$ centuries, during the Islamic Golden Age, Ibn Sahl and Ibn al–Haytham made advances in optics that were essential to the development of spectacle–quality lenses and the telescope. There is some documentary evidence, but no surviving designs or physical evidence, that the principles of telescopes were known to Leonard Digges, Taqi al–Din, and Giambattista della Porta in the late 16$^{\text{th}}$ century.

The earliest known working telescopes were the refracting telescopes that appeared in the Netherlands in 1608. Their development is credited to three individuals: Hans Lippershey and Zacharias Janssen, who were spectacle makers in Middelburg, and Jacob Metius of Alkmaar. Galileo greatly improved upon these designs the following year. Niccolò Zucchi is credited with constructing the first reflecting telescope in 1616. In 1668, Isaac Newton designed a reflecting telescope that bears his name, the Newtonian reflector.

Most observatories, including our own, have a number of different types of telescopes. Tonight one of our goals is to familiarize ourselves with the most common types and to understand some of the advantages and drawbacks of their design.

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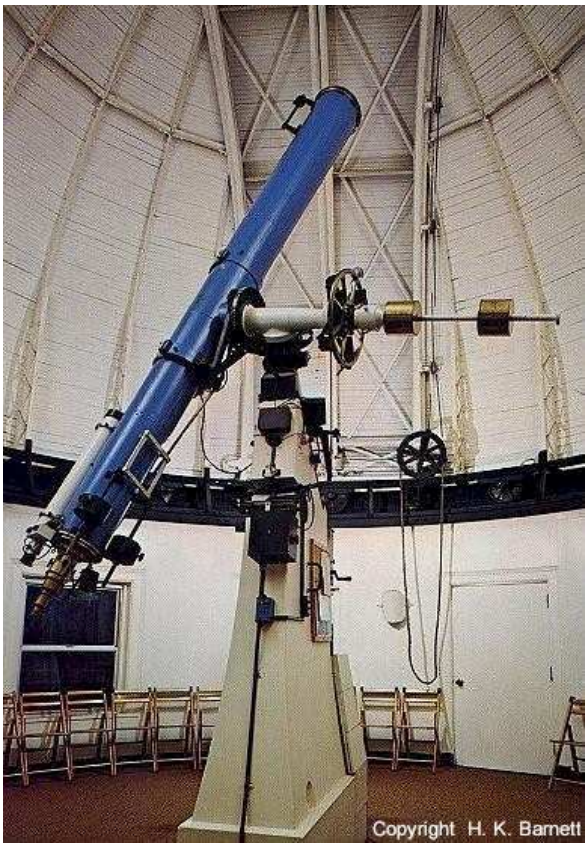

Fig. 1.— The 13–in Fitz–Clark Refractor of the Allegheny Observatory, built in 1861 by Mr. Henry Fitz. It was at that time the third largest telescope in the world. Notice the relative sizes of the telescope and of the chairs. `http://www.pitt.edu/~aobsvtry/fitzclark.html`.

1.1. *The first telescopes: Galilean Refractors*

A refracting or refractor telescope uses a lens as its objective to form an image. The refracting telescope design was originally used in spy glasses and astronomical telescopes, but is also used in other devices such as binoculars and long or telephoto cam-

era lenses.

In all refracting telescopes, the combination of an objective lens and some type of eyepiece is used to gather more light than the human eye can collect, focus it, and present the viewer with a brighter, clearer, and magnified image. The objective in a refracting telescope refracts or bends light. This refraction causes parallel light rays to converge at a focal point; those that were not parallel converge upon a focal plane. Refracting telescopes come in many different configurations to correct for image orientation and various types of aberration.

1.2. *The most common reflector telescopes: Newtonians/Dobsonians*

The Newtonian telescope, invented in 1689 by Sir Isaac Newton (1643–1727), is a reflector that uses a parabolic primary mirror and a flat diagonal secondary mirror.

FIG. 2.— Cameron handling the 12–in Dobsonian reflecting telescope on the Pupin roof. *Picture by Destry Saul.*

The Dobsonian telescope is a design that has become popular among amateur astronomers because it results in an extremely simple and rugged large–aperture instrument at low cost. The term Dobsonian or "Dob" refers to any telescope with an Altitude–Azimuthal mount and a Newtonian telescope tube assembly that feature several innovations made popular by John Dobson. The telescope is a favorite among amateur telescope–makers who pioneered the design and has been made increasingly popular by commercial telescope makers.

1.3. *The most common modern telescopes: the hybrid (catadioptric) Schmidt–Cassegrains*

Developed in 1672 by Laurent Cassegrain, the Cassegrain reflector is a combination of a primary concave mirror and a secondary convex mirror, both aligned symmetrically about the optical axis. The primary mirror usually contains a hole in the center thereby permitting light to reach an eyepiece, a camera, or a detector. The primary mirror is parabolic while the secondary mirror is hyperbolic.

The Schmidt camera was invented by Bernhard Schmidt in 1930. Its optical components are a spherical primary mirror and a correcting lens, known as the corrector plate, located at the center of curvature of the primary mirror.

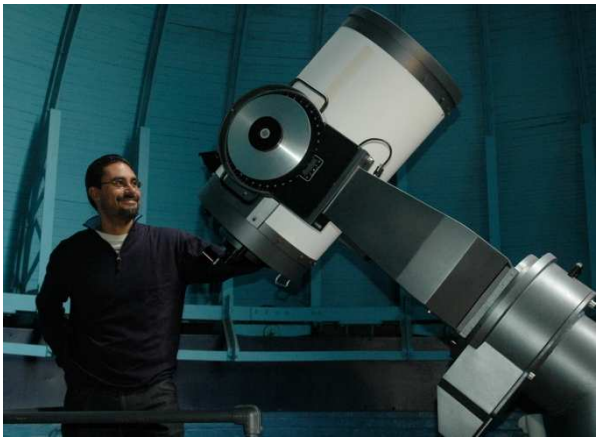

FIG. 3.— Marcel standing by the 16–in Schmidt–Cassegrain reflecting telescope in the observatory dome. *Picture by Destry Saul.*

An early Schmidt–Cassegrain telescope was patented in 1946 by artist/architect/physicist Roger Hayward. As in the Schmidt camera this design used a spherical primary mirror and a corrector plate to correct for spherical aberration. From the Cassegrain, it inherited the convex secondary mirror, perforated primary mirror, and a final focal plane located behind the primary.

This design is very popular with consumer telescope manufacturers because it combines easy–to–manufacture optical surfaces to create an instrument with the long focal length of a refracting telescope with the lower cost per aperture of a reflecting telescope. The compact design makes it comparably easy to transport, which adds to the telescopes' marketability. Their high f–ratio, however, means they are not a wide–field telescope like their Schmidt camera predecessors.