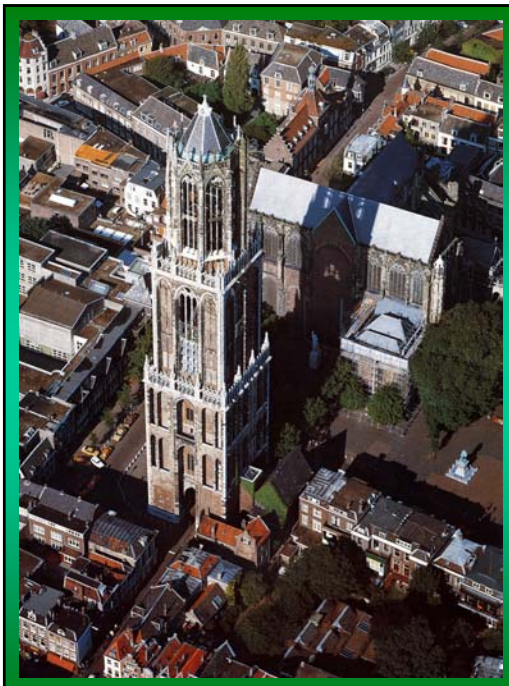
PCES 6.1

The DUTCH GOLDEN AGE (I)

Even before the Renaissance, the 'low-country' region (modern Belgium, Netherlands) was along with Nth Italy the most important economic zone in Europe. With Protestantism came a concerted effort by Philip II of Spain to consolidate the Spanish empire. Like England, the Dutch successfully resisted. By 1629 the region was divided into a free Protestant north, and a disputed southern region- a split formalized in 1648.



The Dom Tower in Utrecht (constructed 14th Century)

Near central Amsterdam

PCES 6.2

The DUTCH GOLDEN AGE (II)

From the 1580's to 1672 a remarkable cultural surge took place, with its zenith in ~ 1650-70. Refugees from war & religious persecution flocked to Amsterdam, now the world's largest port.

Rembrandt, 1640; self-P

'The Stalmeesters' (Rembrandt, 1662)

'Anatomy lesson of Dr N. Tulp' (Rembrandt, 1632)

Danae (Rembrandt, 1636-43)

PCES 6.3

DUTCH GOLDEN AGE (III)

Jan Six (Rembrandt, 1654)

The separation into strong provinces hindered the power of the church to control intellectual life in the Dutch republic. By 1645, Leiden university was the largest in the Protestant world. Alliances with England maintained the exchanges which had begun even before Erasmus.

The Golden age brought an outpouring of innovation in Art & architecture, & the founding of universities like Leiden (1575) Groningen (1614), & Utrecht (1634). These were the 1st international universities- over1/2 the students were foreign. Jewish refugees helped found the Amsterdam bourse.

'The Night Watch' (Rembrandt, 1642)

PCES 6.4

DUTCH GOLDEN AGE (IV)

Girl with a Pearl Earring (Vermeer, 1665)

The mechanistic & mathematical ideas of Descartes quickly took hold in Holland- his colleague F. van Schootens trained Huyghens. The reactionary movement led by Voetius against Cartesian ideas was unsuccessful- although it inconvenienced Descartes.

As today, the Dutch depended heavily on trade. With England, they became a great sea power (later tamed by the English). The great Dutch land reclamation project accelerated. After 1630, religious toleration was widespread, but public morals were rigidly controlled.

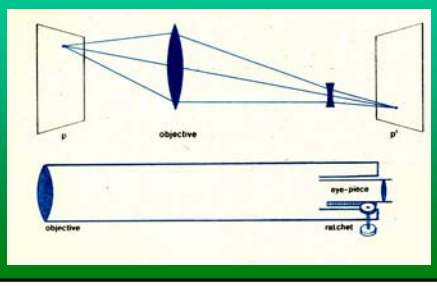
'View of Delft' (Vermeer, 1661)

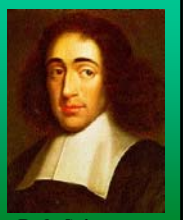
Dutch Optics- the TELESCOPE

Hans Lippershey
(1570-1619)

Extraordinary technical innovation often accompanies any intellectual or scientific revolution. In the Netherlands this began very early. Although this is debated, most consider the telescope was invented in 1608 by Lippershey. Within 2 years Galileo and many others had them, with the rapid consequences we have seen. Very quickly refracting telescopes much superior to the original design were being made- the remarkable philosopher Spinoza made his living making lenses for telescopes and spectacles.

The principles governing the lens, or of the telescope, were not properly understood at the time- the discovery was an accident, and design of lenses was a hit-and miss affair. The laws of refraction were first understood by Snell in 1620, allowing some understanding of the shape required for a lens to bring light to a focus. However there was much more to find out about light before really good telescopes could be made. At the time it was widely believed that light was made from tiny corpuscles, which travelled in straight lines through space- a belief to be enshrined in later theories from both Descartes & Newton.

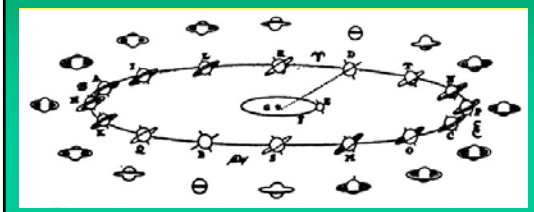




B. de Spinoza
(1632-1677)

The Ideas of C. HUYGHENS (1629-95)

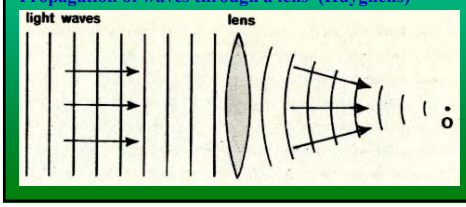
Working out of Leiden, Huyghens was an astronomical pioneer, as well as being one of Europe's foremost mathematicians, and a remarkable physicist. In astronomy he is best known for his explanation of Saturn's rings- a remarkable piece of deduction (see below), and his theoretical work on the best form of lenses.

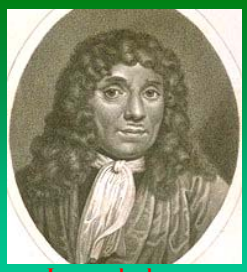


Huyghens explanation of the appearance of Saturn

However Huyghens's most important contribution to science by far was his wave theory of light. He argued that the known properties of light, such as the refraction and the propagation in straight lines, could be understood by assuming that light was a wave motion in some invisible medium, analogous to the motion of waves on a fluid. The facts of refraction could be understood by if the waves travelled more slowly in a dense medium (like waves in shallow water). He gave the first mathematical theory of wave propagation, showing amongst other things how they could be built up from 'elementary wavelets', radiated in circular patterns from multiple sources.

Propagation of waves through a lens (Huyghens)





Leeuwenhoek

VERMEER and OPTICS

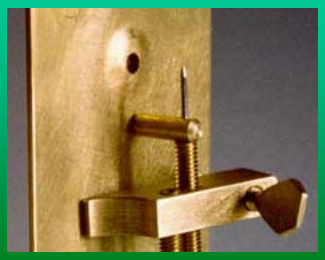
'The Astronomer' (Vermeer, 1668)

It has been widely speculated that Vermeer used some of the new discoveries in optics to help in the execution of his paintings- at least a 'camera obscura' being used, and even the uses of lenses to project the image of the subject onto the canvas.

A very interesting speculation, which is unproven, is that Vermeer may have picked up the techniques required to do this from the remarkable Antonie van Leeuwenhoek (1632-1723). Leewenhoek was the executor of Vermeer's will, and the suggestion is that he made available his understanding of optics to Vermeer, and provided him with lenses. Leeuwenhoek was the pioneer of microscopy- in advance of the rest of the world despite having no university education. It is further argued that Leeuwenhoek was actually the model for the painting above.

MICROSCOPES & the discovery of MICRO-ORGANISMS

The microscopes of Leeuwenhoek could magnify up to 180x. A nearly spherical lens was held between 2 metal sheets, and the microscopic sample placed on a needle whose position could be adjusted with a screw.



In a series of communications Leeuwenhoek revealed his results on the discovery of microscopic life (which he called 'animalcules'), of blood cells, and so on- like a Galileo of the microscopic world, he gave detailed reports on everything he saw.

It was years before others could repeat his results, even in Holland. Below we see results of Robert Hooke (1635-1703), one of the 1st British scientists to do similar work.