

NEWTON ON IMPACT OF SPHERES (ca. late 1670s)

PROBLEM XII.

Having given the Magnitudes and Motions of Spherical Bodies perfectly elastick, moving in the same right Line, and striking against one another, to determine their Motions after Reflexion.

The Resolution of this Question depends on these Conditions, that each Body will suffer as much by Re-action as the Action of each is upon the other, and that they must recede from each other after Reflexion with the same Velocity or Swiftnes as they met before it. These Things being supposed, let the Velocity of the Bodies A and B, be a and b respectively; and their Motions (as being composed of their Bulk and Velocity together) will be aA and bB . And if the Bodies tend the same Way, and A moving more swiftly, follows B, make x the Decrement of the Motion aA , and the Increment of the Motion bB arising by the Percussion; and the Motions after Reflexion will be $aA-x$ and $bB+x$; and the

Celerities $\frac{aA-x}{A}$ and $\frac{bB+x}{B}$, whose Difference is $= a-b$

the Difference of the Celerities before Reflexion. Therefore there arises this Equation $\frac{bB+x}{B} - \frac{aA-x}{A} = a-b$, and

thence by Reduction x becomes $= \frac{2aAB - 2bAB}{A+B}$, which

being substituted for x in the Celerities $\frac{aA-x}{A}$, and $\frac{bB+x}{B}$,

there comes out $\frac{aA - aB + 2bB}{A+B}$ for the Celerity of A,

and $\frac{2aA - bA + bB}{A+B}$ for the Celerity of B after Reflexion.

But if the Bodies move towards one another, then changing every where the Sign of b , the Velocities after Reflexion will be $\frac{aA - aB - 2bB}{A+B}$ and $\frac{2aA + bA - bB}{A+B}$; either

of which, if they come out, by Chance, Negative, it argues that Motion, after Reflexion, to tend a contrary Way to that which A tended to before Reflexion. Which is also to be understood of A's Motion in the former Case.

EXAMPLE. If the homogeneous Bodies [or Bodies of the same Sort] A of 3 Pounds with 8 Degrees of Velocity, and B a Body of 9 Pounds with 2 Degrees of Velocity, tend the same Way; then for A, a , B and b , write 3, 8, 9 and 2; and $\left(\frac{aA - aB + 2bB}{A+B}\right)$ becomes -1 , and

$\left(\frac{2aA - bA + bB}{A+B}\right)$ becomes 5. Therefore A will return back with one Degree of Velocity after Reflexion, and B will go on with 5 Degrees.

De motu corporum - ex mutuo impulsu.

Hypothesis. Recd Jan: 7. 1668.
Eist. R.B. 4. 31

1.
Corpus quodlibet semel motum, si nihil obstat, progredietur eadem perpetuo celeritate, et secundum lineam rectam.

2.
Cum corpora duo dura inter se aequalia aequali celeritate ac directo sibi mutuo occurrunt, resiliunt utrumque eadem qua uidentur celeritate.

dicuntur autem directo occurrere, cum in eadem linea recta, utriusque extra gravitatis conjugationem moventur, punctumque contactus accidunt in eadem recta.

3.
Motum corporum celeritatibus aequalibus aut inaequalibus respectibus intelligendas esse, facta relationes ad alia corpora quae tanquam quiescentia considerantur, ut si fortassis et haec et illa alio communi motu involvantur ac proinde cum corpora duo sibi mutuo occurrunt, tamen si alteri praeterea motus utriusque simul obnoxium fuerit, eandem aliter illa se invicem impellerent respectu ipsius qui eodem quoque motu defertur, ac si omnibus aduersitibus est motus abesse.

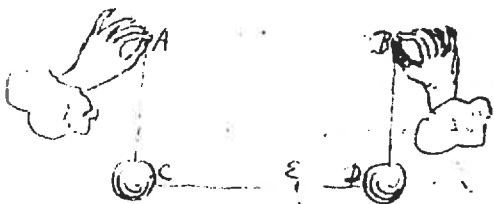
Voluit siquis navi vectus, quae aequalibus motu progredietur globulos duos aequalibus aequali celeritate in se invicem impingere faciat, suo nimirum et partium navis respectu, dicimus aequali quoque celeritate utrumque resiliere debere, quidem vectoris respectu; plene sicut contingit si, in navi quiescente aut in terra consistens, eandem

globulos aequali celeritate collidi fuerit.

4.

Sive ipse corpora duo manibus suis sustentans
aut motibus ea concurrere faciam, sive aliis illa
sustentans eosdem motus sui respectu illis dederit, respicit,
missionis eorum corporum eandem fore cum respectu.

Velut si immotus ipse consistens corpora C, D ex filis



suspensa sustentans manibus A,

B, eas, movendo, simul corpus

C transferam celeritate CE,

et corpus D celeritate DE, ita

ut sibi mutuo occurrant in E.

Duo eosdem motus utrius ex repulsionibus contrarias sui
respectu, sive ipse manibus suis capita filorum hanc
illa ita moviderit, sive aliis duis manibus illa hanc
eosdem motus sui respectu producat.

His positis de corporum aequalium occurrere, ut quibus
legibus illa a se mutuo impellantur demonstrabimus,
cum viro ad inaequalia viro erit, Hypothesis quaedam
necessarias jam dictis addeamus.

Propositiō 1.

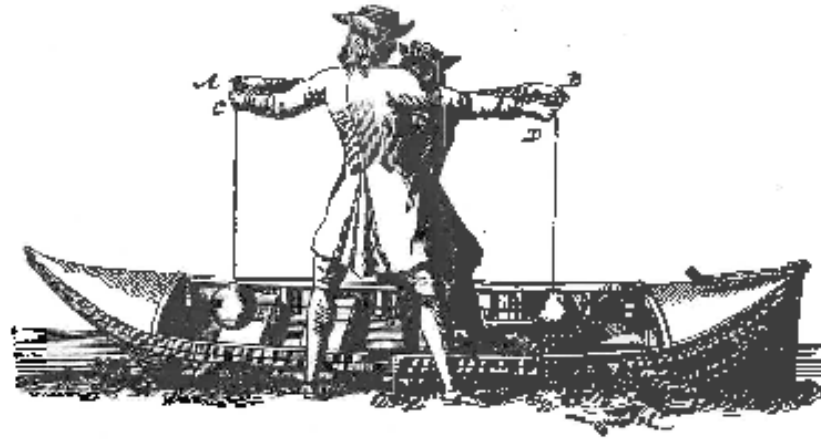
Si corpori quiescenti aliud aequale corpus directè
occurrat; post contactum hoc quidem quiescet,
quiescenti viro acquiratur eadem quae fuit in
impollente celeritas.

GALILEAN-HUYGENSIAN RELATIVITY

“The motion of bodies and their equal and unequal speeds are to be understood, respectively, in relation to other bodies which are considered as at rest, even though perhaps both the former and the latter are involved in a common motion. **And accordingly when two bodies collide with one another, even if both together are further subject to another uniform motion, they will move each other with respect to a body that is carried by the same common motion no differently than if this motion coming from outside were absent to all.”**

[Huygens, manuscript at Royal Society, 1669]

Huygens, 1669 Manuscript



“Thus, if someone conveyed on a boat that is moving with a uniform motion were to cause equal balls to strike one another at equal speeds with respect to himself and the parts of the boat, we say that both should rebound also at equal speeds with respect to the same passenger, just as would clearly happen if he were to cause the same balls to collide at equal speeds in a boat at rest or while standing on the ground.”