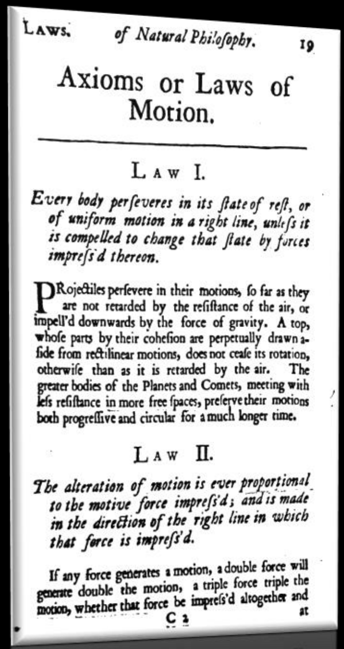
Exploring Changes and *Methods* in How Inquiring Histories of Exact Sciences have been Written (… and Philosophically Argued ?)

(KGW ([1618-1621]1937–2009) *Epitome Astronomiae Copernicanae*, VII, Book V, p. 369)



LAWS. *of Natural Philosophy.* 19

Axioms or Laws of Motion.

LAW I.

Every body perseveres in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impress'd thereon.

PRojectiles persevere in their motions, so far as they are not retarded by the resistance of the air, or impell'd downwards by the force of gravity. A top, whose parts by their cohesion are perpetually drawn aside from rectilinear motions, does not cease its rotation, otherwise than as it is retarded by the air. The greater bodies of the Planets and Comets, meeting with less resistance in more free spaces, preserve their motions both progressive and circular for a much longer time.

LAW II.

The alteration of motion is ever proportional to the motive force impress'd; and is made in the direction of the right line in which that force is impress'd.

If any force generates a motion, a double force will generate double the motion, a triple force triple the motion, whether that force be impress'd altogether and at

C 2

Newton ([1687]1803) *Principia*, I, p. 19

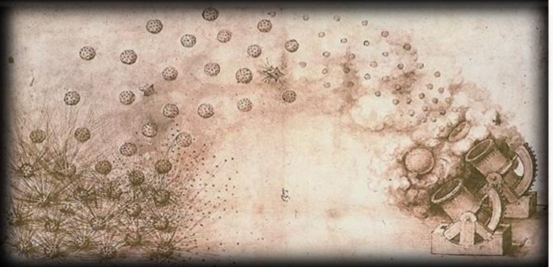
A Research Program:
On the Inquiring-Choices within the Emergencies of Relationships between Physics and Mathematics into Historical Discourse

Prof. Raffaele Pisano, Lille University, France | raffaele.pisano@univ-lille.fr

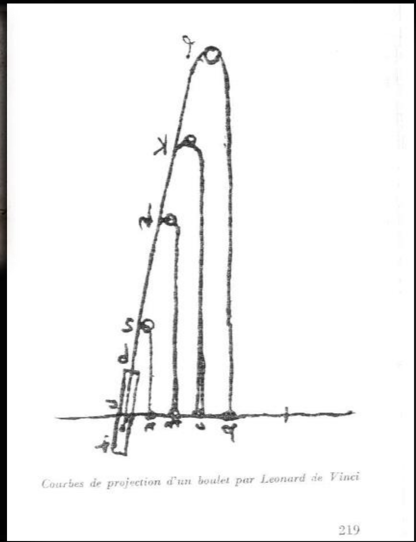
[*Visiting Professor*, Centre for Philosophy of Natural and Social Science, L.S.E., London, U.K.
Honorary Affiliated, HPS Unit, Sydney University, Australia]

What

Examples

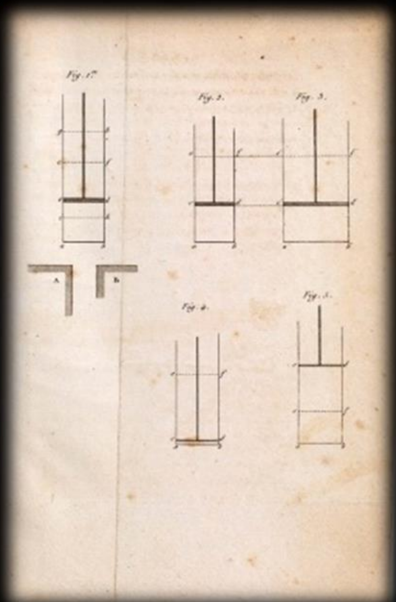


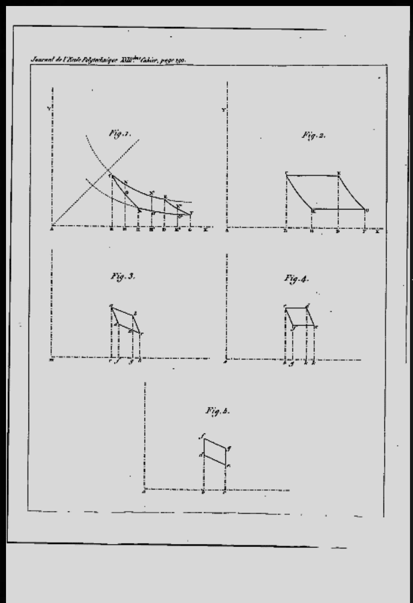
Da Vinci L (1504) *Mortar' model Codice Atlantico*, f. 33r



da Vinci L (ca 1504) *Codex Atlanticus*, f.33r. (see also: Gille B (1964) *Les ingénieurs de la Renaissance*. Hermann, Paris, p 219)

Académie des Sciences
[Carnot S., 1824, folio 118]
Numéro de BL : LIV-1006-006278.
Date : 23/06/2010
Devis n° : DEV-1005-00835
Client : R. Pisano CLI-048007





Clapeyron (1834): *Mémoire sur la puissance motrice de la chaleur*. Journal de l' École royale polytechnique
Vol. XIV: 153–190
(and 191)

A Narrative

- Inquiring History of Physics (*Research Program*)

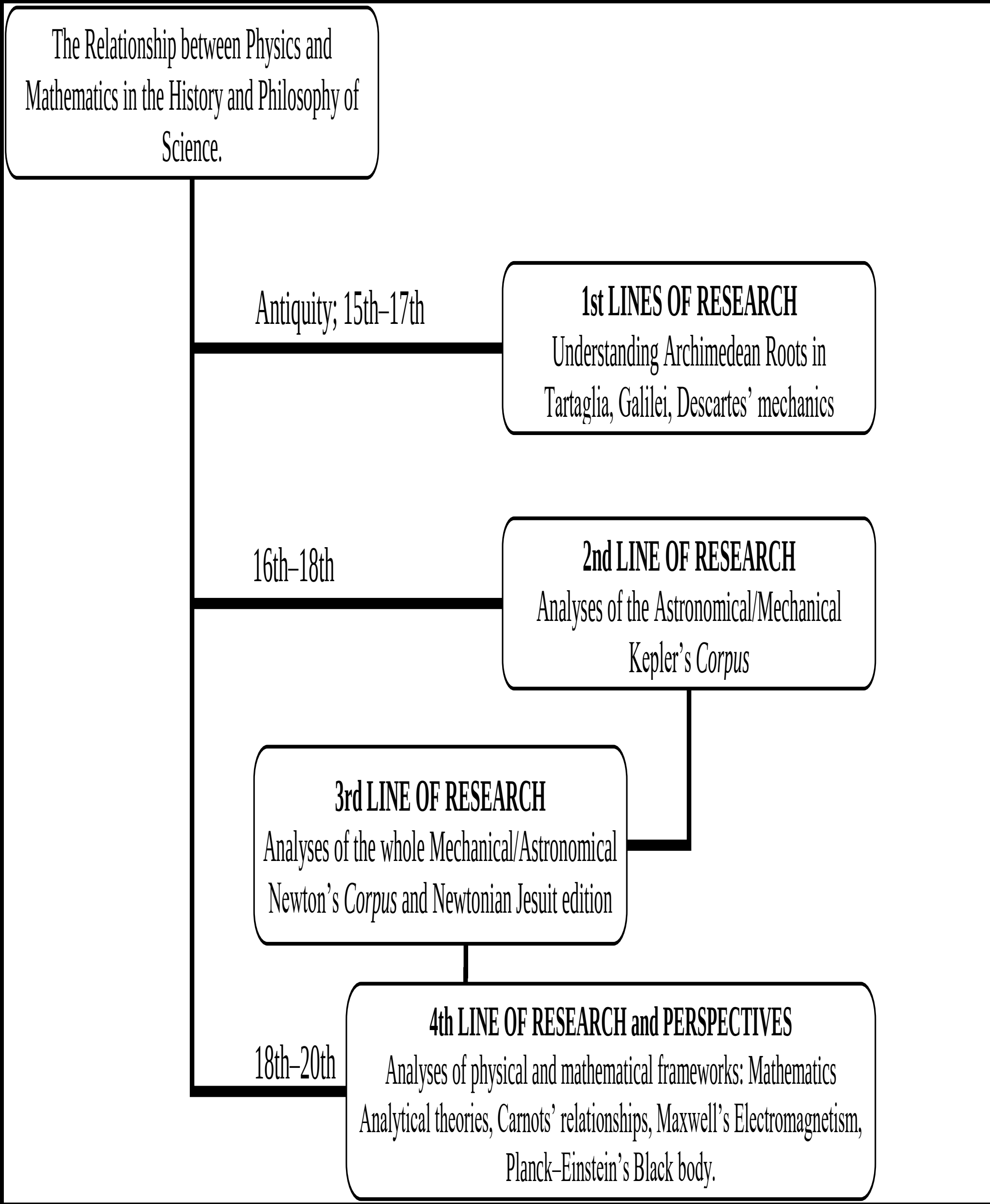
To

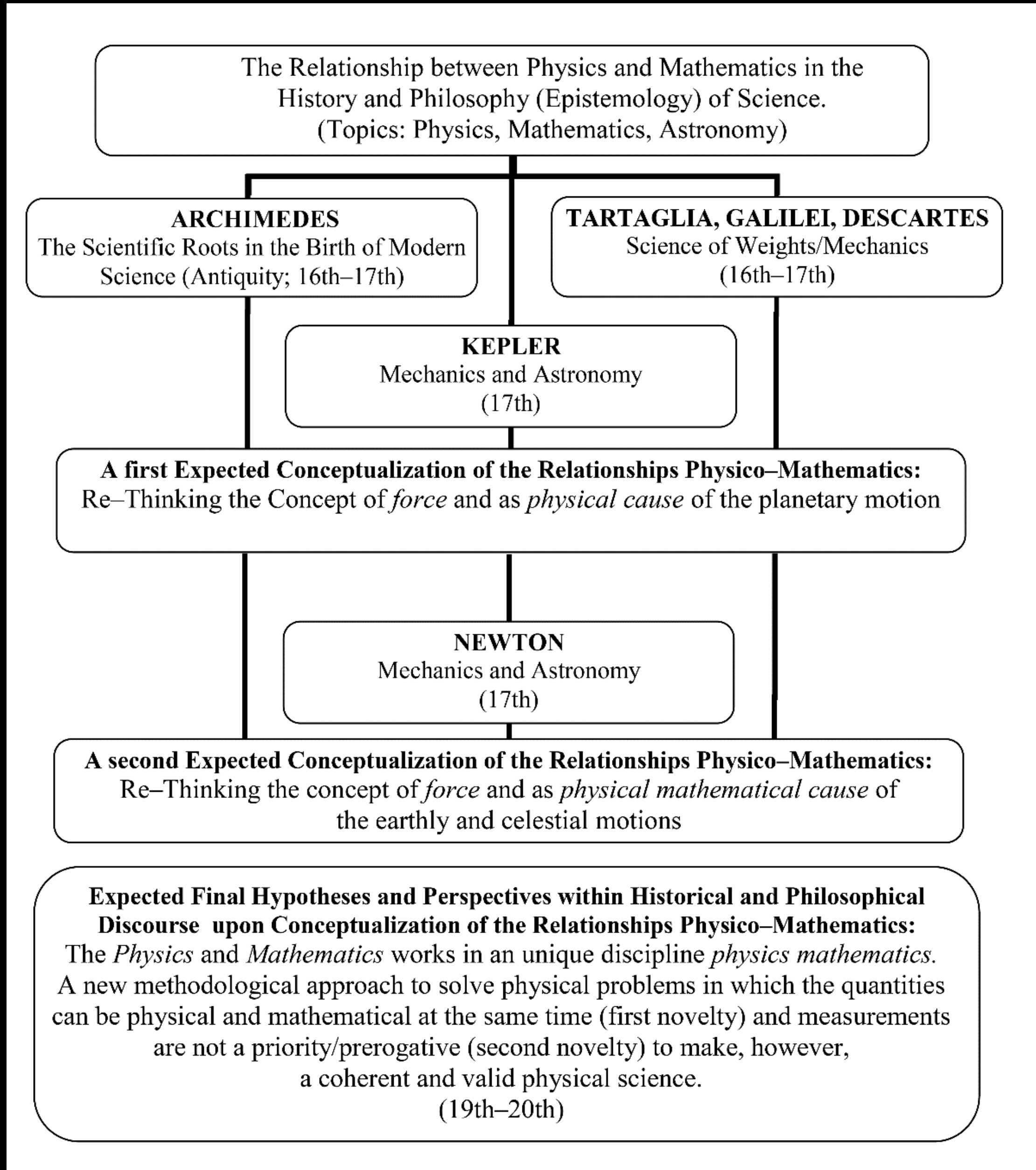
- Advanced *Knowledge on* the *Relationships between Physics and Mathematics* within History and Philosophy of Science:
- *Historical Hypotheses* & *Epistemological Interpretations*

- Inquiring history by specifics needs:
  - moving to a meta-historical theory… ?
  - For example: diagrams as a platform for narrative understanding of the scientific data?
  - see also *Historical Epistemology of Science (not French school)*

Pisano R (2016) Details on the mathematical interplay between Leonardo da Vinci and Luca Pacioli. Journal of the British Society for the History of Mathematics 31/2:104–111

Properties for Inquiring Research Needs and Accomplishments. The Relationship between Physics and Mathematics





Ante litteam: HPS versus (?) Narrative/Describing/Explanation/Interpreting

1962.
"History of Science without philosophy of Science is blind, I must now undertake to show that philosophy of science without History of Science is empty".

Hanson NR (1962) The Irrelevance of History of Science to Philosophy of Science. The Journal of Philosophy 59:[p. 580] 574–586

Paraphrasing of a Kant's passage in *Critique of Pure Reason*: "Thoughts without content are void; intuitions without concepts[ions are] blind" .

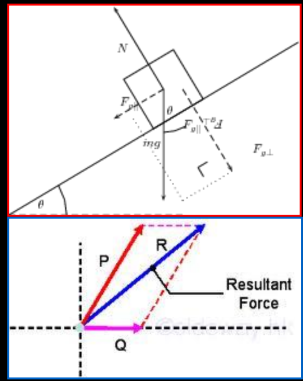
[1855] *Transcendental Logic. On Logic in general* [A51-B75], p. 46 (Kant tried to bring together the - at that time - <u>apparently</u> opposed ideas of empiricism and rationalism).

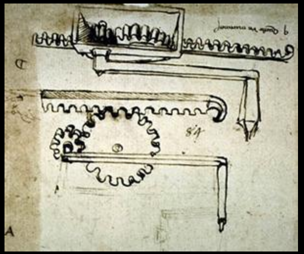
1971. (+ debate Lakatos-Kuhn (*Notes on Lakatos*..) … etc.).
"Philosophy of science without history of science is empty; history of science without philosophy of science is blind".

Lakatos I (1971) History of Science and Its Rational Reconstructions In: Buck RC, Cohen RS (eds). PSA Proceedings. The Boston Studies in the Philosophy of Science. VIII, Springer. Reidel, pp. [91] 91–136.

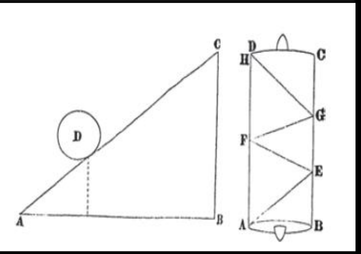
Recently *Historical epistemology of science*, 2012.

Mauskopf S, Schmaltz T (eds.) (2012) *Integrating History and Philosophy of Science: Problems and Prospects*. Boston Studies in the Philosophy and History of Science. Springer. Dordrecht.





The mechanism for the transformation and rotation movement (rack) by Leonardo da Vinci. (*Codice Atlantico*, non-aut, 998r).

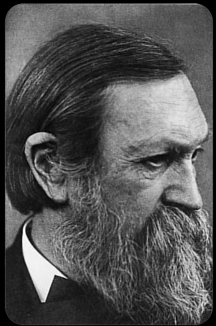


Geometric representation of the inclined plane as abstract object, and the geometric model explanation by the Galileo screws.
(*Le mecaniche*, Opere, II, p. 184).

?.

Mills D (1851) *The Doubling Room*. The Illustrated London News, Halliwell, Lancashire, Issue: 25 octobre, p. 524
[Over doubled fine thread for lace-making].

Ernst Mach (1838-1916)



Between 19th and 20th century, Ernst Mach (1838-1916) generated a radically new vision of foundations of physics:

« [...] The fertile methods of thought of Galileo, Huygens, S. Carnot, Mayer, and their peers, are all reducible to the simple but significant perception, that purely periodical alterations of one set of circumstances can only constitute the source of similarly periodical alterations of a second set of circumstances, not of continuous and permanent alterations».

(Mach E. [1883] 1974).*The Science Of Mechanics - A Critical And Historical Account Of Its Development*, 4th Edition, Merchant Book ed, 1, 503 line 27).

Alexandre Koyré (1892-1962)

a) the ***destruction of the cosmos*** **and therefore the disappearance from science - at least in principle, if not always in fact – of all considerations based on this concept**

b) the ***geometrization of space*****, that is, the substitution of the homogeneous and abstract - however now considered as real – dimension space of the Euclidean geometry for the concrete and differentiated place-continuum of pre-Galilean Physics and Astronomy.**

(1965. *Newtonian studies*, Harvard University Press, Cambr. Mass. 53, 6, line 17).

Thomas Khun (1922-1996)

Kuhn based his research on the idea of scanning scientific structures in the history of science which can establish themselves as *paradigm* or produce a *replacement* of an old framework.

Incommensurability among scientific theories

1962. *Structure of Scientific Revolutions.*

1978. *Black-Body Theory and the Quantum Discontinuity*

Table 11.9 (continued)

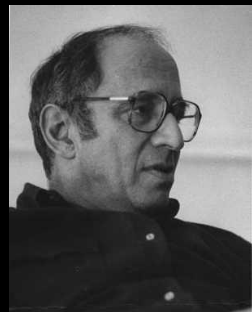
Sources cited by Sadi Carnot in his *Works*

Réflexions sur la puissance motrice du feu (Carnot 1978)[f]	*Recherche d'une formule propre à représenter la puissance motrice de la vapeur d'eau* (Carnot S–EP)	*Notes sur les mathématiques, la physique et autres sujets* (Carnot 1878b)
Traits élémentaire de physique ou de chimie [e.g.: *Traité élémentaire de chimie* by Lavoisier] (*Ivi*, p 15, ft 1)	*Traité de physique [expérimentale et mathématique]* by Biot, p [530–]531 (*Ivi*, folio 3)	*Annales de chimie et de physique* 1821, p 357 (*Ivi*, folio 6r)
Annales de physique et de chimie (*Ivi*, p 30, ft 1)	*Conservatoire des Arts et Métiers* (*Ivi*, folio 6)	*Mécanique céleste*, t 12, p 97 (*Ibidem*)
Annales de physique et de chimie 1818, t 7, p 122 (*Ivi*, p 51, ft 1)	*Traité de physique [expérimentale et mathématique]* , p [530–]531 (*Ivi*, folio 17)	*Annales [de chimie et de physique]*[g] 1823a, b, p 344 (*Ibidem*)
Annales de chimie [et de physique 1813] t 85, p 72, p 224 (*Ivi*, p 55, ft 1)	Dalton's table (*Ivi*, folio 20)	*Annales [de chimie et de physique]* 1823, p 192 (*Ibidem*)
[*Traité de*] *Mécanique céleste*(*Ivi*, p 59, ft 1)		On Perkins [*Annales de chimie et de physique* 1821, t 16, pp 321–327] (*Ibidem*)
Annales de physique et de chimie 1822, p 267 (*Ivi*, p 59, ft 1)		"Small advertisements 17 March. Manufacture of ice, rue Michel–le Comte, 27 [. . .]" (*Ivi*, folio 15v)
Annales de chimie et de physique 1818 (*Ivi*, p 65, ft 1)		*Journal du commerce*, 16 and 17 March[h] (*Ibidem*)
Traité de physique [expérimentale et mathématique] by Biot, vol 1, p 272, p 531 (*Ivi*, p 68, ft 1)		*American colonization*[i] (*Ibidem*)
Annales de chimie et de physique 1818, p 294 (*Ivi*, p 86, ft 1)		On Scheele and Kirwan's notes [*Supplement au Traité chimique de l'air et du feu de M. Scheele*, Trans. by le Baron de Dietrich 1785, Paris], p 149.[j] (*Ibidem*)

(continued)

Table 1: Some examples cited by Kuhn

Theory	Number of examples and periods
Chemistry	3 (17^{th}), 20 (18^{th}), 7 (19^{th}), 2 (20^{th})
Thermodynamics	4 (18^{th}), 4 (19^{th}), 1 (20^{th})
Mechanics	13 (16^{th}), 21 (17^{th}), 3 (18^{th}), 1 (19^{th})



The Structure of Scientific Revolutions:

- 1700: a development of infinitesimal analyses as an important interpretative and theoretical component for inquiring/describing natural phenomena.

Paradigm lost ? Only Newtonian?

- Mechanics… Celeste mechanics, structural mechanics, analytical theories, kinetic gas modelling, etc. and thermodynamics ?

Gillispie CC, Pisano R (2014). Lazare and Sadi Carnot. A Scientific and Filial Relationship. Dordrecht, Springer, p. 397

Author	Key-word	Categories	Main Subject
Mach (1838-1916)	Foundations	Economy of thought.	Mechanics
Duhem (1861-1916)	Continuity	Geometry, infinite, cosmos, active.	Statics
Koyré (1892-1964)	Discontinuity	The destruction of the cosmos **and** geometrization of space.	Mechanics
Crombie (1916-1996)	Regularity	Individual regularity and regularity of population.	Mechanics
Khun (1922-1996)	Paradigm	Normal, anomaly.	Classical physics
Thackray	Foundations	Inertial homogeneity of matter and short-range forces.	Classical chemistry/physics
Schuster	Models in Play	Grand method; Physico-mathematatics; Natural philosophy;	Classical physics

Properties for Inquiring Scientific Discourse of Exact Science into HPS

Alistair Cameron Crombie (1915-1996)

Six major categories-headings

Style among conception of nature, premises upon the scientific validity of a theory, scientific experience and interactions between an idea and its realization. arious kind of investigations and scientific demonstrations, general

A study upon *individual regularity*:

1. Arguing by means of analyses and synthesis (postulation).
2. Exploration by means of controlled experiments, observation and measure.
3. The construction of hypothetical modeling.

A study upon *regularity of populations:*

4. The taxonomy
5. The method of historical derivation (genetic method) was applied first to languages and human cultures, then to geological history (evolution).
6. Probabilistic and statistical analysis

Imre Lakatos (1922-1974), L.S.E., UK

"In writing a historical case study, one should, I think, adopt the following procedure: (1) one gives a rational reconstruction; (2) one tries to compare this rational reconstruction [re-description, interpretation] *with actual history and to criticize both one's rational reconstruction for lack of historicity and the actual history for lack of rationality. Thus any historical study must be preceded by a heuristic study: history of science without philosophy of science is blind."*

Lakatos I 1978. *The Methodology of Scientific Research Programmes.* Worrall J, Currie G (eds.). Philosophical Papers. I. The Cambridge University Press, Cambridge, pp. 52-53]

See also:

Lakatos I (1970) Falsification and the Methodology of Scientific Research Programmes. In: Lakatos I, Musgrave A (eds). *Criticism and the Growth of Knowledge*. IV. The Cambridge University Press, Cambridge, p. 138. (Author's *Italic*).

- *Ontology* and *epistemology* change along with these theories: i.e., *how much changing scientific theories reflect our living reality? Modelling?*
- And, *in what measure theory––and––reality re-adapt themselves within a given epistemic context?*

How Read Exact Sciences of the Past & Which and how Write its History ?

History by *facts*

- Historical objective facts, experiments, dates of discoveries
- Primary sources and the early theories
- Birth of new experimental apparatus
- Academic context, societies, academies
- Etc.

History built by *events*

- (Foundations of scientific theories)
- Biography and correspondence
- Concepts (e.g.: intuitive and surrogate concepts)
- Mathematical content of a theory
- Etc.

- Is History and Philosophy of Sciences one subject, or two subjects?
- And, History of Ideas and Physics-Mathematics?
  - If two, what has split them apart, given that once they were thought of as two aspects of a common enterprise?

- Mutual needs among HPSs of Exact Sciences
  - How?
  - Only because a teaching discipline (recruitment, etc.)?
  - Only because previous thinkers-influencers?
  - Only because a country of reference?
  - Only because it is really e research discipline?
  - For ex, see: HSS, HOPOS, AHES, ect.

A choice: Inquiring History of Physics (Physics-Mathematics) by (its?) Needs

For example

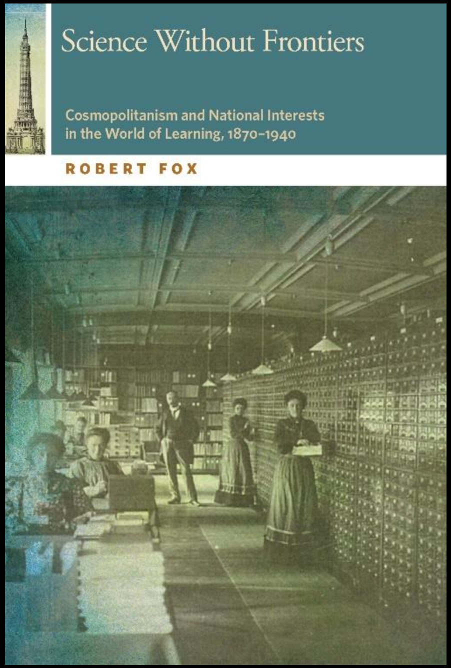
Needs

Historical and epistemological structures of a scientific theory

Inquiring

- By Logic (classical, non-classical),
- By Analogies
- By Mathematic (relationship physics-mathematics, theorems and results, etc.)
- By geometrical figures of speech/styles (figures and describing phenomena, rhetoric, etc.),
- By experimental/theoretical data,
- By impact (paradigms etc.)
- By Context
- By Foundations
- By diagrams

- A case: hat kind of historiographical choices for inquiring history of physics?
- Can a particular fundamental choice generate a variations of meaning for historical understanding?
- And what about motivation & production?



- Carry out *Results* and *Benefits* (*Research accomplishments*) within an Interdisciplinary Culture of HPS <u>without Frontiers</u>.

[1] Archimedean Science: *On the Equilibrium of Planes.*

190 ARCHIMEDES

6. If magnitudes at certain distances be in equilibrium, (other) magnitudes equal to them will also be in equilibrium at the same distances.

7. In any figure whose perimeter is concave in (one and) the same direction the centre of gravity must be within the figure."

Proposition 1.

Weights which balance at equal distances are equal.

For, if they are unequal, take away from the greater the difference between the two. The remainders will then not balance [*Post.* 3]; which is absurd.

Therefore the weights cannot be unequal.

Proposition 2.

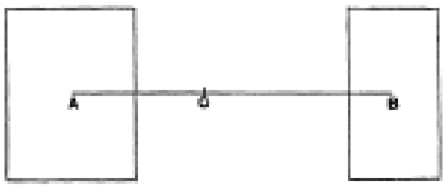
Unequal weights at equal distances will not balance but will incline towards the greater weight.

For take away from the greater the difference between the two. The equal remainders will therefore balance [*Post.* 1]. Hence, if we add the difference again, the weights will not balance but incline towards the greater [*Post.* 2].

Proposition 3.

Unequal weights will balance at unequal distances, the greater weight being at the lesser distance.

Let A, B be two unequal weights (of which A is the greater) balancing about C at distances AC, BC respectively.



Then shall AC be less than BC. For, if not, take away from A the weight $(A-B)$. The remainders will then incline

1st *Supposition* and 1st *Proposition*

- 1st Sup. Equal weights [suspended] at equal distances [from fulcrum] are in equilibrium; equal weights suspended at unequal distances [from fulcrum] are not in equilibrium [state] but [they] incline towards the weight is [suspended] at the greater distance [from fulcrum].

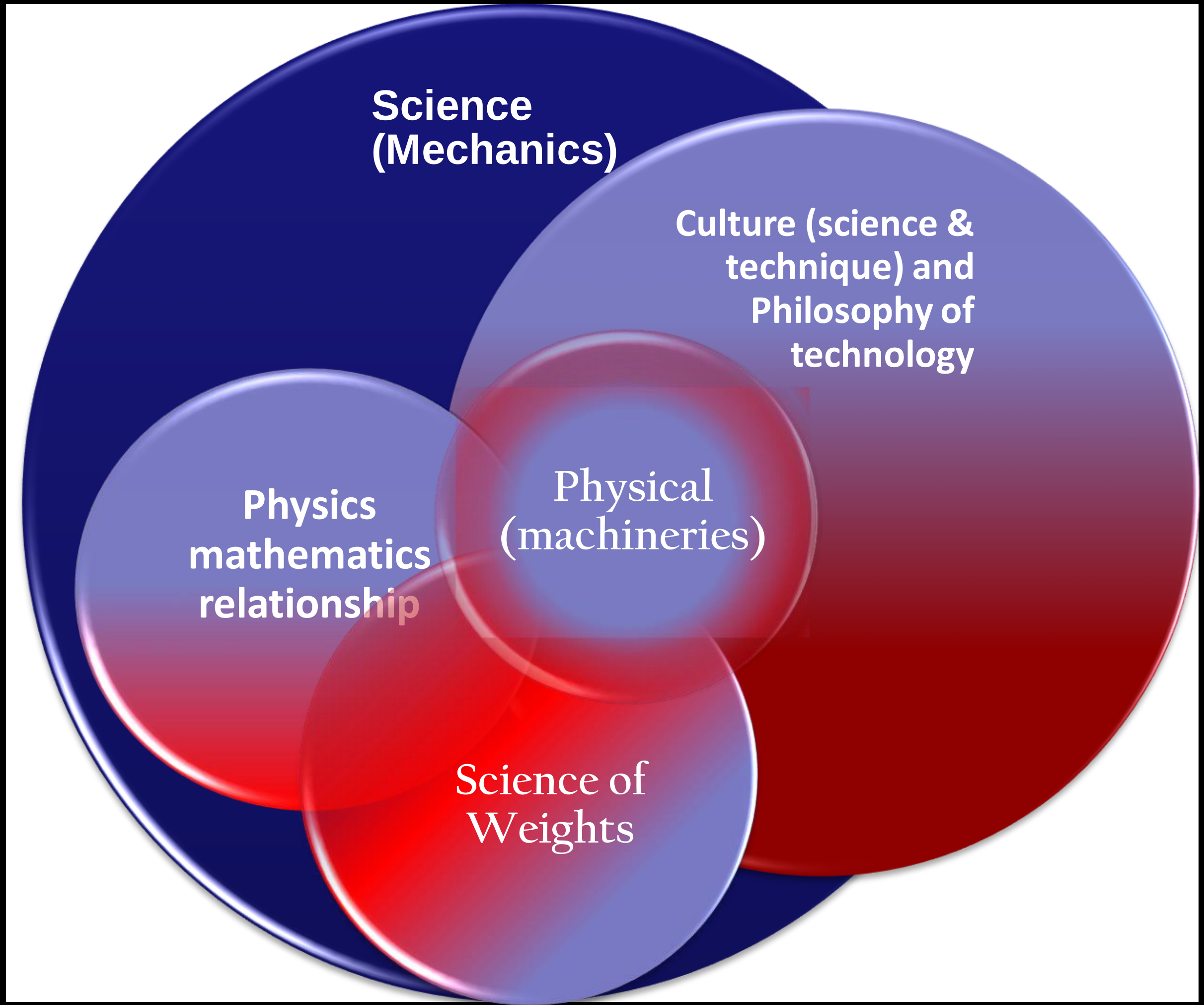
- 1st Prop. [If] Weights [suspended] at equal distance [from fulcrum are] in equilibrium, [then they are] are equal [between them]. [proved by *red. ad ab.* by Supp. 3].

A Historical-Logical inquiring.
Archimedes tries to show that, under given experimental conditions (which he does not explain), "The weights are equal [between them] and not that "The weights are in *equilibrium state* [between them]";
Situation (probably) that he already supposes (Supp. 1) for geometric construction or (maybe) because he just wrote in the lost manuscript.

Archimedes, *On the Equilibrium of Planes*, edited by T. L. Heath. book I, pp. 189-190.

[2] Mechanics & Mechanical Machines: No theory, No Machines?

1661. The Frontispieces from Georg Andreas Böckler's *Theatrum Machinarum Novum*



Pisano R, Bussotti P (2014) Historical and Philosophical Reflections on the Culture of Machines around the Renaissance. How Science and Technique Work? *Acta Baltica Historiae et Philosophiae Scientiarum* 2/2 [see also 2015 3/1]

- The *history of science* (scientific theories) is a science (measurement & calculus), included epistemological questions about it.
- *Historical* (facts) and *contingent* (possibilities, science in context) have a scientific and philosophical value, as well.

[3] Kepler Force Conceptualization: an Interplay between Physics, Mathematics and Metaphysics

The *Core* of the Research Programme

KEPLER.
Analyses of *Mysterium Cosmographicum* (1596), *Astronomia Nova* (1609), *Epitome Astronomiae Copernicanae* (1618-1621).
CORRELATION with NEWTON.
Analyses of the *Philosophiae naturalis mathematica principia* (1687) & succeeding *Jesuit Editions* (1739–1742).

PHYSICS MATHEMATICS. The roots of mathematical physics within new discipline physics mathematics during 18th–20th. Anlyses of Maxwell 's electromagnetism, Mathematics in 19th, Birth of Quantum mechanics (Planck, Einstein).

A Research Program

1596; 1621 — 1609 — 1618; 1621 — 1619

- Kepler's relationships between kinematics (motion) and dynamics (force): the forces act as the inverse of the two bodies–distance (KGW III, XXXII, 233-236) and not as inverse-square of the two bodies-distance. Problem *ellipticité* of the orbits. →
- The main geometrical-mathematical problem to solve and move *versus* a (sort of) physical astronomy was: What kind of force make the paths elliptical geometrically?

Iamque in eo eram, ut eidem etiam Telluri motum Solarem, ut Copernicus mathematicis, sic ego physicis, seu mavis Metaphysicis rationibus ascriberem. (*Mysterium*, 1596, KGW, I, p. 9, lines 17-19).

I had then reached the point of ascribing to the same Earth the motion of the Sun, but where Copernicus did so through mathematical arguments, mine were physical, or rather Metaphysical.

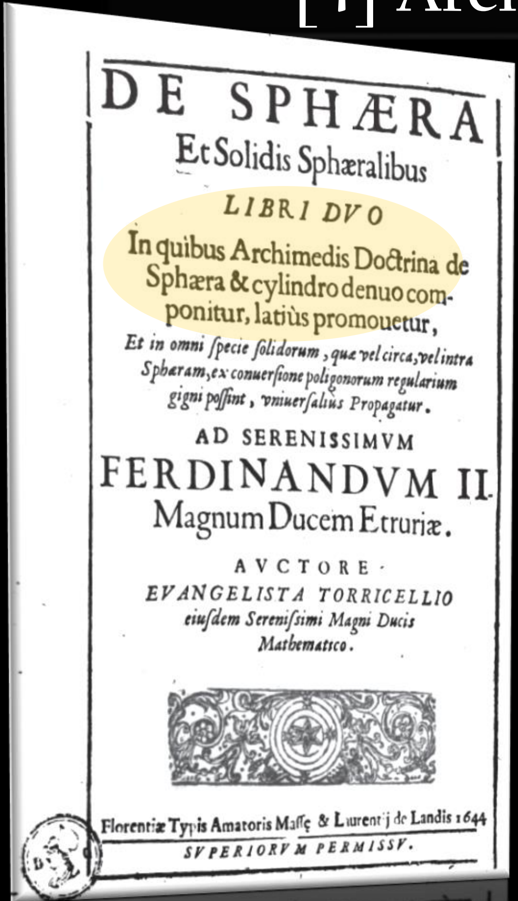
- How a correct kinematics can develop a wrong dynamics?
- A conceptualization of force before Newton: *Physical? Mathematical? Metaphysical-cosmological modelling for forces and effects?*

- 19^{th}: physical astronomy versus become celestial rational mechanics studies.

Newton (1729) III, [No formulas, arguments & theorems only] *Of the System of the World*, pp. 200-245
[voir Pr. VIII, Th. VIII, p. 226]

Pisano R, Bussotti P (2015). On the Conceptualization of Force in Johannes Kepler's Corpus: an Interplay between Physics, Mathematics and Metaphysics. In Pisano R, Agassi J, Drozdova D (eds.) *1964-2014. Homage to Alexandre Koyré*. Springer.

[4] Archimedean Approach in Torricelli's Reasoning


DE SPHÆRA
Et Solidis Sphæralibus
LIBRI DVO
In quibus Archimedis Doctrina de Sphæra & cylindro denuo componitur, latiùs promouetur,
Et in omni specie solidorum, quæ vel circa, vel intra Sphæram, ex conuersione poligonorum regularium gigni possint, vniuersalius Propagatur.
AD SERENISSIMVM
FERDINANDVM II.
Magnum Ducem Etruriæ.
AVCTORE
EVANGELISTA TORRICELLIO
eiusdem Serenissimi Magni Ducis Mathematico.
Florentiæ Typis Amatoris Massæ & Laurentij de Landis 1644
SVPERIORVM PERMISSV.

Archimedes
On equilibrium of planes

- *Quadrature of the parabola* *Proposition* 17 and 24*.
- The works of Archimedes, 246; 251; [Ivi, "*Method - Propositions* 1-2, 15-18]

Torricelli
Opera Goemetrica

- *Quadratura parabolae pluris modis per duplicem positionem more antiquorum absoluta*
- *Propositio* III, 33 et sgg.

Quadratura parabolae pluris modis: Trying a solution for non-solved problems
i.e., The Archimedean theorem* (pr. 24) was proved by Torricelli in
21 unlike procedures:
- 11 by *method of exhaustion.*
- 10 by Cavalieri's *method of indivisibles.*
- *Ad absurdum* proof and *method of exhaustion.*

(Early)
Torricelli Principle of Virtual Work

***Praemittimus*. Duo gravia simul coniuncta ex se moveri non posse, nisi centrum commune gravitatis ipsorum discenda.**

***Premise*. Two heavy bodies linked together cannot move by themselves unless their common centre of gravity does not descend.**

(Torricelli 1644, Liber primus De motu gravium naturaliter descendentium, p. 99, line 4)

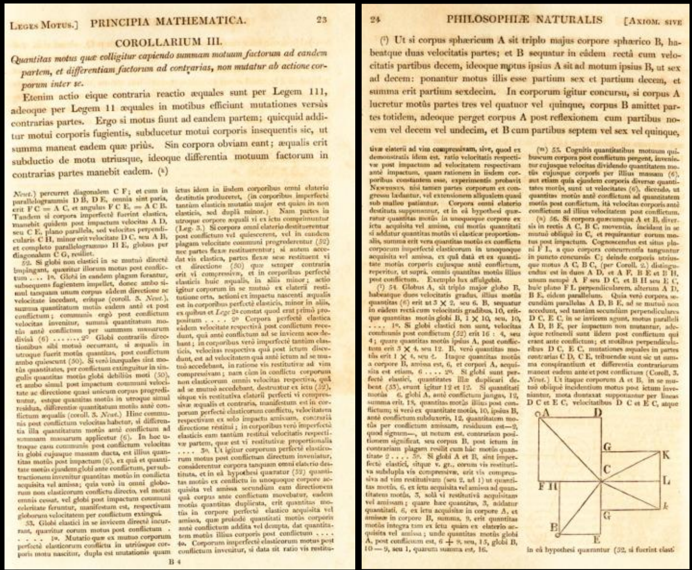
(Modern)
Principle of Virtual Work

The necessary and sufficient condition for equilibrium of a mechanical system without friction is that the virtual work done by the externally applied forces *f* is zero.

$$\sum f_i \cdot dr_i = 0$$

Heath T.L. 2002. "On the Spiral - Proposition 10", 162,.
Galileo G. 1954. *Dialogues Concerning Two New Sciences*, II, 140-146, IV 286-294, op. cit.;
Id., 1890-1909. "Discorsi e dimostrazioni matematiche sopra due nuove scienze", Vol. VIII, II, 176-183; IV, 306 et sgg)
Cavalieri B. 1635. *Geometria Indivisibilius continuo rum nuova quadam ratione promota*, Theorema I-Proposizione I, Libro IV, Ferrone, Bologna, 285
Valerio L. 1606. *Quadratura parabolae per simplex falsum et altera quam secunda Archimedia expeditur*,

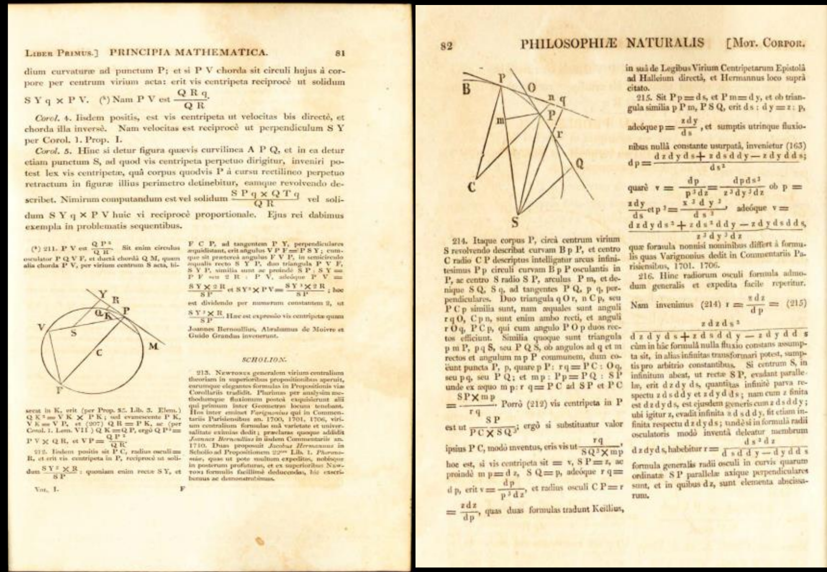
[5] Newtonian Geneva edition (1822) & Physics Mathematics Relationship



LEGES MOTUS.] PRINCIPIA MATHEMATICA. 23

COROLLARIUM III.

24 PHILOSOPHIÆ NATURALIS [AXIOM. SIVE



LIBER PRIMUS.] PRINCIPIA MATHEMATICA. 81

SCHOLIUM.

82 PHILOSOPHIÆ NATURALIS [MOT. CORPOR.

After the initial six propositions in which Newton supplied the foundations of central forces' theory, the commentators add a *Scholium* in which they refer the results by Keill, Hermann, Varignon, Johann Bernoulli, obtained between 1700 and 1714

Corollary III, Axioms or laws of the **motion.** The principle of conservations of the quantity of motion

Many are the cases in which rethinking (Scientific & HPS) by new notes is necessary to explain and clarify:

- the concept and the **mathematical procedures** used by Newton;
- to provide physical and **astronomical explanations** of the phenomena dealt with by Newton
- understanding of Newton's methods and its transcription into more analytical terms.

Table 5 (Continued)

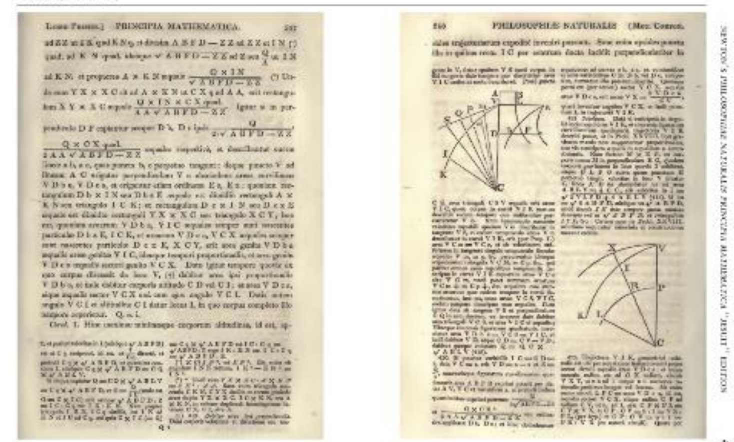


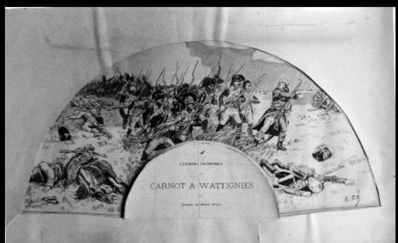
Figure 5. Prosecution of the proof. The analytical part finishes at line 7.

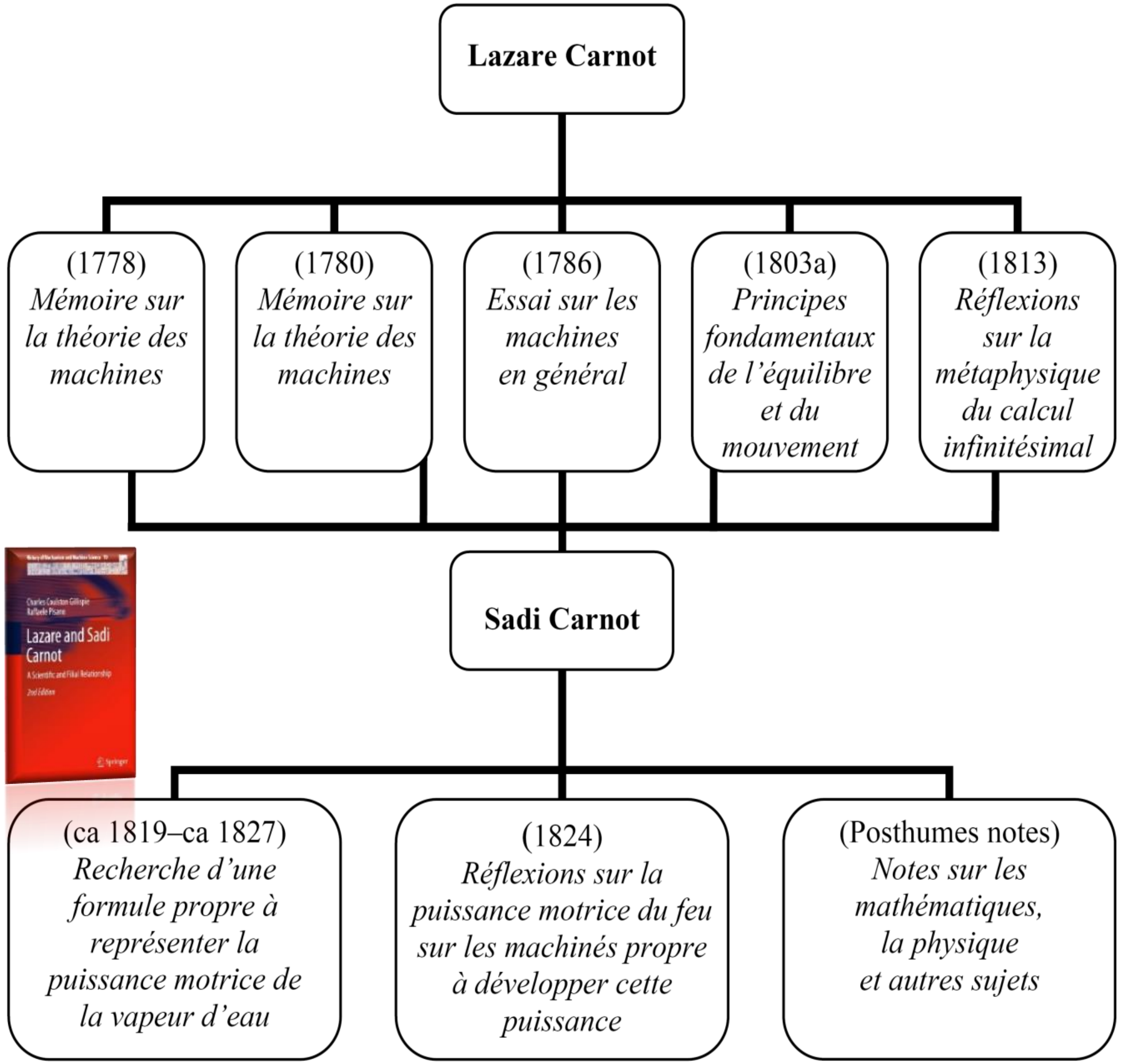
Figure 6. Commentaries to proposition XLI. Almost the whole page is written by the commentators. Newton's text is relegated to the first two lines.

Bussotti P, Pisano R (2014) Newton's Philosophiae Naturalis Principia Mathematica "Jesuit" Edition: The Tenor of a Huge Work. History of Mathematics section. *Accademia Nazionale Lincei Rendiconti Lincei Matematica e Applicazioni* 25:413–444

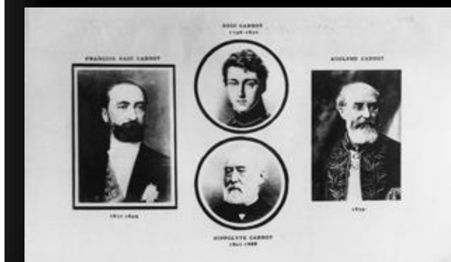
Pisano R, Bussotti P (2016.) A Newtonian Tale Details on Notes and Proofs in Geneva Edition of Newton's Principia. Journal of the British Society for the History of Mathematics 31/3: 160-178

[7] Lazare and Sadi Carnot. A Filial and Scientific Relationship

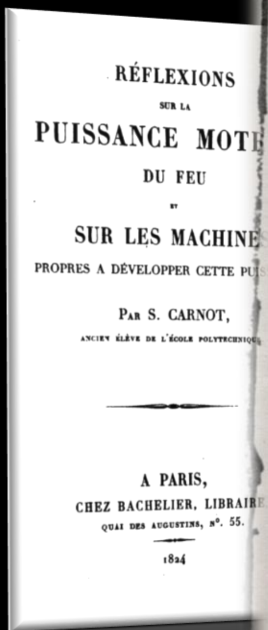


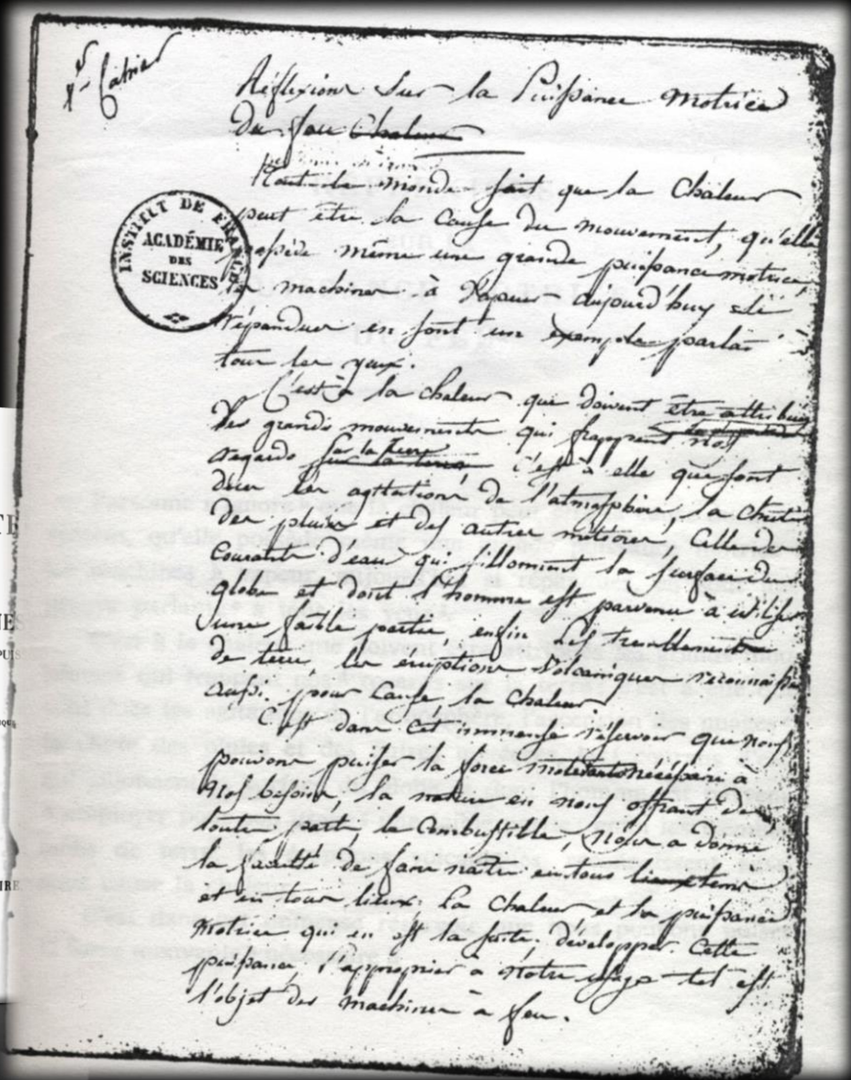


Lazare and Sadi Carnot's scientific filial



[8] A Science Book without Mathematics?


RÉFLEXIONS
SUR LA
PUISSANCE MOT
DU FEU
ET
SUR LES MACHINE
PROPRES A DÉVELOPPER CETTE PU
PAR S. CARNOT,
ANCIEN ÉLÈVE DE L'ÉCOLE POLYTECHNIQU
A PARIS,
CHEZ BACHELIER, LIBRAIRE
QUAI DES AUGUSTINS, N°. 55.
1824


1er Cahier

INSTITUT DE FRANCE
ACADÉMIE DES SCIENCES

Réflexions sur la Puissance motrice du feu ~~Chaleur~~

Tout le monde sait que la Chaleur peut être la cause du mouvement, qu'elle possède même une grande puissance motrice; les machines à vapeur aujourd'hui si répandues en font une preuve parlante à tous les yeux.

C'est à la chaleur que doivent être attribués ces grands mouvements qui frappent nos regards sur la terre; c'est à elle que sont dues les agitations de l'atmosphère, l'ascension des nuages, la chute des pluies et des autres météores, les courants d'eau qui sillonnent la surface du globe et dont l'homme est parvenu à utiliser une faible partie, enfin les tremblements de terre, les éruptions volcaniques reconnaissent aussi pour cause la chaleur.

C'est dans cet immense réservoir que nous pouvons puiser la force ~~motrice~~ nécessaire à nos besoins, la nature en nous offrant de toutes parts le combustible, nous a donné la faculté de faire naître en tous lieux et en tous temps la chaleur et la puissance motrice qui en est la suite. Développer cette puissance, l'approprier à notre usage, tel est l'objet des machines à feu.

p. 1

Recherche d'une formule
propre à représenter la puissance motrice
de la Vapeur d'Eau

On peut remarquer dans le jeu d'une Machine à feu, à piston, à détente et à condenseur, trois périodes principales (A).

1ère période — introduction de la vapeur arrivant librement de la chaudière sous le piston.

2me pér. — exten[s]ion [1] de volume ou détente de la vapeur après la fermeture de la communication entre la chaudière et le cylindre.

3me période — retour du piston à son point de départ après que la capacité du cylindre a été mise en communication avec le condenseur.

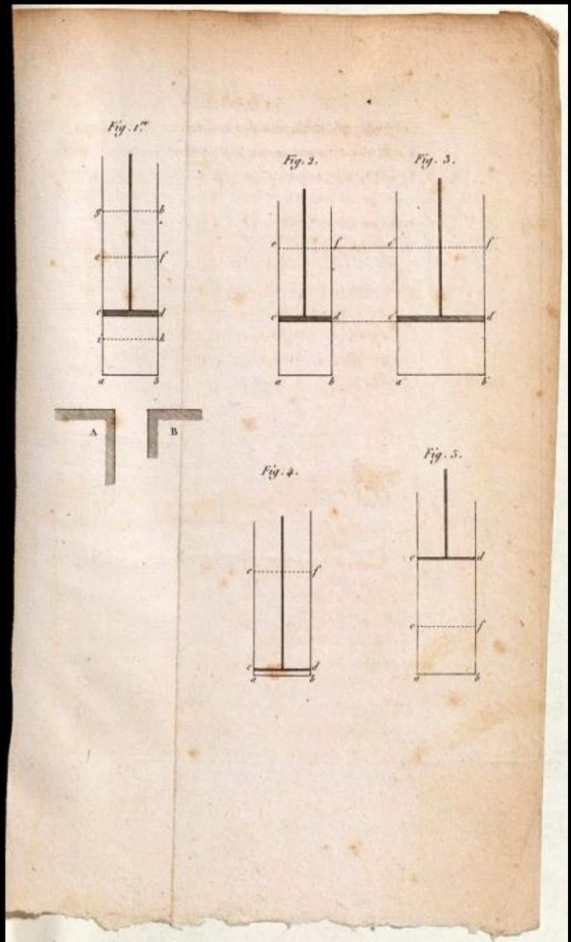
Dans la première période la pression est constante et égale à celle qui existe dans la chaudière.

Recherche d'une formule propre à représenter la puissance motrice de la Vapeur d'Eau, in Carnot, S. 1978, *op. cit.*, pp. 223-225, op. cit.

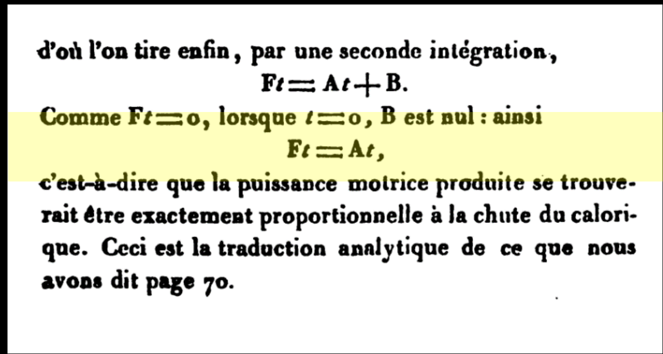
Gabbey A. W., Herivel J. W. 1966. « Un manuscrit inédit de Sadi Carnot » In: *Revue d'histoire des sciences et de leurs applications*, Tome 19 n°2. pp. 151-166.

Sadi's Inedit manuscript: November 1819 ‹ *t* ‹ March 1827

[9] S. Carnot's Theorem (1824) and the Cycle (1834)



[Carnot S., 1824, folio 118] Numéro de BL : LIV-1006-006278
Date : 23/06/2010 - Devis n° : DEV-1005-00835
Client : R. Pisano CLI-048007,



d'où l'on tire enfin, par une seconde intégration,

$$Ft = At + B.$$

Comme $Ft = o$, lorsque $t = o$, B est nul : ainsi

$$Ft = At,$$

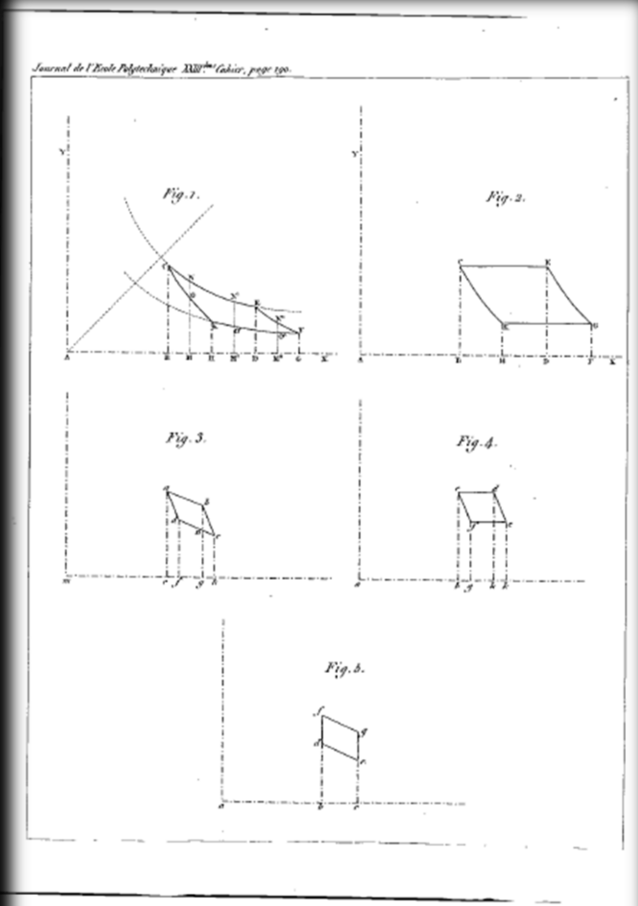
c'est-à-dire que la puissance motrice produite se trouverait être exactement proportionnelle à la chute du calorique. Ceci est la traduction analytique de ce que nous avons dit page 70.

The *tentative* calculus
for $d\eta$ in a footnote (*Ivi*, pp. 73-79)

- The cycle is composed by two isotherm (as in all of his cycles) and two isochors by W=0. (Carnot S. 1978. *Réflexions sur la puissance motrice du feu*, pp.39-40)

- The cycle is composed by two isotherm and two adiabatics by Q=0. (*Ivi*, pp. 29-38)

$$\eta = \frac{W_{\max}}{Q} = f(\Delta t)$$



1834

Clapeyron: Mémoire sur la puissance motrice de la chaleur, «*Journal* de l'*Ecole royale polytechnique*» *Vol. XIV*, 1834, pp. 153–190(-191).

Table 7.2 List of possible roles played by a DNS within a scientific PO–theory

Role	Meaning of the role	Abbreviation
Problem	Fundamental problem of the theory to be solved	[PR]
General principles	General principles of theoretical Physics or mathematics	[GP]
Theoretical premise i.e. principles upon the relationship with reality	Author's introduction on the theoretical or experimental arguments	[TP]
Methodological principle of the theory	Reasoning and proposition which indicate a direction to the solution	[MP]
Ad absurdum proof	Technique of argumentation	[*]
Operative principle i.e. principle of resolution of a problem to which theory applies	Reasoning or proposition on actions and techniques to be performed	[PO]

In fact these six roles might cover the possible roles played by DNSs in Sadi Carnot's theory. However it appears dubious as to which category to attribute to some DNS's (Appendix); for instance, DNSs 50 and 51 (Appendix) are operative principles, although such sentences are mentioned in a reasoning concerning Carnot's famous theorem (*ad absurdum proof*) on the independence of motive power from the kind of gas; moreover, DNSs 10 and 11 are expressed by means of *ad absurdum* arguments; even though they are theoretical presuppositions. However, these ambiguities are few in number with respect to the total number of DNSs.

7.2.4 *Sadi Carnot's Arguments Through his DNSs*

Now we can gather all of the DNSs according to their theoretical roles and then connect the resulting six groups according to the following Fig. 7.5.[21] We put a DNS whose physical meaning is similar to that of a previous DNS in parentheses. The table offers a global vision of the development of *Réflexions sur la puissance motrice du feu* while providing a particular summary of the theoretical content of the book (Fig. 7.4).

Let us remark that the set of DNSs is well distributed in all cases; the DNSs play all the possible theoretical roles within a scientific theory. Therefore, there is no remarkable aspect (not including the mathematical part) of Sadi Carnot's theory that is not represented by DNS's. After DNS 49 (independence of W_{max} from the kind of gas) there are 13 DNS's that express operative principles outlined by the entire theory; except for DNSs 61 and 62 which constitute Sadi Carnot's afterthought regarding the validity of caloric theory.

[21] The DNSs serial numbers in the flow–chart cases are those listed in the Appendix.

Based on previous historical–epistemological studies on DNSs (see Chapters 6 and 7; Drago et al. 2001; Bellini et al. 2007), in order to better introduce all crucial aspects, we provide a concise reconstruction of Lazare and Sadi Carnot's main reasonings (Figs. 11.3 and 11.4):

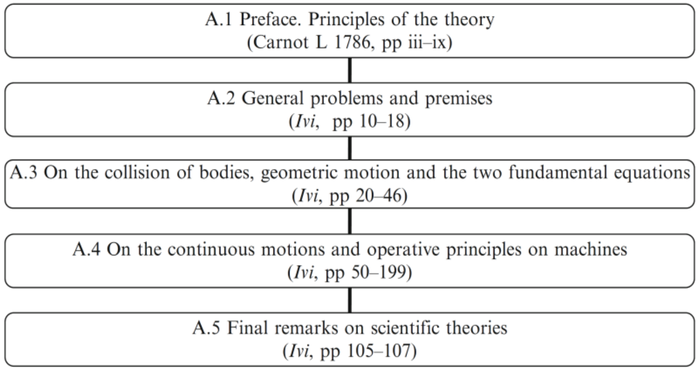


Fig. 11.3 Lazare Carnot's main reasonings (Carnot 1786)

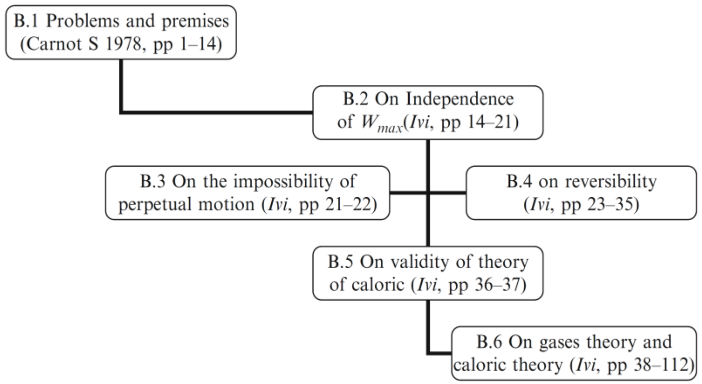
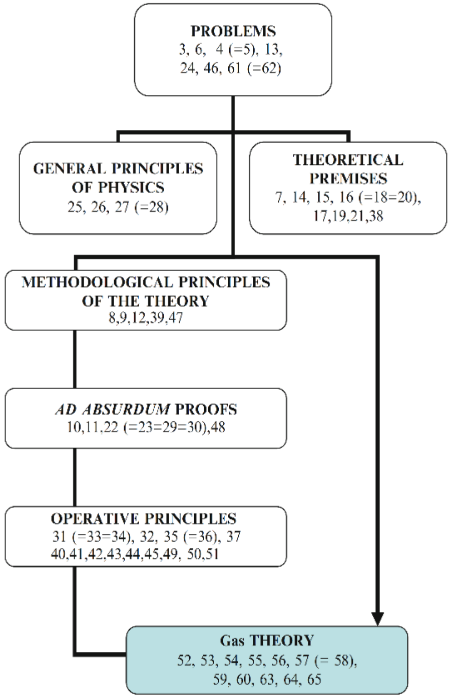


Fig. 11.4 Sadi Carnot 's main reasonings (Carnot 1978; Pisano 2010. For the reference and details, please see Chapters 6 and 7)

As stated in previous chapters there are several hypotheses on the relationship between the two Carnots: e.g., such as continuity of method and arguments focusing on mechanical machines and heat machines. Moreover, based on previous historical and epistemological open problems (Gillispie 1976, pp 23–33 see above Chapters 7 and 9) on Table 11.1 and (Fig. 11.5) we broaden and specify the common parts of the



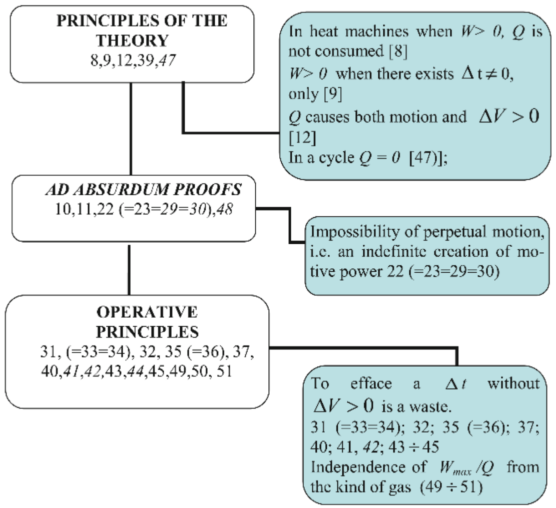


Fig. 7.6 The relationship between mathematics and logic expressed by DNSs

Concepts (mainly)	I. Newton (1642-1727) Newtonian mechanics [paradigm]	L. Carnot (1753-1823) Mechanics / Machines	S. Carnot (1796-1832) Thermodynamics / Machines
Space Time	Infinite and absolute Infinite and absolute	Limited and Relational	Limited and Relational
Bodies	Mathematical points	Global, machines	Global, machines
Intertia	Perpetual	Impossibility of perpetual motion	Impossibility of perpetual motion
Basic-concept	Acceleration	Transformations	Transformations
Interaction	Force-Cause	Work; $\sum_i m_i \vec{W}_i^2 = \sum_i m_i \vec{V}_i^2$	Work [moment-of-activity]
Setting of theory	The law of motion in a dynamics theory, *F=ma*	The laws in *Collision theory*	Integration of *dq/t*
Techniques	Fluxions… infinitesimal	Geometrical motion; vector calculus	Cycle
Results	Mathematical results…	Invariants; Geometrical motions for mechanical machines	Maximum efficiency of heat machines

[10] 1873. *A Treatise on Electricity and Magnetism* (Vol. II)

When the values of all the variables (q) are given, the position of each of the moveable pieces is known, and, in virtue of the imaginary mechanism, the configuration of the entire system is determined.

The Velocities.

556.] During the motion of the system the configuration changes in some definite manner, and since the configuration at each instant is fully defined by the values of the variables (q), the velocity of every part of the system, as well as its configuration, will be completely defined if we know the values of the variables (q), together with their velocities $\left(\frac{dq}{dt}\right.$, or, according to Newton's notation, $\left.\dot{q}\right)$.

The Forces.

557.] By a proper regulation of the motion of the variables, any motion of the system, consistent with the nature of the connexions, may be produced. In order to produce this motion by moving the variable pieces, forces must be applied to these pieces.

We shall denote the force which must be applied to any variable q_r by F_r. The system of forces (F) is mechanically equivalent (in virtue of the connexions of the system) to the system of forces, whatever it may be, which really produces the motion.

The Momenta.

558.] When a body moves in such a way that its configuration, with respect to the force which acts on it, remains always the same, (as, for instance, in the case of a force acting on a single particle in the line of its motion,) the moving force is measured by the rate of increase of the momentum. If F is the moving force, and p the momentum,

$$F = \frac{dp}{dt},$$

whence

$$p = \int F\,dt.$$

The time-integral of a force is called the Impulse of the force; so that we may assert that the momentum is the impulse of the force which would bring the body from a state of rest into the given state of motion.

In the case of a connected system in motion, the configuration is continually changing at a rate depending on the velocities ($\dot{q}$), so

and the work spent in producing the motion is equivalent to the kinetic energy. Hence

$$T_{p\dot{q}} = \tfrac{1}{2}(p_1\dot{q}_1 + p_2\dot{q}_2 + \&c.), \qquad (13)$$

where $T_{p\dot{q}}$ denotes the kinetic energy expressed in terms of the momenta and velocities. The variables q_1, q_2, &c. do not enter into this expression.

The kinetic energy is therefore half the sum of the products of the momenta into their corresponding velocities.

When the kinetic energy is expressed in this way we shall denote it by the symbol $T_{p\dot{q}}$. It is a function of the momenta and velocities only, and does not involve the variables themselves.

563.] There is a third method of expressing the kinetic energy, which is generally, indeed, regarded as the fundamental one. By solving the equations (3) we may express the momenta in terms of the velocities, and then, introducing these values in (13), we shall have an expression for T involving only the velocities and the variables. When T is expressed in this form we shall indicate it by the symbol $T_{\dot{q}}$. This is the form in which the kinetic energy is expressed in the equations of Lagrange.

564.] It is manifest that, since T_p, $T_{\dot{q}}$, and $T_{p\dot{q}}$ are three different expressions for the same thing,

$$T_p + T_{\dot{q}} - 2T_{p\dot{q}} = 0,$$

or

$$T_p + T_{\dot{q}} - p_1\dot{q}_1 - p_2\dot{q}_2 - \&c. = 0. \qquad (14)$$

Hence, if all the quantities p, q, and $\dot{q}$ vary,

$$\left(\frac{dT_p}{dp_1} - \dot{q}_1\right)\delta p_1 + \left(\frac{dT_p}{dp_2} - \dot{q}_2\right)\delta p_2 + \&c.$$

$$+\left(\frac{dT_{\dot{q}}}{d\dot{q}_1} - p_1\right)\delta\dot{q}_1 + \left(\frac{dT_{\dot{q}}}{d\dot{q}_2} - p_2\right)\delta\dot{q}_2 + \&c.$$

$$+\left(\frac{dT_p}{dq_1} + \frac{dT_{\dot{q}}}{dq_1}\right)\delta q_1 + \left(\frac{dT_p}{dq_2} + \frac{dT_{\dot{q}}}{dq_2}\right)\delta q_2 + \&c. = 0. \qquad (15)$$

The variations δp are not independent of the variations δq and $\delta\dot{q}$, so that we cannot at once assert that the coefficient of each variation in this equation is zero. But we know, from equations (3), that

$$\frac{dT_p}{dp_1} - \dot{q}_1 = 0,\ \&c., \qquad (16)$$

so that the terms involving the variations δp vanish of themselves.

The remaining variations $\delta\dot{q}$ and δq are now all independent, so that we find, by equating to zero the coefficients of $\delta\dot{q}_1$, &c.,

$$p_1 = \frac{dT_{\dot{q}}}{d\dot{q}_1}, \qquad p_2 = \frac{dT_{\dot{q}}}{d\dot{q}_2},\ \&c.; \qquad (17)$$

In the whole chapter V (Maxwell 1873, II, Pt IV, V, 184–194) - contrary to Newtonian mechanics - Maxwell expressed motion and energy relationships within the system as a whole, rather than in terms of laws of motion governing the actions of forces.

Thus, after several methods proposed, he announced ***a third method*** **related with Lagrange.**

Pisano R (2013) On Lagrangian in Maxwell's electromagnetic theory. Scientiatum VI. The Federate University of Rio de Janeiro Press, Rio de Janeiro, pp. 44–59

Maxwell 1873, II, Pt IV, V, pp. 184–186, p. 191; see Chap. VI for describing physical system.

[11] On Quantum Mechanics & Shared Cross-References Knowledge (?)

A development

[...]

1900-1901. Planck: black body (Einstein ad hoc hypothesis)

1905-1917. Einstein: Relativity, etc.

1913. Bohr: atomic model, energy, etc.

1925-1927. Schroedringer: wave equation and wave develops the processing of quantum mechanics, electron wave.

1927. Heisenberg: *the **uncertainty principle**.*

1927. Bohr: ***complementarity principle,*** *Copenhagen interpretation*

[...]

Kuhn: relation quantitative relationship among electromagnetic fields and matter's properties (electrons and atoms). *What about the use of the Planck's constant in classical physic and in modern physics?*

2. The energy of (classical) harmonic oscillator is quantized (?)

3. Thus, if the energy of harmonic oscillator is quantized (?)...that is out from classical physics ... does it mean that we accept this result .... as an application of modern physics to classical physics ?

Left to right: Max Planck, Albert Einstein, Niels Bohr, Louis de Broglie, Max Born, Paul Dirac, Werner Heisenberg, Wolfgang Pauli, Erwin Schrödinger, Richard Feynman.

http://en.wikipedia.org/wiki/File:10_Quantum_Mechanics_Masters.jpg

[12-*a*] On Quantum Mechanics & Shared Cross-References Knowledge (?)

1923. **Louis de Broglie (1892-1987):** On 10 Sept. (Ph.D. thesis on 25 Nov.) proposed his theory concerning wave-behavior of the matter.

1924. **Satyendra Nath Bose (1894-1974):** on 2 July proposed a new analyses statistical procedure

1924. **Einstein**: on 10 July extended Bose's procedure to a set of gas-particles material and mono-atomics. By another reasoning associated energy and frequency making stronger de Broglie's equations.

1924. **Max Born (1882-1970)** called the new theory: *quantum mechanics*.

1925. **Wolfgang Pauli (1900-1958):** on 16 January formulated his *principle of exclusion.*

1925. **Werner Heisenberg (1901-1976):** on 25 July his first article on matrix-interpretation of the mechanics (*Quantum-theoretical interpretation of kinetic and mechanical relations*).

1925. **Born-Jordan (1902-1980):** on 25 Sept. make stronger Heisenberg's theory.

[12-*b*] On Quantum Mechanics & Shared Cross-References Knowledge (?)

1925. **Paul A. M. Dirac (1902-1984):** on 7 Nov. generalized and analyzed and make stronger the mathematical form of Heisenberg's theory (he introduced "commentator" [p; q]).

1925. **Born, Heisenberg and Jordan**: on 16 Nov. published the first complete treatise of the mechanics using matrix theory.

1926. **Pauli**: on 17 January utilized matrix mechanics to calculate discrete spectrum of the atom of hydrogen.

1926. **Erwin Schrödinger** (1887-1961): on 27 Jan. published-open *Quantisierung als Eigenwertproblem* (*Quantization as an Eigenvalue Problem*) road to wave-mechanical interpretation

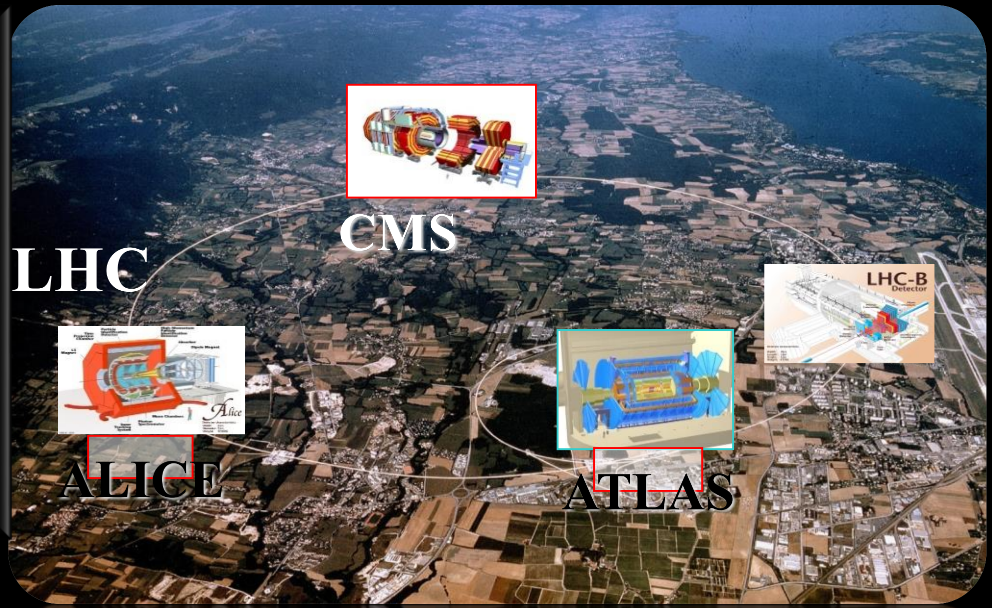
1926. **Enrico Fermi** (1901-1954): on 7 Feb. published *Statistic by Fermi-Dirac*.

1926. **Born**: on 25 June published a job concerning the statistical interpretation of wave function.

1926. **Dirac**: on 26 August re-interpreted Planck's theory and still obtained by another road…*Statistic by Fermi-Dirac*.

1927. **Heisenberg**: on 23 March presented the relationship of indeterminations within the new mechanics.

Cfr: Nisati A (2012) SISFA key-note speaker



A provocative incitement
Quantum Mechanics' Organization: Epistemological Reflections to be solved (?)

- Nowadays quantum mechanics seems to open the door to a new challenge:

- it is necessary to declare inquiring and make clearer its foundations, for example, :
  - *to analyze the cultural paradigm within of two centuries of mechanisms and teaching almost totally mechanistic (?)*

- For example. QM has really proposed a explanation of an autonomous theory … or is it a structured rejected of previous foundations introducing a new formalism *ad hoc*?

- By acceptation of quanta in physics, is it should mean (maybe) to also admit a back to foundation of classical science?

- The tentative to assiomatically formalize Relativity. (by using isotropy of space or low of propagation, in the end a constant is always to determine …or a parameter to specify).

- What kind of revolution (1900) had we … in physics and mathematics… only foundations? Cultural? Methodological?

What is the Story

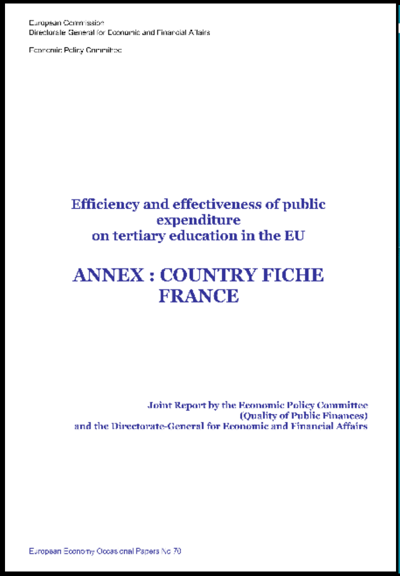
Czech Republic
- University (Philosophy dept.) vs Academy of science (Historical dept.)

U.S.A.
- HSS , HOPOS | History of Science [NO Epistemology, ?? Philosophy]

Belgium
- Access to professorship , very long-term as non tenure-track

France
- Doctorate
- CNRS, CR1, CR2, DR1, DR2
- Laboratoires (Research) / Departments (Teaching)
- Sections University CNU : Qualifications
- In order to be MCF, *Qualifications*, 4 years
- In order to be Prof: *Habilitation*, HDR, 4 years, 2C, 1Cl, Cl. Exp.
- 26-05-2018: Call for Inter-Country Research Centre

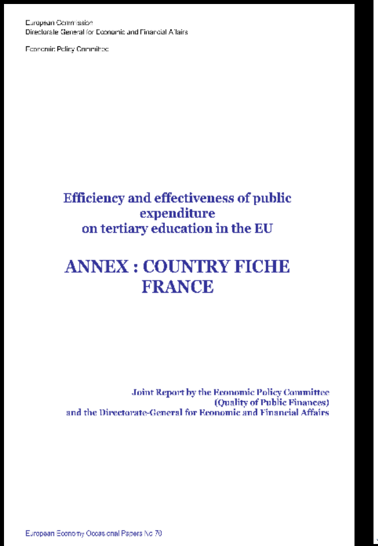
U.K.: *History of Natural Science* | *History of Science and Technology* | *History of Science and Medicine* | *CPNSS-Philosophy of natural Science* | *History of science &(in) Society*
Australia : *HPS* | *Intellectual History & Ideas*
Etc.

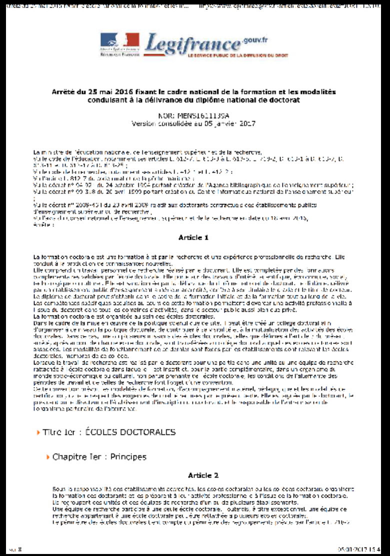


4) University education, especially at doctorate level, is less attractive

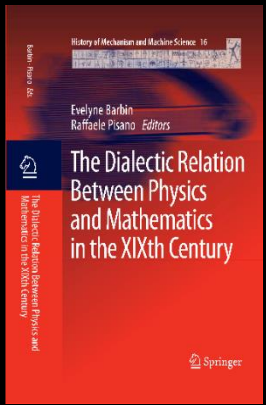
The Ministry for Research has predicted a more than 30% drop in the number of PhDs awarded by 2017.[12] The number of PhD students will decrease from 70,000 in 2007 to 47,500 in 2017, the result of demographic change (through 2012) and a steepening decline in enrolments in higher education, particularly in universities. This decrease particularly affects scientific disciplines within universities, medical tracks excepted. In order to encourage students to enrol in PhD courses, a number of initiatives have been taken recently, consisting mainly of involving graduate engineering schools in research activity (in particular within the centres of research and of higher education (PRES).

p. 12

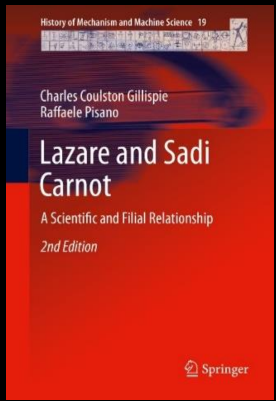




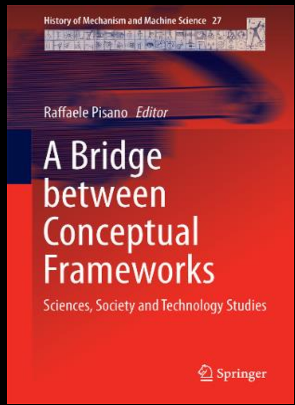
Very Recent Accomplishments on the Relationship Physics-Mathematics into History of Exact Sciences & Intellectual History | *plus* p-r-b papers



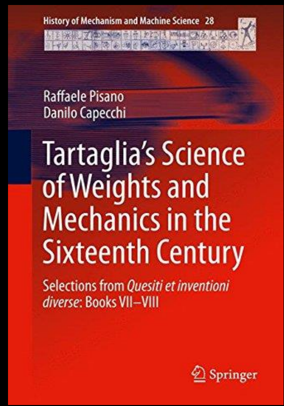
2013



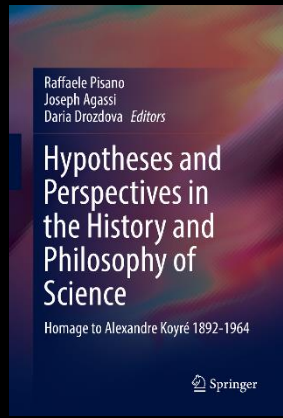
2014 [2nd ed.]



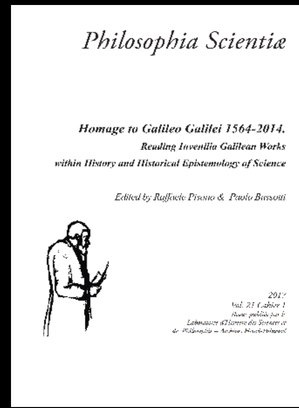
2015



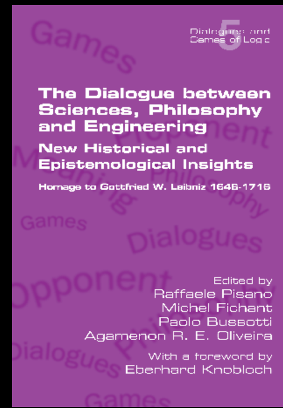
2015



2017



2017



2017

OXFORD UNIVERSITY PRESS

2020

Philosophiae Naturalis Principia Mathematica.

***Criticism Analysis and Full Transcription and Translation from Le Seur and Jacquier Geneva Edition* (1822)**

Publication « expected » : 2020, 5 volumes