ISTITUTO E MUSEO
DI STORIA DELLA SCIENZA

CHRONOLOGY

1608: THE INVENTION OF THE TELESCOPE
On October 2 the Dutch Estates General discuss the patent application presented by a certain Hans Lipperhey (?-1619), an optician in Middleburg who came from Wesel (western Germany), for the production of "a device to observe things at a distance". This is the first certain source testifying to the invention of the telescope. The patent is denied because the Estates General deem that, due to the intrinsic simplicity of the instrument, which consists of only two lenses, it would be impossible to keep the secret of its construction for long. However, the Dutch government commissions a certain number of these instruments from Lipperhey, specifying that they are to be of the binocular type with lenses made of rock crystal.

1609: THE FIRST TELESCOPES
In the month of April, rudimentary examples of the telescope with magnification of 3 or 4 are on sale in Paris, and probably in London as well, at opticians' shops.

1609: GALILEO'S FIRST TELESCOPE
In May, Galileo (1564-1642) first hears of the invention of the telescope. The news is confirmed to him a few days later in a letter from Paris written by the Frenchman Jacques Badovere (1570/1580-c. 1620), already his disciple.
In July and August Galileo builds his first telescope, which has a magnification of 3.

1609: THOMAS HARRIOT OBSERVES THE MOON
On August 5 the English mathematician and astronomer Thomas Harriot (c. 1560-1621) observes the Moon with a 6-power telescope, making a sketch of the lunar surface that has come down to us. It is a rather rough representation, testifying to the poor quality of Harriot's instrument.

1609: IN VENICE GALILEO DEMONSTRATES AN 8-POWER TELESCOPE
On August 21, on the bell tower of St. Mark's, in the presence of the Doge and other Venetian notables, Galileo (1564-1642) gives a demonstration of a telescope made by him with magnification of about 8. This will win him a lifetime appointment to a university chair, and a raise in salary from 520 to 1000 florins a year.

1610: GALILEO'S DISCOVERIES
On January 7, Galileo (1564-1642), using a 20-power telescope fabricated by him, discovers three of Jupiter's satellites. A fourth satellite is then discovered on the night of January 10.

1610: THE *SIDEREUS NUNCIUS*
The *Sidereus Nuncius* [Starry Messenger] by Galileo (1564-1642), dedicated to Grand Duke Cosimo II de' Medici (1590-1621) is published in Venice.

1610: THE "THREE-BODIED" NATURE OF SATURN
On July 30, in a letter to Belisario Vinta (1542-1613), the Secretary of State to Grand Duke Cosimo II (1590-1621), Galileo (1564-1642) — while awaiting the publishing of his discovery in a planned new edition of the *Sidereus Nuncius* (Venice, 1610) — announces the "three-bodied" nature of Saturn.
In August, in a letter to Giuliano de' Medici, Tuscan ambassador to Prague, Galileo announces the discovery of the "three-bodied" nature of Saturn, in the form of an anagram that Kepler (1571-1630) tries in vain to decipher. He had already informed Belisario Vinta of his discovery on July 30.

1610: THE PHASES OF VENUS
In a letter to Giuliano de' Medici dated December 11, Galileo (1564-1642) announces under the form of an anagram, which Kepler (1571-1630) tries in vain to decipher, his discovery of the phases of Venus.

1611: GALILEO IN ROME
In late March Galileo (1564-1642) goes to Rome to demonstrate the discoveries he has made with the telescope to the ecclesiastical authorities.

1611: KEPLER'S *DIOPTRICE*
In Augsburg the *Dioptrice* by Johann Kepler (1571-1630) is published. In this text the author suggests, among other things, replacing the diverging eyepiece of the Galilean telescope with a converging lens (Keplerian telescope).

1611: GALILEO MEMBER OF THE ACADEMY OF THE LINCEI
In Rome Galileo becomes a member of the Academy of the Lincei in a convivial meeting held on April 14 in the villa on the Janiculum owned by Cardinal Cesi, the uncle of Prince Federico, founder of the Academy.

1612: SUNSPOTS
Under the pseudonym of *Apelles latens post tabulam* (Apelles hidden behind the painting) the Jesuit Father Scheiner (1573-1650) publishes three letters, sent to Marc Welser (1558-1614), on sunspots.

1613: THE *ISTORIA E DIMOSTRAZIONI INTORNO ALLE MACCHIE SOLARI*
Under the title of *Istoria e dimostrazioni intorno alle macchie solari e loro accidenti* [History and demonstrations concerning sunspots and their characteristics], the three letters written by Galileo (1564-1642) to Marc Welser (1558-1614) are published in Rome under the aegis of the Academy of the Lincei.

1613: THE *DISPUTATIO DE COELO*
The *Disputatio de coelo* by Cesare Cremonini (1550-1631) is published in Venice.

1616: BELLARMINO'S ADMONITION TO GALILEO
The so-called first trial of Galileo (1564-1642) takes place. The *De revolutionibus orbium coelestium* of Copernicus (1473-1543) is prohibited *donec corrigantur* (pending correction). Galileo, who is informed of this measure by Cardinal Bellarmino (1542-1621), is ordered not to hold or defend the heliocentric theory. The proposition, "Sol est centrum mundi et omnino immobilis motu locali" is censured by the Holy Inquisition, insofar as deemed philosophically

absurd and formally heretical; the proposition "Terra non est centrum mundi nec immobilis, sed secundum se totam se movere etiam motu diurno" is censured on the grounds that it is erroneous in faith at least.

1618: THE *TELESCOPIUM SIVE ARS PERFICIENDI*
The *Telescopium sive ars perficiendi* by Girolamo Sirtori is published in Frankfurt.

1621: SNELL FORMULATES THE LAW OF SINES
Willebrord Snell (1580-1626) formulates the law of sines.

1623: THE *SAGGIATORE*
Edited by the Academy of the Lincei and dedicated to the new Pope Urban VIII (1568-1644) *Il Saggiatore* **[The Assayer]**by Galileo (1564-1642) is published in late October in Rome.

1630: THE *ROSA URSINA* AND THE *COMMENTATIONES IN MOTUM TERRAE DIURNUM & ANNUUM*
Father Christoph Scheiner (1573-1650) publishes the *Rosa Ursina* at Bracciano.
The *Commentationes in motum Terrae diurnum & annuum* by Philip Landsberg (1561-1632) is published at Middelburg.

1630: THE DARK BANDS ON JUPITER
On May 17, 1630 the Jesuit priest Niccolò Zucchi (1586-1670), professor of theology and mathematics at the Collegio Romano, discovers the dark bands on the disc of Jupiter. A crater on the moon is dedicated to Father Zucchi.

1632: THE *DIALOGO SOPRA I DUE MASSIMI SISTEMI DEL MONDO*
In February the *Dialogo sopra i due massimi sistemi del mondo* [Dialogue on the Two Great World Systems]by Galileo (1564-1642) is published in Florence by G. B. Landini. It had been finished two years earlier, after having been interrupted several times.

1633: GALILEO'S TRIAL
On April 12 the first hearing of the so-called second trial of Galileo (1564-1642) is held, in which he appears before the Holy Office.
On June 22 of the same year, the trial concludes with Galileo's abjuration and sentencing to prison. The prison sentence is mitigated into a sort of house arrest and in July Galileo goes to Siena where he stays as guest of Archbishop Ascanio Piccolomini (1597-1671). In December he obtains authorization from the Pope to return to the villa “Il Gioiello” at Arcetri, in the vicinity of Florence, where he remains in confinement until his death.

1636: THE *HARMONIE UNIVERSELLE*
The *Harmonie Universelle* by Marin Mersenne (1588-1648) is published in Paris.

1637: THE *DIOPTRIQUE*
The *Dioptrique* is published in Leyden. Based on the law of sines, formulated in 1621 by Willebrord Snell (1580-1626), Descartes (1596-1650) demonstrates in 1621 that a plano-convex lens whose surface is of hyperbolic section would be free from spherical aberration. But despite various attempts, neither Descartes nor any of his contemporaries were able to produce lenses with hyperbolic surfaces.

1639: THE MICROMETER
The Englishman William Gascoigne (1612-1644) introduces the micrometer, a device to be applied to the eyepiece of a telescope to measure angular distances.

1642: DEATH OF GALILEO
On January 8 at Arcetri, near Florence, in the villa "Il Gioiello" where he is confined, Galileo (1564-1642) dies.

1642: THE *OCULUS ENOCH ET ELIAE SIUE RADIUS SIDEREOMYSTICUS*
The *Oculus Enoch et Eliae siue Radius sidereomysticus* by Anton Maria Schyrleus de Rheita (1604-1660) is published in Antwerp. This treatise contains a large section dedicated to binocular telescopes.

1646: THE *NOVAE COELESTIUM TERRESTRIUMQUE RERUM OBSERVATIONES*
The Neapolitan Francesco Fontana (c.1580-1656) publishes the *Novae Coelestium Terrestriumque Rerum Observationes* in Naples. Fontana was probably the first, starting in the early 1630s, to systematically utilize and market the Keplerian telescope, (which he even claims, in the *Observationes*, to have invented in 1608) and his instruments soon became renowned all over Italy and France. This work contains 28 plates of the Moon observed in its various phases and, although surpassed already in the following year by the famous *Selenographia* (Gdańsk, 1647) of Hevelius (1611-1687), Fontana's text is the first selenographic work having a certain organic structure. The treatise also includes observations on Mars, on whose surface Fontana observed a great dark patch, probably the Syrtis Major.

1655: THE DISCOVERY OF TITAN
On March 25, utilizing a telescope he had built himself having an aperture a little over 5 cm, Christiaan Huygens (1629-1695) discovers Titan, the largest of Saturn's satellites. This was the first discovery of a new celestial body after that of the four satellites of Jupiter made by Galileo 45 years before.

1656: THE *DE SATURNI LUNA OBSERVATIO NOVA*
The *De Saturni luna observatio nova* is published in the Hague. In this brief treatise, dedicated to the discovery of Titan the year before, Huygens (1629-1695) includes an anagram on the discovery of Saturn's ring. The anagram, whose meaning was to be disclosed only in 1659, when Huygens divulged his discovery, reads in fact: "Annulo cingitur, tenui, plano, nusquam cohaerente, ad eclipticam inclinato" ([Saturn] is surrounded by a slender ring, flat, which does not touch [the planet] at any point and is inclined in respect to the ecliptic).

1659: THE *SYSTEMA SATURNIUM*
Christiaan Huygens (1629-1695) publishes the *Systema Saturnium* in The Hague.

1660: THE *BREVIS ANNOTATIO IN SYSTEMA SATURNIUM CHRISTANI EUGENII*
Eustachio Divini (1610-1685), the most famous optician in all Europe around the middle of the 17th century, publishes in Rome the *Brevis annotatio in Systema Saturnium Christani Eugenii*, dedicated to Leopoldo de' Medici (1617-1675), the brother of the Grand Duke of Tuscany. In this work Divini claims that he, not Christiaan Huygens (1629-1695), had been the first to discover the satellites of Saturn.

1663: GREGORY'S TELESCOPE
The Scotsman James Gregory (1638-1675) designs a reflecting telescope with a primary mirror (objective) of parabolic section and a secondary one of elliptical section, situated beyond the focal point of the primary. This optical combination furnishes erect images without the need for an erector. For this reason too, the Gregorian telescope met with great success around the middle of the 18th century, above all thanks to the work of the famous Scottish optician James Short (1710-1768),

who made over a thousand of these telescopes, some of them very large, during the course of his career.

1666: THE *THEORICAE MEDICEORUM PLANETARUM EX CAUSIS PHYSICIS DEDUCTAE*
Giovanni Alfonso Borelli (1608-1679) publishes the *Theoricae Mediceorum planetarum ex causis physicis deductae* in Florence.

1666: THE *MARTIS CIRCA AXEM PROPRIUM REVOLUBILIS OBSERVATIONES*
The *Martis circa axem proprium revolubilis observationes* by Giovanni Domenico Cassini (1625-1712) is published in Bologna. Cassini, using telescopes built by the famous optician Giuseppe Campani (1635-1715), had observed Mars, making drawings of its surface and determining its orbital period, which he estimated as 24hr 40min (a value less than 3min greater than the one accepted today) on an axis that was almost perpendicular to its orbital plane. An orbital period very close to the one assumed by Cassini had been determined in 1659 by Christiaan Huygens (1629-1695) who however, being unsure of the result, had failed to publish his discovery.

1668: NEWTON'S REFLECTING TELESCOPE
Isaac Newton (1642-1727) builds a reflector with parabolic objective and a plane secondary mirror of elliptical section that sends the light beam laterally outside of the tube.

1671: THE DISCOVERY OF IAPETUS
In December, utilizing a 17-foot telescope built by Giuseppe Campani (1635-1715), Giovannni Domenico Cassini (1625-1712) discovers a second satellite of Saturn, Iapetus.

1671: THE SECOND EXAMPLE OF NEWTON'S REFLECTING TELESCOPE
Isaac Newton (1642-1727) builds a second example of the telescope he has designed. The instrument is presented to the Royal Society of London, where it arouses great interest.

1672: CASSEGRAIN'S REFLECTING TELESCOPE
The Frenchman Laurent Cassegrain (c. 1629-1693), at the time professor of physics at Chartres, designs a reflector with a parabolic objective and a hyperbolic secondary, placed in front of the focal point of the primary, which focuses the image behind the latter, passing through a hole in it. Thanks to the diverging element, consisting of the hyperbolic secondary, this optical combination, still in use today, especially for amateur telescopes, provides for relatively long focal lengths (typically f/15) with tubes of limited dimensions.

1672: THE DISCOVERY OF RHEA
In December, utilizing a 34-foot telescope built by Giuseppe Campani (1635-1715), Giovanni Domenico Cassini (1625-1712) discovers a third satellite of Saturn, Rhea.

1673: THE *HOROLOGIUM OSCILLATORIUM SIVE DE MOTU PENDULORUM*
The *Horologium oscillatorium sive de motu pendulorum* by Christiaan Huygens (1629-1695) is published in Paris. In it the author describes the application of the pendulum to the measurement of time.

1684: THE DISCOVERY OF TETHYS AND DIONE
In March, utilizing the 100-foot and 136-foot telescopes of Giuseppe Campani (1635-1715), Giovanni Domenico Cassini (1625-1712) discovers two more satellites of Saturn, Tethys and Dione. The incredible series of discoveries made by Cassini using telescopes built by Campani sanctioned the latter's fame as Europe's finest optician.

1687: THE *PHILOSOPHIAE NATURALIS PRINCIPIA MATHEMATICA*

The *Philosophiae naturalis principia mathematica* by Isaac Newton (1642-1727) is published in London.

1721: HADLEY'S REFLECTING TELESCOPE

On January 12, John Hadley (1682-1744) presents to the Royal Society, of which he is a member, a Newtonian reflector fabricated by him with an aperture of 6 inches (approx. 15 cm) and a focal length of 62 inches (approx. 157 cm). This is the first example of a reflector with performance levels comparable to those of the refracting telescopes of the time. The technical solutions adopted were numerous and innovative, such as a screw focus mechanism, a checker and micrometric movements that greatly facilitated the sighting and tracking of celestial bodies. As compared to the refractor 123 feet long (approx. 37.5 m) of Huygens (1629-1695), Hadley's reflector, although less luminous (the mirrors of the time were made of a copper and tin alloy called speculum metal, which reflected only about 60% of the incident light), had virtually the same definition, with the difference that, being only about 1.8 m long, the Newtonian telescope was vastly easier to use.

1729: THE ACHROMATIC OBJECTIVE

Chester Moor Hall (1703-1771) invents the achromatic objective.