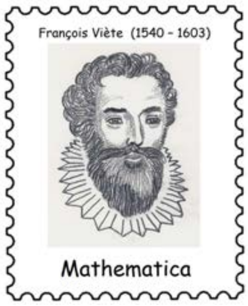
CHRISTIAAN HUYGENS (April 14, 1629 – July 8, 1695)

by Heinz Klaus Strick, Germany

Born in the Hague as the son of a poet and wealthy diplomat, Christiaan Huygens enjoyed extensive and varied training from various private tutors. In addition to Latin, Greek, French and Italian, he also learnt arithmetic, logic, geography and composition. His father Constantin Huygens had connections with many important scientists all over Europe, not least due to his work on behalf of Wilhelm II, Prince of Orange, the governor of the young Republic of the Netherlands.

One of the friends of the family was René Descartes (1596 – 1650), who had lived in liberal Holland since 1629.



(drawing: © Andreas Strick)

At the age of 16, Christiaan Huygens began studying law in Leiden, and attended mathematics lectures by Frans von Schooten (1615 – 1660), a gifted teacher of mathematics and editor of François Viète's (1540 – 1603) *Opera mathematica*. He then moved to Breda, where John Pell (1611 – 1685) taught, and received his doctorate in law at the Protestant University of Angers.

Contrary to family tradition, he did not enter the diplomatic service but devoted himself to scientific research. In his first publication, published in 1651, he dealt with the determination of tangents to curves and the centres of gravity of surfaces. He also proved that a squaring of the circle by the Flemish mathematician Grégoire de Saint-Vincent, published in 1647, was faulty.

With this reputation, Huygens set off on a journey to Paris in 1655. There he heard about the famous correspondence between Pierre de Fermat (1608 – 1665) and Blaise Pascal (1623 – 1662) from 1654, but found out nothing about its contents:

... although these men put each other to the test with many difficult questions, they did not reveal their methods. Therefore I was forced to investigate and fathom everything myself from the very beginning ...

Huygens set himself the goal of developing a general method of solving gambling problems that could be applied to other problems as well, beyond the solution of the two problems *Problème des dés and Problème des partis* (Problems of dice and games).

He was convinced: "Although the outcome of games of chance alone is uncertain, it is always possible to calculate exactly how much closer (*... quam perdendum proprior sit...*) a player is to winning than to losing".

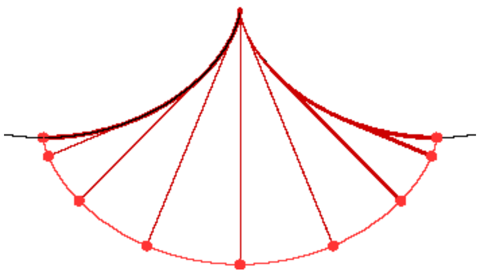
The term "probability" does not appear in his texts; rather, he uses the term "hope" (Latin: *expectatio*): "In gambling, the hope of a player to receive something is so high that if he has this hope, he can reach the same hope again if he plays under the same condition".

Thus, he demanded of a just game that all those involved in the game would be willing to exchange their own role with that of another. His theory of gambling (*Tractatus de Ratiociniis in Aleae Ludo – Van Rekeningh in Spelen van Geluck)* was published in 1657 as part of the book *Exercitationum Mathematicarum* by his teacher Frans von Schooten. Jakob Bernoulli's posthumous work *Ars conjectandi* (The Art of Conjecture), published in 1713, contained the Huygens's treatise as its first chapter – with extensive commentary.

As early as 1654, Huygens and his brother developed a special method of grinding optical lenses. With a telescope he built himself, he discovered Titan, the first moon of Saturn. In 1656, he solved the riddle of what Galileo called the *handles of Saturn*. Saturn is surrounded by a ring that is not connected to the planet and whose appearance changes depending on the angle from which it is viewed from the earth (*Systema Saturnium,* 1659). He determined the rotation period of Mars and could make out individual stars in the centre of the Orion Nebula (now called the Huygens region).

For seafaring one needs accurate clocks to determine the longitude of ships. The difference in longitude can be determined from the time difference between the displayed time and the time calculated by celestial observation. Huygens was also intensively engaged in the problem of exact time measurement, taking up the idea of Marin Mersenne (1588 – 1648) to use a pendulum for this purpose.

During his studies, he discovered the laws connecting the period of oscillation and the length of the pendulum and was thus able to determine the gravitational constant. He found out that a pendulum oscillates *tautochronously* (i.e. it takes exactly the same time to oscillate – regardless of how far it is deflected at the beginning) when the pendulum body moves on a cycloid arc. This can be realized by guiding the thread on which the oscillating mass is suspended along two cycloid-shaped templates.



Source: Techn. FH Berlin

In 1656 Huygens had the design of such a pendulum clock patented. He commissioned the clockmaker Salomon Coster to realise his ideas: Each time the pendulum swung through a certain point, the clock advanced by one unit of time; at the same time, the pendulum received a regular impulse so that the oscillation did not stop.

The clocks he designed have an accuracy of better than 10 seconds per day. In 1673 he published *Horologium oscillatorium sive de motu pendulorum* (Oscillatory motion of the pendulum clock). However, the work encompassed much more than just his studies on the construction of a pendulum clock. It contained extensive research on bodies falling vertically or parallel to curves and on centrifugal forces, as well as on the properties of cycloids (curve length, centres of curvature, envelopes).

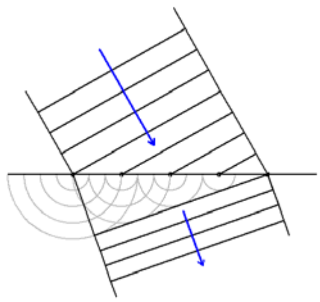
The fact that HUYGENS dedicated this work to his patron, the French King LOUIS XIV, who had attempted to occupy the Netherlands the year before, was something that caused resentment at home. (LOUIS XIV had appointed him in 1666 to head the *Académie Royale des Sciences* in Paris, so that he could organise it along the lines of the *Royal Society*. HUYGENS had already been elected a member of the London Society in 1663.)

When in 1681 Protestants were no longer tolerated in France, HUYGENS returned to the Hague. After the revocation of the *Edict of Nantes* in 1685 he broke off all contacts with France. In 1688 the Dutch regent, Prince WILLIAM OF ORANGE, became the new English king WILLIAM III after the Glorious Revolution.

In 1689 HUYGENS travelled to England to meet ISAAC NEWTON (1643 – 1727). On the one hand he admired his *Philosophiae Naturalis Principia Mathematica* published in 1687; on the other hand he considered the idea that masses can influence each other at a distance absurd.

After his return, he published his theory of light (*Traité de la lumière*), with the help of which he was able to explain the reflection and refraction of light at the interface between media of different optical densities as well as the phenomena of double refraction and diffraction.

The HUYGENS principle, named after him, states:



- *Every point of a wave front can be considered as the starting point of a new wave. Thus, when a wave front encounters a boundary surface, new waves are created whose envelope is the "new" wave front.*

The last five years of his life were spent by HUYGENS, who was unmarried all his life, on his estate near The Hague, sick and lonely.

The last bitter dispute with ISAAC NEWTON, who developed the corpuscular theory for the propagation of light, was "decided" in NEWTON's favour by the *Royal Society* in 1715, 20 years after HUYGENS' death.

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https://www.spektrum.de/wissen/christiaan-huygens-1629-1695-gluecksspiele-pendel-und-die-physik-des-lichts/984923

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