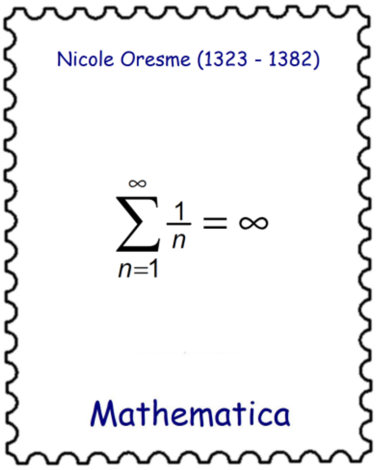
NICOLE ORESME (1323 – July 11, 1382)

by HEINZ KLAUS STRICK, Germany

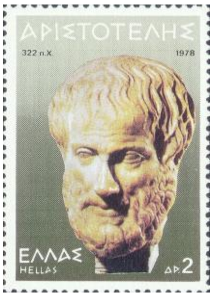


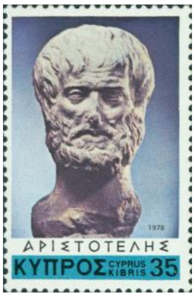
NICOLE ORESME is known to have been born around 1323 in the French village Allemagne (today: Fleury-sur-Orne), a town near Caen (Normandy). In the early 1340s, he studied Arts at the *Collège de Navarre*, a royal institution for students who were unable to pay tuition fees.

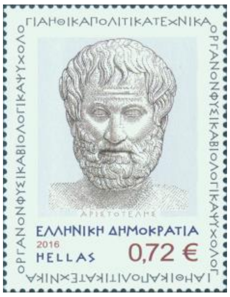
In 1348 he began studying theology at the University of Paris. In 1356 he was appointed head (*grand-maître*) of the *Collège de Navarre*. His doctorate (1362) was followed by his appointment as canon of the Sainte-Chapelle in Paris, and later also as dean of the Cathedral of Rouen.

ORESME made friends with the Dauphin CHARLES, who appointed him court chaplain and his personal advisor in 1364 after his enthronement as King CHARLES V. In 1377, the king appointed him Bishop of Lisieux. Lisieux is today a town of only 20,000 inhabitants, though in Roman times and in the Middle Ages it was an important regional centre, situated between Caen and Rouen. ORESME held the office of bishop until his death in 1382.

NICOLE ORESME is considered one of the most important scholars of the late Middle Ages. On behalf of the king, he translated various works by ARISTOTLE into French; for this purpose, he "invented" some new terms that have since become part of the vocabulary of the French language. From his commentaries on the translated writings, it is clear that a new era had begun in which the views of ancient philosophers, hitherto adopted without reflection, were being critically reconsidered.



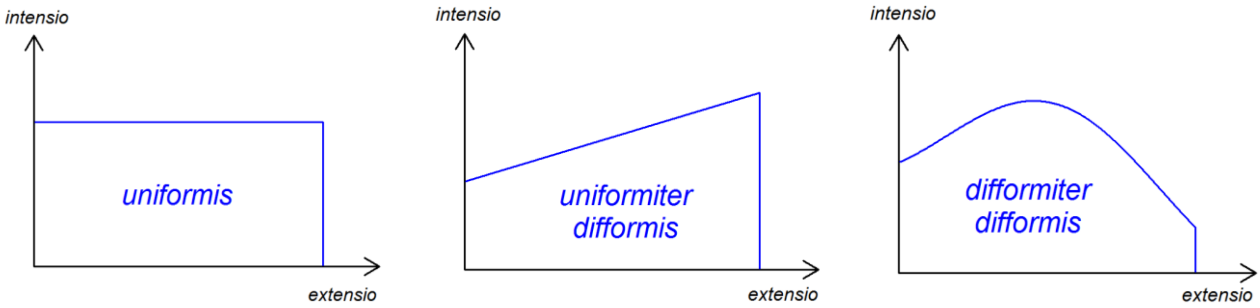




Among ORESME's teachers was JEAN BURIDAN, who had studied the theory of movement of ARISTOTLE. According to this theory, a constant force is required to maintain the motion of an object. Such a force is exerted by the surrounding medium, so in a vacuum no movement is possible. BURIDAN modified this theory by introducing an *impetus* as the cause of motion - after the body has received an "impetus", this is "used up" by the moving body.

In his work *De configurationibus qualitatum et motuum*, ORESME went beyond BURIDAN's approach and attempted to illustrate movement processes through diagrams. He distinguished between *extensio* and *intensio* as associated properties – specifically, in the case of the movement of a body, time as *extensio* (extension) and speed as *intensio*.

He depicted different forms of movement in a kind of coordinate system: a uniform movement (*uniformis*) with the help of a straight line that runs parallel to the time axis, a uniformly accelerated movement, i.e. a movement in which the speed increases by the same amount in the same time intervals (*uniformiter difformis*), with the help of an ascending straight line, as well as a movement in which the speed does not change uniformly (*difformiter difformis*).



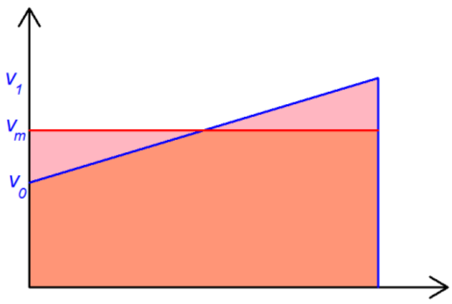
The fact that ORESME recognised a connection between the area of the surface represented in the graph and the distance covered in the movement is clear from his writing *Tractatus de configuratione intensionum*.

At Merton College, Oxford University, the so-called *Merton Rule* was established around 1328 by the scholars THOMAS BRADWARDINE and RICHARD SWINESHEAD:

> *If a body is accelerated uniformly from a velocity* v_0 *to a velocity* v_1 *in a certain interval of time, then the body in this time interval travels the same distance as a body moving at the speed* $v_m = \frac{1}{2} \cdot (v_0 + v_1)$.

The validity of this rule – made eloquently plausible by the Oxford scholars – can easily be justified by ORESME with the help of the second graph. The *Tractatus de configuratione intensionum* states:

> *Every uniformly non-uniform quality has the same quantity as if it were uniformly given to the same object with the degree of the middle point.*



The polymath ORESME also dealt with the question of which musical intervals sound "beautiful" (*pulcher*) and which sound "ugly" (*turpis*) and which division ratios on the strings should be chosen for the tones.

In this context, he further developed the classical doctrine of proportions. His writings *Algorismus proportionum* and *De proportionibus proportionum*, for example, contained instructions on how to find numbers a_1 and a_2 for which $b_1 : a_1 = a_1 : a_2 = a_2 : b_2$ for a given numerical ratio $b_1 : b_2$.

In today's usual notation, one would write this down with the help of fractional exponents:

$$\frac{a_1}{a_2} = \left(\frac{b_1}{b_2}\right)^{\frac{1}{3}}.$$

Also he gave calculation rules for dealing with this type of proportion.

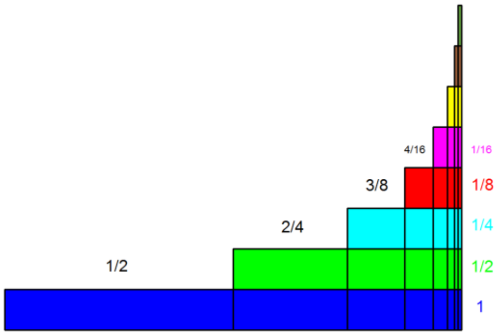
ORESME wrote only two of his works in French: *Traité de la sphère* and *Traité du ciel et du monde*. Here he argued that neither observation nor experiment can determine whether the earth or the sky is rotating, and he refuted the arguments that ARISTOTLE had once used to justify why the earth could not move.

Nevertheless, he tended to argue that the geocentric world view was probably correct. In principle, however, he held the view that phenomena in nature must have natural explanations, and he was sharply opposed to any form of occultism and the attempt of astrologers to deduce statements about future events and destinies from the position of the planets.

In his book on money (*De origine, natura, jure et mutationibus monetarum*), ORESME denied the right of rulers to mint coins. Rather, the money belonged to the people, who otherwise suffer when the rulers reduce the value of the coins through uncontrolled coinage.

ORESME was also ahead of its time in the treatment of infinite series. In the *Questiones super geometriam Euclidis* he showed that the terms of geometric series can be expressed in simple terms and can be represented in a simple way, e.g.

$$\frac{1}{2}+\left(\frac{1}{2}\right)^2+\left(\frac{1}{2}\right)^3+\ldots+\left(\frac{1}{2}\right)^n=1-\left(\frac{1}{2}\right)^n$$



By a clever rearrangement he derived from this:

It can be deduced that the following equation also holds:

$$\frac{1}{2}+\frac{2}{4}+\frac{3}{8}+\ldots+\frac{n}{2^n}=1+\left(1-\left(\frac{1}{2}\right)^n\right)=2-\left(\frac{1}{2}\right)^n.$$

And since the term on the right approaches the value 2 with increasing *n*, this also applies to $\frac{1}{2}+\frac{2}{4}+\frac{3}{8}+\ldots+\frac{n}{2^n}$.

ORESME was the first to prove that the partial sums $H_n=1+\frac{1}{2}+\frac{1}{3}+\ldots+\frac{1}{n-1}+\frac{1}{n}$ of the so-called harmonic series grow beyond all limits, i.e. in contrast to the geometric series under consideration, this series was not convergent.

His ingenious idea consisted in first taking *n* to be 2, then 4, 8, 16, ...

The result is that on the left-hand side of the inequality sign, partial sums of the harmonic series are shown with $n=2^k$, and on the right side the elements of a divergent linear sequence a_k with $a_k=1+\frac{1}{2}\cdot k$.

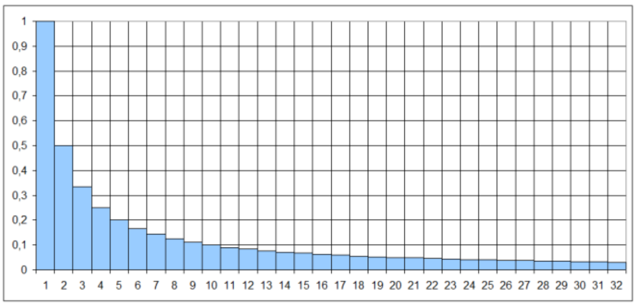
Therefore the harmonic series diverges.

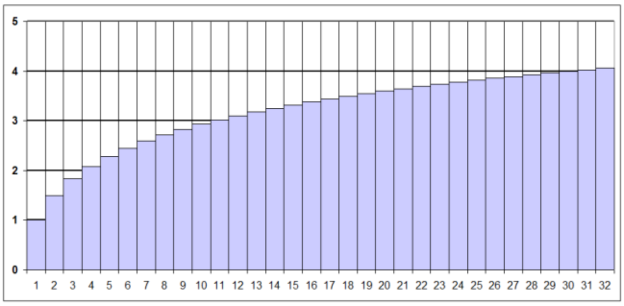
$$H_4=1+\tfrac{1}{2}+\left(\tfrac{1}{3}+\tfrac{1}{4}\right)>1+\tfrac{1}{2}+\left(\tfrac{1}{4}+\tfrac{1}{4}\right)=2=a_2$$

$$H_8=1+\tfrac{1}{2}+\left(\tfrac{1}{3}+\tfrac{1}{4}\right)+\left(\tfrac{1}{5}+\tfrac{1}{6}+\tfrac{1}{7}+\tfrac{1}{8}\right)>1+\tfrac{1}{2}+\left(\tfrac{1}{4}+\tfrac{1}{4}\right)+\left(\tfrac{1}{8}+\tfrac{1}{8}+\tfrac{1}{8}+\tfrac{1}{8}\right)=2.5=a_3$$

$$H_{16}=1+\tfrac{1}{2}+\left(\tfrac{1}{3}+\tfrac{1}{4}\right)+\left(\tfrac{1}{5}+\tfrac{1}{6}+\tfrac{1}{7}+\tfrac{1}{8}\right)+\left(\tfrac{1}{9}+\tfrac{1}{10}+\tfrac{1}{11}+\tfrac{1}{12}+\tfrac{1}{13}+\tfrac{1}{14}+\tfrac{1}{15}+\tfrac{1}{16}\right)$$

$$>1+\tfrac{1}{2}+\left(\tfrac{1}{4}+\tfrac{1}{4}\right)+\left(\tfrac{1}{8}+\tfrac{1}{8}+\tfrac{1}{8}+\tfrac{1}{8}\right)+\left(\tfrac{1}{16}+\tfrac{1}{16}+\tfrac{1}{16}+\tfrac{1}{16}+\tfrac{1}{16}+\tfrac{1}{16}+\tfrac{1}{16}+\tfrac{1}{16}\right)=3=a_4 \quad \ldots$$





(graphics about the infinite series from “Mathematik ist wunderschön”, Springer 2020)

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