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Gassendi and *l'Affaire Galilée* of the Laws of Motion*

The Argument

In the lively discussions on Galileo's laws of motion after the Pisan's death, we observe what might be called a new "Galilean affair." That is, a trial brought against his new science of motion mainly by French and Italian Jesuits with the substantial adherence of M. Mersenne. This new trail was originated by Gassendi's presentation of Galileo's *de motu* not simply as a perfectly coherent doctrine, but also as a convincing argument in favor of the truth of Copernicanism.

L'affaire Galilée that I will be dealing with does not concern the condemnation of the Pisan scientist in 1633 and the reactions which this event produced in Europe. Even if for many reasons it still remains problematical, that *affaire* has been the object of thorough studies, even recent ones, to which I have nothing new to add. There is, however, another Galilean *affaire* that began immediately after the conclusion of the first, upon the death of Galileo in 1642. In this second episode the scandal was represented by the Galilean laws of motion, submitted to a series of severe censures between 1642 and 1648, especially in France.

At the origin of the *affaire* of the Galilean science of motion is the articulated presentation that Gassendi gave of it in the *De motu impresso a motore traslato* published in 1642 (Gassendi 1642),[1] but materially drafted in 1640, two years after the publication of Galileo's *Two new sciences*, that Gassendi had read with considerable attention.

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* This paper reproduces, with a few changes, the essay published in Italian in 1993 (Galluzzi 1993). Since then a few studies have been published which discuss the themes dealt with in this work, shedding new light on the protagonists of this capital discussion. Among these new contributions appear of special interest the long awaited critical edition of Baliani 's *De motu*, edited by Giovanna Baroncelli, and the essay by Carla Rita Palmerino (Palmerino 2000). This last work presents an insightful examination of the reasons behind the evolution of the attitude of Father Mersenne in the lively European discussions on the Galilean science *de motu*.

[1] I am using the version included in the edition of 1658. In this edition the title of the work was changed and a third *epistula* "ad venerandum senem Iosephum Galterium" was added. The third *epistula* contains a reply of the Canon of Digne to accusations moved to him by Morin (n. 11; Gassendi 1642, 3:478–563).

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The conclusion of this *affaire* which, unlike the first, did not end with any formal convictions, can be made to coincide with the death of Marin Mersenne, in 1648. During these seven years, Mersenne was in fact the active and able director of a controversy to which he also offered a significant personal contribution. Since 1633, Mersenne had manifested interest in the Galilean science of motion, having inserted in his *Harmonie Universelle* a description of it, based on the *Dialogues* (Mersenne 1637, 1:85–92, 125–128).[2] Nor must it be forgotten that in 1634 he published a version of the Galilean treatise on mechanics (Mersenne 1634a),[3] while in 1638 he gave to the press *Le nouvelles pensées de Galilée*, a free translation of part of the *Two new sciences* (Mersenne 1639).[4] In France, thanks to Mersenne and to his epistolary network, the Jesuits Pierre Le Cazre and Honoré Fabri were involved in the *affaire*, as well as Boulliau, Roberval, Le Tenneur and, more marginally, Descartes and Pierre Fermat. In Holland, the solicitations of Mersenne caused the intervention of the "enfant prodige" Christiaan Huygens, who would give eloquent proof of his own mathematical talent. Lastly, during his journey to Italy between the end of 1644 and the first months of 1645, Mersenne succeeded in involving in these discussions Evangelista Torricelli and Michelangelo Ricci. Moreover, after his return to France, he kept up an intense epistolary exchange on these same topics with Galileo's disciples in Florence and Rome, as well as with the Genoese Giovan Battista Baliani.

In the *De motu impresso* of 1642, Gassendi, for the first time, clearly laid out the problematic issues that would become the core of the new *affaire*.

The brilliant pages by Alexandre Koyré on the *De motu impresso* by Gassendi in the *Études Galiléennes* (Koyré [1939] 1961)[5] and in the *Newtonian Studies* (Koyré 1965),[6] a point of reference that is still important today. While stressing Gassendi's mathematical limits, Koyré exalted his transformation of Galilean kinematics into dynamics and his bold insertion of the Galilean theory of motion into an organic philosophical framework.

Interested above all in reconstructing the exquisitely intellectual aspects of the process of definition and assimilation of the key concepts of the new conception of the physical world, Koyré has rightly recognized the *De motu impresso* by Gassendi as a significant stage in the process of progressive geometrization of the cosmos. Koyré nevertheless showed scarce interest in the reactions that the *De motu* provoked, especially in France, in the years immediately following its publication.

However, contemporary readers of Gassendi's *Epistulae* were provoked, not so much by the considerable conceptual novelties on which Koyré has insisted, but

[2] For the intricate editorial genesis of the edition of this monumental work, see Lenoble [1943] 1971, XXI–XXV.

[3] A critical edition of Mersenne's translation was published by B. Rochot in 1966, with an insightful introduction.

[4] For the selective and interpretative character of Mersenne's translation of the Galilean *Two New Sciences*, see Costabel and Lerner 1973, 1:7–51.

[5] I am using the Italian translation by M. Torrini (Koyré 1976, 311–324).

[6] I am using the Italian translation by P. Galluzzi (Koyré 1972, 194–197, 204–206).

rather by the Galilean definition of natural motion, accepted without reserve by Gassendi, with all the consequences which derived from it in terms of relations between spaces traversed from rest in equal successive times, of the paths of projectiles, and of the relationship between the prescriptions of Galileo's laws and the motions of "real" bodies.

Although it may seem paradoxical, in the many reactions following Gassendi's work — the speculations on the indifference of bodies to motion or to rest, on the violent character of free fall, on gravity and its external cause, on the relativistic conception of motion, and on many other similar key concepts — assumed much less importance than the careful examination of Galileo's definition on the acceleration in natural motion and of the laws that the Pisan had deduced in the *Two new sciences*.

To understand this phenomenon, we have to focus carefully on the decisive role that the Galilean laws of motion played in the *Epistulae duae de motu impresso* by Gassendi. He had in fact proposed a bold integration of the Dialogue and the *Two new sciences*, accomplishing that organic objective which had been in Galileo's mind since 1609, but which the anti-Copernican sentence of 1633 had prevented him from achieving.

To the reader of the *De motu impresso*, the Copernican structure of the Gassendian universe appeared evident, even if the heliocentric theory was declared in purely hypothetical terms. Gassendi's universe appeared dominated by simple laws of universal validity, which expressed the rigorous convergence between the rational principles of the new physics and the mechanical action of forces: a universe that could be understood through measurement, thanks to mathematical procedures and instruments. It was a universe in which absolute reference points were missing and in which, as a consequence, there were no privileged directions of movement; a universe wisely regulated by its Creator — the most refined mechanic — who, due to the perfection of the original plan, could remain discreetly detached from the everyday operation of the great machine of the world, where occult "qualities," "impulses," and internal virtues disappeared. In this universe, there was no room even for gravity — it being replaced solely by infinite and empty spaces traversed by atoms in continuous movement. The movement that dominated this universe and that guaranteed its orderly conservation throughout time was governed by laws which Galileo had defined and described.

In the *De motu impresso*, Gassendi strived to show with acute speculations and with convincing experiments the absolute unsustainability of the integration of Ptolemaic cosmology and Aristotelian dynamics, which had been very effective for a long time. The criticism of traditional dynamics implied the necessity of abandoning geocentric cosmology and paved the way for an entirely new science of motion which Gassendi derived from Galileo, while transforming it, particularly through deducing the effects described by the Pisan scientist from precise physical causes. Gassendi, in short, gave an eloquent demonstration of the formidable allegiance between the Copernican cosmology and the Galilean doctrine of motion,

vigorously emphasizing their congruence and full compatibility. It was above all through stressing the indisputable superiority of the Galilean science of motion over traditional dynamics, and its capacity to sustain experimental tests, that Gassendi intended to effectively undermine traditional cosmology, which found its fundamental support in the Aristotelian concept of nature and motion.

In effect, the Galilean laws of motion seemed to account perfectly for those "real" motions that the principles of Aristotelian physics were unable to explain. Gassendi also pointed out the dramatic conceptual fragility of ancient dynamics, cleverly emphasizing how such fragility undermined the foundations of that same traditional cosmology that, by the admission of its own supporters, was closely tied to the Aristotelian science of motion. In fact, those who had tried to elaborate a series of presumed confutations of the motions of the Earth had relied on the principles and on the laws of the traditional theory of motion.

It begins to be clear why the *De motu impresso* by Gassendi gave rise to a new Galilean *affaire*. It must be stressed that this new episode is closely connected to the Galilean *affaire* of 1633 of which it constitutes a natural appendix. The passionate defense of the Galilean laws of motion implied for Gassendi the sound promotion of the philosophical and conceptual foundations of Copernican cosmology. Such a defense, moreover, did not entail any obligation to explicitly declare his own adhesion to the theory of the Earth's motions, thus avoiding the risk of a confrontation with the ecclesiastic authorities who had condemned it.[7]

The First Reactions to Gassendi's *De motu*

The intrinsic alliance between Copernican theory, new philosophy, and Galilean science of motion appeared evident to the contemporary readers of the *Epistulae de motu impresso a motore translato* as a result of the immediate and instinctive reaction by the notorious astrologer Morin (Costabel 1974)[8] and by the Jesuit Pierre Le Cazre,[9] Rector of the Dijon College.

[7] Although the *De motu impresso a motore translato* contains many points that are worthy of investigation, an exhaustive analysis of this text is still lacking. Besides the above quoted pages of A. Koyré, useful remarks on Gassendi's *Epistulae* are to be found in Bloch 1971 (190–201).

[8] As is known, Morin heavily attacked Galileo before and after the sentence of 1633 (Morin 1631 and 1634). At the conclusion of his work of 1634, Morin explicitly informed the reader that the *Dialogue* had been condemned by the Holy See and that Galileo had been forced to abjure his doctrines. In the letter to Jean de Beaugrand, of 11 November 1635, Galileo vigorously resented the gratuitous malignity of Morin stating that Morin would have offended him much less by publishing the sentence and the abjuration than by keeping silent about it: "soggiunge che havrebbe aggiunta la sentenza e abiurazione fatta in Roma, ma ha stimato meglio il tacerla per sostentar la mia fama .... Assai ... meno m'havrebbe offeso il Morino publicando che tacendo mie sentenze e abiurazioni" (Galilei 1890–1909, 16:341ff.).

[9] Biographical data on Father Le Cazre (Rennes 1589; Dijon 1664) are extremely scarce. Rector of the Colleges of Dijon, Metz, and Nancy, he was Provincial of Champagne and Assistant of France. For Sommervogel he "scripsit docte et accurate multa de disciplinis philosophicis, theologicis, mathematicis, physicis" [he wrote many erudite and accurate things on philosophical, theological,

In his very fierce *Alae Telluris fractae* (Morin 1643),[10] Morin, going directly to the heart of the matter, maintains that Gassendi had just bared his true face as a follower of Copernicus, notwithstanding the formal condemnation of heliocentrism by the ecclesiastic authorities. According to Morin, who had already distinguished himself in the denouncement of Galileo's Copernicanism, Gassendi's concept of free fall guided by purely mechanical attractive forces and performed according to the space-time proportions rigorously described by Galileo, constituted, in fact, a fundamental component and a distinct characteristic of the Copernican system: attraction and the Galilean laws of naturally accelerated motion conferred therefore an indelible stamp of infamy.

Gassendi avoided replying publicly to this attack of unprecedented violence. However, he immediately wrote a bitter answer that would see the light, unbeknownst to him and with his apparent disapproval ("me invito"), on the initiative of some of his friends in 1649 (Gassendi 1649).[11] In his rebuttal, Gassendi reasserted the purely hypothetical nature of his references to the Earth's motions, but he energetically defended the definition of acceleration in free fall and the laws of natural motion that Galileo had described in the *Discourses*. He took care, moreover, to emphasize that that concept of motion, as well as the causal model of attraction, did not necessarily presuppose the Copernican system, but would have also been admissible in the hypothesis of an immobile Earth (Gassendi 1658, 3:562–563).

Even the Jesuit Le Cazre, in his first private letter, sent to Gassendi from Dijon on November 3 1642 (ibid., 6:448–452) through Senator Filbert de la Mare,[12] stressed the evident integration in the *De motu impresso a motore translato* between the Galilean analysis of the laws of motion and the Copernican system although without emulating Morin in his verbal affronts and explicit threats.

It is worth remembering that Gassendi had established in his *Epistulae* of 1642 the most evident link between the laws of motion and the Copernican system through his endorsement of the Galilean explanation of the tides. Le Cazre formulated radical criticism of Galileo's concept of motion, which depended, as he

mathematical and physical disciplines]. Moreover, he affirms that in the National Library of Paris there is a manuscript treatise by Father Cazre, *De descensu gravium* (Sommervogel supposes it is a copy of one of the letters to Gassendi); the signature that he gives (Ms. Lat. 61, 40A) is unfortunately wrong and does not consent retrieval of the manuscript (Sommervogel 1890–1932, 2:col. 934–935). When the *De motu impresso* was published, Father Le Cazre was Rector of the important Jesuit College of Dijon (Tannery et al. 1945–1988, 9:321–323, 323 n. 5).

[10] For the later attacks by Morin against the corpuscular philosophy of Gassendi, see Sortais 1921–1923, 2:167–173.

[11] L'*Apologia* also contains the so-called "Copernican letters" of Galileo. Gassendi's reply — a letter to his friend Gaultier — was published unbeknown to him on the initiative of some of his friends, who were worried that his not answering could harm the reputation of the Canon of Digne. One year later a new edition was issued which contained the letter in which Gassendi protested his own complete extraneity, or rather contrariety, to the publication of the *Apologia* (Gassendi 1650). For Gassendi's letter of justification, see Gassendi 1650, 5–6. Gaultier's answer to the *Alae Telluris fractae* was republished in Gassendi 1658, 3:520–563.

[12] De la Mare, who had received a presentation copy of the *De motu impresso* from Gassendi (see his letter of thanks in Gassendi 1658, 6:447), lent it to Le Cazre (Gassendi 1658, 4:448–452).

stated, upon false principles "ex principiis falsis" (ibid.). He refused to admit that the parabola — which, according to Galileo and Gassendi, resulted from the composition of a uniform horizontal motion with the acceleration of free fall — would not have brought about an increase in the time of fall and an impact of greater intensity (ibid., 448–449). He also contested the increase of spaces traversed in equal times from rest, according to the series of odd numbers, that had been proposed by Galileo and reaffirmed by Gassendi (ibid.). Lastly, he denied that a heavy body projected perpendicularly would have taken the same amount of time in its ascent, as it would in its descent (ibid.).

After having hurriedly detached himself from the fundamental Galilean-Gassendian conceptions of motion, the Jesuit launched an attack upon philosophical-cosmological matters. He emphasized that atomism and the reduction of qualities to single local motions proposed by Gassendi in the *De motu* would not be appreciated by learned and pious men "viris eruditis ac piis minus placitura videantur" (ibid., 449). In fact, as a necessary consequence, it resulted that accidental forms do not exist; then they cannot be separated from substance, with serious consequences for the Eucharist mystery "formae accidentariae nullae sunt, multoque minus inveniri et esse possunt ab omni substantia separatae. Quid sanctioribus igitur nostrae Religionis mysteriis fiet?" (ibid., 450). This distressing interrogative on the destiny of the dogma of the Eucharist sustained the "friendly" recommendation to renounce the publication of the work on the philosophy of Epicurus: "Audio certe tibi etiamnum in manibus esse iustum volumen aliud, quo haec Epicuri ac Democriti somnia illustrare labores... Vix per Deum immortalem ne tui nominis authoritate, infirmioribus quidem errandi, caeteris vero prae conceptam ingenj tui ac iudicij sagacitate opinionem imminuendi praebeas occasionem" (ibid., 450–451).

Le Cazre insinuated that, in the light of his purely hypothetically declared assumption of the Earth's motion, the care and insistence with which Gassendi continually proposed arguments, observations, and experiments in favor of the Copernican system, appeared somewhat strange:

> Cur adeo studiose caetera quoque omnia Copernicanorum argumenta congeris ... Cur ... de Telluris eiusdem circa Solem motu tam prolixam nec ad praedictum finem necessariam adjungis disputationem in qua Copernicanorum argumenta omnia et rationes quae potes et vales dicendi facultate stabilire et confirmare, sed aliorum quoque obiectiones infirmare, pari studio et contentione moliris? Quid amabo te amplius eras facturus si eam sententiam animo destinato asserendam propugnandamque assumeres? (Ibid., 451)

And before manifesting his own surprise at Gassendi's subscription to the Galilean theory of the tides,[13] Le Cazre reminded Gassendi that the anti-Copernican verdict

[13] Gassendi had reproposed the Galilean theory of tides and was shown to consider it as convincing

was issued not simply by some Cardinals, but by the Pope himself "non Cardinales tantum aliquot (ut ais), sed supremum Ecclesiae caput; Pontificio decreto in Galilaeo damnaverit, et ut ne in posterum verbo aut scripto doceretur sanctissime prohibuerit."[14] It had been, according to Cazre, a very healthy edict that impeded the followers of that wrongful theory from sustaining absurd consequences "portenta propemodo infinita ... excolantes culicem et elephantos deglutientes"; and he recalled at the same time that philosophers were obliged to submit to the dogmas of faith.[15]

Considering the Jesuit's threatening tone, the specification of his friendly intentions by Senator de la Mare in his letter of transmission to Gassendi of Le Cazre's writing, were certainly read with some relief on the part of the Canon of Digne: "de quo apud te praestare possum eum esse qui haec ad te scripserit non severiori Catholicae fidei tuendi studio adductus ... sed unius veritatis inquirendae ratione" (ibid., 452).[16]

Gassendi's reply to the Jesuit was published in 1646, as the last of three letters (Gassendi 1646)[17] in response to the *Physica demonstratio* (Le Cazre 1646)[18] given to the press by Le Cazre in 1645, in order to refute the Galilean conception of motion. Gassendi responded to the Jesuit's accusations point by point, claiming firmly the *libertas philosophandi* in physical investigation and supporting the compatibility of atomism with the Christian faith.[19] Furthermore, he insisted on the extraordinarily rational and experimental congruence exhibited by the organic body of doctrines formed by the Copernican system, by the conception of atoms in

in the *Epistola II De motu impresso a motore translato* (Gassendi 1658, 3:517–519). He was even more explicit when he proposed again the Copernican proof deduced from tides (*de aestu maris deque defensa a Morino titubatione Telluris*) in the *Pars secunda* of his reply to the *Alae Telluris fractae* of Morin (Gassendi 1658, 3:531–41).

[14] Gassendi — like Peiresc and other French Galileans — remained convinced for a long time that the sentence of 1633 had been issued against Galileo "ad personam." Thus the sentence did not imply, in his view, adherence to geocentricism as an article of faith. In the *De motu impresso*, the Canon of Digne affirmed that only Cardinals had approved the sentence: "Cardinales aliquot approbasse Terrae quietem dicuntur" clearly showing that he did not consider these positions in favour of the immobility and centrality of the Earth as "articulum fidei" (an article of faith), nor as a dogma "apud universam Ecclesiam promulgatum ac receptum" (Gassendi 1658, 3:519).

[15] "Nempe meminisse semper oportet nos non philosophos tantum esse, sed etiam Christianos, philosophiamque nostram nec debere, nec vero etiam posse a Christiana Fide discrepare" (Gassendi 1658, 6:451).

[16] In his letter of 7 November 1642, De la Mare defined Le Cazre as "vir alioquin maxime inter suos extimationis et philosophicis mathematicisque disciplinis large imbutus, ut tu melius aliquando ex illius scriptis noveris, quae non pauca habet de motu."

[17] The *Epistola tertia*: "quod, tametsi tempore primam, visum est tamen postponere, quod praeter argumentum cum superioribus commune, contineat etiam explicationem plurium aliarum difficultatum" (Gassendi 1658, 3:625–650), dated December 6 1642, contains the reply to criticisms by Le Cazre in his letter of 3 November 1642. The first two *Epistulae* confuted Le Cazre's arguments (Le Cazre 1645b and 1646) against the Galilean-Gassendian science *de motu*.

[18] The work was dedicated to Gassendi.

[19] Replying to the accusation of defending a "rash" philosophy, Gassendi defended *libertas philosophandi*: "ad quae mere sunt naturalia, quod attinet, non nego quidem ea me philosophari libertate, ut non uni alicui Sectae eruditorum, ut vocas, haerescam" (Gassendi 1658, 3:627). Gassendi devoted a long paragraph to the compatibility of the philosophy of atoms with Christian faith in general and the sacrament of the Eucharist in particular (Gassendi 1658, 3:636–638).

movement in empty spaces and by the Galilean conception of motion with its relativistic structure and its rigorous laws, which appeared to Gassendi the direct consequence of the mechanical attractions between the atoms. He lastly emphasized that the superiority, at least on a hypothetical level, of this organic body of doctrines was further highlighted by the possibility it offered of conceiving and constructing working models of the world machine. As is well known, the conception of knowledge as a tool which allows man to reproduce natural phenomena is continuously insisted upon by Gassendi.

In an extraordinary passage of his letter to Le Cazre of November 1642, Gassendi in fact described a physical model, a sort of hydraulic planetary, capable of simulating the formation and the orderly functioning of the cosmos. If a new Daedalus or an Archita could construct this type of system, he stressed, basing themselves on the new principles of the Galilean-Gassendian dynamics, why should we exclude the possibility that Divine omnipotence would be able to create the universe in which we live and make it work perfectly using these same principles?:

> Heinc proinde dico, et unumquemque Siderum globum in ea parte mundani spatij, quam Deus ab initio ipsi praescripsit, circumgyrari, et globum Telluris in ea parte mundani spatij quiescere, in qua Deus ipsum initio constituit. Rem ita esse intelligo, ut si quis plureis apparet globos ex ea materia, quae sub pari mole, sive ambitu tantum ponderet, quantum aqua, et ipsos in aqua quiescente constituat. Quilibet enim eorum globorum, ubicumque fuerit constitutus, ibi conquiescet; et neque ex summo imum petet, neque ex imo summum; neque ex utrovis extremo medium; neque ex medio utrumvis extremum; neque ex medio, extremove locum interceptum, neque ex loco intercepto medium aut extremum. Etsi fingas Daedalum, Architam, aut alium artificem adeo ingeniosum, ut uno eorum alicubi intra aquam constituto efficere possit ... varios illis circa ipsum obeundos motus indere; ii globi peragent suos motus quamcumque ad partem instituti fuerint; nempe seu prope superficiem, seu prope fundum; seu sub medium, seu prope medium, seu procul a medio; scilicet tam ille, quam isti, ob ipsam cum aqua ...aequilibritatem neque graves erunt, ut subsidant, neque leves ut avolent.
>
> Subinde ergo comparo cum immoto globo Tellurem, cum circum-ductis Sidera; et dico, sicut globus ille emoveri potest e loco in quo est, et promoveri versus alium; sic posse quoque Tellurem emoveri e loco in quo est et promoveri versus alium, sic posse ipsam quoque Tellurem emoveri a loco in quo est et promoveri versus Lunam; addoque ut globus ille in quocumque alio aquae loco reponatur, in eo pari modo quiescet, neque priorem repetet; sic et Tellurem, in quocumque loco constituta fuerit, in eo mansuram, nec pristinum repetituram. Et dicis tu quidem *attolli*, quod ego heic simpliciter dico *emoveri*. (Gassendi 1658, 3:631–632)

As in the "Platonic myth" of the Galilean *Dialogue*, acceleration, the properties of

motion, and attraction with its purely mechanical model of action, constituted the fundamental elements of cosmogony. At the same time, the presumed privilege of centrality invoked for the Earth by Le Cazre and by the supporters of traditional ideas appeared simply as the effect of Man's natural tendency to make himself the measure of everything:

> Translata Terra versus Lunam ad Antipodas existentem nos non propterea avolaturos in derelictum a Terra locum; ut neque etiam antipodas, translata Terra versus Lunam factam nobis ad verticem; sed et illos et nos perinde in eadem antiqua sede versaturos, tanquam simul translato Terrae centro, respectu cuius et comparate ad situm capitis pedumque nostrorum, censebimur semper ascendere et descendere, sive locum sursum deorsumque habere; non autem simpliciter respectu loci in quo Terra aut erit, aut fuerit, et qui seu centrum Mundi sit, seu non sit, nihil ad ascensum aut descensum faciat. (Ibid., 632).

Gassendi would later on insist upon the inevitable and necessary congruence between the principles of motion introduced by Galileo and the structure of the real world. Inertia and the conservation of motion, the composition of motions, and acceleration as a continuous process constitute, in fact, the major components of a new natural philosophy and of a new conception of the universe (ibid., 632–636).

After the violent reactions of Le Cazre and Morin, the debate on the *De motu* by Gassendi assumes a different tone.

Insinuations regarding the Copernican implications attenuated, while the adversaries' attention concentrated on the critical examination of Gassendi's presentation of the Galilean laws of motion.

The reasons behind the attenuation of the cosmological polemics can only be hypothesized. Gassendi was an influential person, a respected man of the Church, esteemed with irreproachable behavior. He had besides, on many occasions, stressed that the theories that he was outlining belonged to the sphere of purely hypothetical doctrines, which he proposed only in trying to account for phenomena; in any event, he was absolutely ready to submit to the decisions of the Church.[20]

Under these circumstances, an explicit accusation of heresy directed at Gassendi had little chance of success and could even backfire against whoever proclaimed it. Therefore, it was more prudent and opportune to try to confute the new conception of motion, demonstrating its intrinsic weakness and thereby undermining the

[20] He answered Le Cazre's insinuations, for example, by confirming that, even though, as far as he knew, the Sovereign Pontiff had not confirmed the sentence of Galileo, making it "universal," he was very ready to submit to the decisions of the Church: "quod me attinet, me vel sola fama, habitaque fides tuis literis ita movet ut non expectem promulgationem [of the sentence], sed statim prorsus exosculer et plane caeca, ut dicitur obedientia ipsum excipiam" (Gassendi 1658, 3:641). However, he had presented arguments that seemed not only to make plausible, but also necessary and diffusely practised a non-literal interpretation of the Holy Scriptures.

structure that Gassendi had proposed as the fundamental evidence in favor of the Copernican hypothesis. This option is evident in the *Physica demonstratio* by Le Cazre (Le Cazre 1646). Here the Jesuit avoided proposing strong insinuations on the connection between the Galilean dynamics exposed in the *De motu impresso a motore translato* and the Copernican system. The Jesuit's attack was concentrated exclusively on the Galilean definition of motion in free fall, which he considered wrong. Le Cazre (ibid, 36ff.) resolutely refuted the odd numbers law (1, 3, 5, 7, 9 etc.) suggesting that it be substituted with the continuously double geometric proportion (1, 2, 4, 8, 16, etc.). He also contested that a heavy body moving naturally from rest, would pass through as Galileo had stated — all the infinite minor degrees of velocity before reaching any given velocity. This different opinion derived from Le Cazre's conviction that velocity increases not according to time, but according to distance (ibid., 26ff.). Lastly, he denied the validity of the postulate proposed by Galileo at the opening of the *De motu naturaliter accelerato*,[21] and he also rejected the experiment of the interrupted pendulum introduced by the Pisan scientist to confirm this postulate.[22]

Le Cazre's reasoning constitutes an emblematic example of the objective difficulties of assimilating the new concept of motion, offering a whole array of paralogisms, misunderstandings, deductions from weak principles, and pseudo-experiments, such as that of the scale with which he believed to have demonstrated that impact (and the velocity of heavy bodies in natural motion), increases with the height of the fall.[23]

Even without the insinuations regarding Gassendi's Copernican sympathies, the discussion of the new laws of motion is still characterized by a strong *vis polemica*. For Le Cazre, Galileo had proclaimed himself author of a "new science," while his construction rests upon false principles "non modo suspicionibus meris, vixque probabilibus coniecturis ... sed ex principiis aperte falsis evidentibusque paralogismis omnia concludi: ex quo consequens est novam illam evanescere scientiam" (ibid., 5–6). And he continued accusing Galileo and his "tyrones" of insolence, of intentional mystifications to sustain at all costs their pseudo-science, and of unheard-of stupidities, giving a sinister laugh at the paradoxical blindness of a philosopher who proclaimed himself to be "linceo": "Lynceus Philosophus ac Mathematicus, Lynceorum princeps, in tam aperta luce caecutiat" (ibid., 9).

The spiteful tone indicates that the objective had not changed, even if Le Cazre had now chosen to open fire, not directly upon Gassendi, who is indeed considered an accomplice, but upon Galileo himself.

Gassendi replied with a letter to Le Cazre in March 1645, later distributed as the

[21] "Altera quoque erroris causa in Galilaei placitis inde etiam manavit quod sibi dari et gratis concedi postulat: gradus velocitatis eiusdem mobilis super diversas planorum inclinationes acquisitos tunc esse aequales, cum eorundem planorum elevationes ponuntur aequales" (Le Cazre 1646, 9ff.).

[22] "Experientia qua Galilaeus suum postulatum confirmat renititur" (Le Cazre 1646, 11).

[23] "Experientia nova et admiratione digna, modum mensuram ac rationem accelerationis motus in naturalium gravis descensu evidenter exprimens" (Le Cazre 1646, 18–26; see also Tannery et al. 1945–1988, 12:122–123).

first of the *Epistolae tres de proportione qua gravia decidentia accelerantur*, published in Paris in 1646 (Gassendi 1658, 3:564–588).[24] He enhanced Le Cazre's misunderstandings, showing the weakness of his reasoning, reversing the interpretation of his scale experiment (ibid., 575–579),[25] and above all, demonstrating with a careful geometric analysis that Le Cazre's continuously double geometric proportion resulted in absurd consequences. Gassendi passionately defended the Galilean theories, particularly insisting on the conception of acceleration as a continuous process and on the fundamental and close connection between velocity and time (ibid., 582–583, 565–566).[26] Regarding the Galilean postulate refuted by Le Cazre, Gassendi informed the interlocutor that it had been demonstrated by Torricelli in the *De motu* of 1644 (ibid., 569–572).[27]

Le Cazre responded with the *Vindiciae demonstrationis physicae*, sent privately to Gassendi from Metz on 6 April 1645.[28] In this writing he meticulously reasserted his own theories, accusing the interlocutor of having falsified or, at the very least, having misunderstood his thought. The Jesuit reproposed the scale experiment (ibid., 604–607), contested the admissibility of the Torricellian demonstration of the postulate,[29] and obstinately insisted upon the falsity of the Galilean conception of motion, drawing arguments from the experiments of both Mersenne in the *Cogitata* (Mersenne 1644a), and the reflections by the Jesuit Onorato Fabri on the real nature and laws of acceleration in free fall.[30]

The second of Gassendi's *Epistulae* of 1646 (Gassendi 1658, 588–625) contains a mordant reply to the *Vindiciae*. It is worth remembering the explicit self-criticism to which Gassendi submits himself: *De quodam lapsu emendando circa causam accelerati gravium motuum* (ibid., 621–623). In the *De motu impresso*, Gassendi had attributed acceleration to a twofold cause: constant attraction from the center, and the air displaced by the descending body which flowed behind it, giving it a further push (ibid., 497–498). This twofold cause (curiously, the second one reproposed the Aristotelian theory of antiperistasis to explain the motion of heavy bodies once separated from their motor; it seemed, furthermore, to presuppose a full universe, which is surprising in an atomist like Gassendi) had been introduced by Gassendi in order to account for the increase according to the series of odd

[24] "Epistola prima admodum Reverendo et religiosissimo doctissimoque Viro P. Petro Cazraeo Societatis Iesu."

[25] "De experimento in bilance facto ac aliud revera probante quam velocitates esse sicut spatia."

[26] Egidio Festa, whom I thank, has brought to my notice that in some texts of the *Syntagma* (Gassendi 1658, 1:341), Gassendi, confirming the "continuous" character of acceleration in natural motion, proposes an analysis from which it follows that this continuity is not intrinsic, but only apparent ("ad sensum"). See Festa, in Gassendi 1994, 2:355–364.

[27] "De postulato Galilaei circa motum super aeque altis non aeque inclinatis planis." Gassendi had had from Pierre Carcavy a copy of the *De motu* of Evangelista Torricelli (Torricelli 1644) where "Galilaei successor eximius demonstraverit in eo istud postulatum" (Gassendi 1658, 3:570).

[28] The *Vindiciae* were sent to press later (Le Cazre 1645b).

[29] "Quae vero de libro Torricelli postea adjungis (etsi ea non viderim) partim vera, partim falsa et saltem incerta esse non dubito" (Gassendi 1658, 3:601).

[30] At least in one case, Father Le Cazre echoes the "physical" analysis of motion of the confrère Honoré Fabri (Gassendi 1658, 3:616).

numbers of spaces traversed in equal times from rest. The new reflections developed in the effort to reassert, against Le Cazre's objections, that acceleration is a continuous process, have now convinced Gassendi that the odd number law can be deduced by the simple hypothesis of an attraction from the center. The recognition of the error is proposed without embarrassment. Indeed, it becomes a further argument to use against Le Cazre's wrong theories. Gassendi admits in fact to having fallen into error because he had not taken into account the continuous process of acceleration "quia enim non attendi velocitatis gradum primo momento acquisitum ita integrum maneret in secundo, ut ad superandum duo spatia valeret, ipsumque habui quasi valeret solum ad superandum unicum" (ibid., 621). He had himself experienced the difficulties implicit in assimilating the "integration" of continually increasing degrees of velocity and the implications of this key concept of Galilean kinematic for the proportion of the spaces traversed in equal times from rest. Ingenuously confirming his *lapsus* he made Le Cazre know at first-hand the decisive importance geometric competence played in the understanding of the new concept of motion and the crucial importance of the close relationship between velocity and time that was contested by Le Cazre.[31]

The *Epistulae* of 1646 marks Gassendi's formal exit from the dispute on the Galilean conception of motion. But his retreat from the scene did not at all bring about a conclusion to the Galilean *affaire* of the laws of motion.

New Interlocutors

Other characters were on the scene long before, proposing new and subtler strategies. The key character was undoubtedly the Jesuit Onorato Fabri who still needs to be studied thoroughly in order to illuminate the many apparently contradictory aspects of his personality and his scientific production.[32]

[31] "Iam lapsus fuit, quatenus proinde velocitates ut spatia habere se admisi imprudens. Quia enim non satis attendi velocitatis gradum primo momento acquisitum ita integrum manere in secundo ut ad superandum duo spatia valeret, ipsumque habui quasi valeret solum ad superandum unicum" (Gassendi 1658, 3:621).

[32] Father Fabri appears like an ambiguous personality, on whom his contemporaries expressed contrasting opinions. He surely represented one of the most important participants in the dialogue which authoritative representatives of the Company of Jesus in Italy and in France held with exponents of the new science. At the same time, Fabri conceived new apologetic strategy views. He tried to incorporate the main scientific novelties, both astronomical and mechanical, into the body of Aristotelian natural philosophy, which he updated substituting syllogistic logic with mathematics. This attitude may help to explain the opposition of the more intransigent representatives of the Jesuit Order against Father Fabri. For example, Thibout wrote to Mersenne, on 17 June 1647, that Fabri "a ce que m'asseure Mons.r Mousnier, il est traversé par les Peres de sa Compaignie, et croit on qu'il font tout ce qu'il peuvent pour le faire sortir, comme ils ont faict leur possible pour empecher l'impression de ses oeuvres" (Tannery et al. 1945–1988, 15:245). The sending to Rome of Fabri, at the end of 1646 at the decision of his superiors of the College of Lyon, where he resided, has indeed been interpreted as punishment inflicted because of his innovative teaching of philosophy and science (Tannery et al. 1945–1988, 15:234–236). On the other hand, the constant contraposition of Fabri to the mechanical and astronomical conclusions of Galileo and Galileans provoked the resolute opposition of many

The debut of Father Fabri in the second Galilean *affaire* goes back to 1643, and appears immediately marked by extremely ambiguous characters. On August 9, 1643, encouraged by a Jesuit brother whom he does not name, Fabri sent a long letter to Gassendi, still in part unpublished, in which he sketched a sort of autobiography (Tannery et al. 1945–1988, 12:275–279).[33] He strongly emphasized his own choice of submitting natural phenomena to rigorous mathematical treatment, in consideration of "rerum physicarum et mathematicarum communio" (ibid., 276).[34] Furthermore, he clearly kept his distance from the natural philosophers of the Scholastic, full of litigious and often purely verbal disputes "Porro, cum Physicam appello, nolim, quaeso, intelligas litigiosam illam quam vulgo in scholis nostri philosophi docent... sed iucundam illam quae naturales effectus primo explorat sensu tum vero ad suas causas reducit" (ibid., 276).

Fabri then revealed to Gassendi his own theories about the physical causes of the motion of the heavenly bodies, specifying that he followed the common opinion as to rest of the Earth and motion of the Sun (ibid., 278). He outlined a system of evident Tychonian structure, but full of Keplerian reminiscences and founded on the explanation of planetary orbits as the consequence of the composition of uniform circular motions and accelerated straight motions. On this basis Fabri came to delineate a purely mechanical cosmogony that echoed the "Platonic myth" of Galileo's *Dialogue*, a work which he appears to have read very attentively (ibid., 279). He also specified that he had conceived a series of arguments against the Copernican system, about which he solicited Gassendi's opinion (ibid., 277–278). Lastly, he informed Gassendi of having written a treatise *de motu locali* based on hundreds of rigorous geometric propositions (ibid., 277).[35] Curiously, Fabri supplied Gassendi with very brief information about the results of his work

authoritative followers of the Pisan scientist. In particular, Giovanni Alfonso Borelli will vigorously denounce the ambiguous new apologetics of the Jesuit of Lyon on several occasions. He considered him an enemy much more dangerous than the declared opponents of the new scientific ideas (Borelli 1667). Borelli had already opposed Fabri's *Brevis adnotatio in Systema Saturnium* in 1659–1660 (Fabri 1659; Galluzzi 1977). As confirmation of the ambiguity of this important personage, there is the different and much more favorable disposition of Prince Leopoldo towards him. The Prince generously received and effectively protected him when, in 1660, Father Fabri was examined and imprisoned by the Holy Office. Fabri had indeed declared the necessity of a not literal interpretation of the passages of the Holy Scriptures where the immobility of the Earth is affirmed, in case an indisputable proof for the movement of the Earth should be produced. Moreover, Michelangelo Ricci presented him to Torricelli with flattering words (Galluzzi et Torrini 1975, 1:381). See Sommervogel 1890–1932, 3:col 510–521; 9:col. 309) and Fellmann 1959, 1971, and 1992; for his polemics with Gassendi, see Sortais 1920–1922, 2:38–401). For an essential biography, see De Vregile 1906, 5–15. For useful information about the development of his reflections *de motu*, see Drake 1970b, 1973, 1974, 1975; Caruso 1987. For Fabri's reflections on mathematics, see Fellmann 1959. A Ph.D. dissertation has been dedicated to Fabri by Lukens (1979).

[33] In this work are published only some paragraphs of the letter. The letter is in the National Library of Paris, Fonds Lat., Nouv. Acq. 600:19–31. This letter is not published in Vol. 6 (which contains the correspondence) of Gassendi's *Opera omnia*.

[34] "Nullus fere sit in Physica tractatus qui mathesi carere possit."

[35] He also added that he had written a treatise on secondary qualities: "motui locali succedunt qualitates sensibiles: color, lumen, sonus, et caet. quarum omnium explicationi quantum mathesis conferat tuo judicio relinquo." Mersenne will give a survey of Fabri's theory of colors (Mersenne 1644b, f. 5r not numbered).

on motion, limiting himself to declaring that acceleration along different inclinations increases according to the inverse sines, a theory which corresponded to that previously proposed by the resolute Copernican Ismael Boulliau (ibid., 3:527, 626–629; Mersenne 1644a, 49–50).[36]

Gassendi's answer, on 20 August of the same year (ibid., 12: 282–284; Gassendi 1658, 6:167–168), was full of appreciation[37] and cautious reserve (especially regarding the Jesuit's anti-Copernican arguments).[38] As to local motion, Gassendi emphasized that the increase of acceleration according to inverse sines is practically equal to the proportion affirmed by Galileo, Mersenne and himself "nonnihil differt ab ea quae Galilaeus, Mersennusque et, si fas dicere, etiam ego, observitare visi sumus." However, the difference "circa ipsa initia motus" was so modest that it could be considered insignificant (ibid., 283–284).[39]

On 21 August of the same year, just twelve days after the letter to Gassendi, Father Fabri addressed a long letter to Mersenne in French (ibid., 285–302), the first known document of a correspondence which had begun some time earlier. The Jesuit illustrated to Mersenne his own ideas regarding the cause and nature of local motion. Curiously enough, he proposed a substantially different theory to that communicated to Gassendi. In "natural" motion, according to Father Fabri, spaces traversed in equal times from rest did not increase according to the Galilean proportion of odd numbers, nor according to inverse sines, but according to natural numbers. He had derived such a proportion from a rigorous causal analysis of motion. Movement for the Jesuit was produced by *impetuosité*: degrees of equal impetus were acquired in single instances of time and the velocity of motion increased by the summing of this impetus.[40] The reasons that induced Father Fabri to propose the increase of spaces according to the series of natural numbers were based on his conception of the "instant." Fabri talked of "physically" finite instants,[41] that is of atoms of equal times, to each of which corresponds the production of a degree of impetus, and, as a consequence, a traversed space. In the

[36] For Boulliau's deduction of the law of the acceleration of natural motion from the Copernican hypothesis, see Koyré [1955] 1973, 55–66.

[37] In particular, Gassendi shows curiosity about the anticipation that he had received on Fabri's treatise of colors: "Miratus iam fueram tuum illum tractatum *de Coloribus* tametsi neque integrum, neque nisi cursim legendum concessum" (Tannery et al. 1945–1988, 12:282).

[38] "Quas te adversus Copernicum excogitasse rationes dicis, dignae erunt haud dubie tua illa solertia; siquidem, tametsi non satis percipio quid ex tarditate ejus partis rotae quae adversam axi viam tenet possit in ipsum colligi; auguror tamen te exinde rationem tenuisse validissimam vel ex eo quod terram quiescentem supponis, ubi de motu coelestium physica causa sermonem instituis" (Tannery et al. 1945–1988, 12:283).

[39] Gassendi verified the extreme similarity between the two propositions in terms of spaces traversed in equal successive times from rest.

[40] "Sur quoi je dis — que ma proportion double arithmetique suppose necessairement des instants et des points, puisque chasque production nouvelle de mon impetuosité se fait dans un instant consequif" (Tannery et al. 1945–1988, 12:286).

[41] "Je compose le continu de points ou d'indivisibles, ce qui est contre tout le 10^{e} d'Euclide ... a mon advis ... le continu, un ligne par exemple, n'est pas divisible actuellement jusques a l'infiny, mais seulement en puisance" (Tannery et al. 1945–1988, 12:290–291).

second instant, the first impetus being conserved, the degrees of impetus become two and therefore the space traversed is doubled. And so on.[42]

Mersenne objected to him that experience demonstrated that spaces in natural motion increased in equal time from rest according to the Galilean proportion of odd numbers. Fabri replied that those results were derived from the fact that "la commune mesure du temps che l'on prent pour mesurer tout les temps de la cheute et la proportion des accroissements de vistesse n'est jamais un instant, et qu'elle en contient presque une infinité."

If "l'on reduit les parties des temps que l'on a prises aux instants, l'on trouvera que l'espace acquis respond a peu près aux experiences de Galileo et de V. R." (ibid., 286). Father Fabri stressed the substantial equivalence on the level of experimental verifications between the two hypotheses, insisting on the fact that the more indivisible physical instants were contained in the equal parts of time taken as measure, the less would result the differences between the values foreseen by the two different proportions.[43] It is not surprising then for Father Fabri that the experiments seemed to substantially confirm the Galilean proportion, notwithstanding it was wrong. The small differences between experiments and theoretical previsions that Mersenne had underlined in the fourth of his *Question theologique, physiques, morales et mathematiques* (ibid., 289)[44] were to be imputed to the slight differences between the mistaken Galilean proportion and Father Fabri's physically correct one.

The Jesuit was careful to explain that, if on the practical and experimental level, both proportions were basically equivalent, on the level of truth their difference was considerable. His hypothesis of "finite" and indivisible instants implied acceleration as a discontinuous process, that is the integration of instantaneous and ever increasing degrees of uniform velocities. Thus, a falling body starting from rest did not pass through all minor degrees of velocity — as Galileo had affirmed — but initiated motion with a determined degree of velocity. The proportion of the growth of spaces traversed in equal times from rest according to natural numbers

[42] For a discussion of Fabri's analysis, see Drake 1970b, 1975.

[43] "D'autant plus que l'on prendra de partyes de temps toutes esgales a 2 instants, comme celle que j'ay prise, durant laquelle le corps qui descent fait les trois partyes de l'espace AB; et d'autant plus aussy que l'on prendra d'espace, ma proportion arithmetique s'esloignera tousjours plus de la vostre, quoyqu'inegalement. Par exemple: sy je ne mets que deux partyes de temps dont chascune soit esgale a deux instants, la proportion de Galilee me donne 12 points d'espace, supposant que durant la 1ere partye de temps le corps descendant face l'espace susdit AB, qui contient 3 points; et ma proportion arithmetique donnera 10 pointz, parce que j'ay 4 instants; et sy je metz trois partyes de temps, la proportion de Galilee me donne 27 et la mienne donne 21, parce qu'il y a 6 instantz; et sy je prens 4 partyes de temps, Galilee me donne 48, et moy qui ay 8 instantz, je donne 36. Par ou il appert que d'autant plus de partyes de temps que l'on prendra successivement, que la proportion de Galilee a la mienne croistra en inegalité majeure, comme il est aysé de voir dans les exemples donnés; car quand j'ay pris seulement 2 partyes de temps, la proportion estoit 1 1/5; quand j'en ay pris trois, elle estoit 1 2/7; quand j'en ay pris 4, elle estoit 1 1/3; et sy j'en prens 5, elle sera 1 4/11" (Tannery et al. 1945–1988, 12:287–288).

[44] "Il ne faut pas s'estonner sy la proportion trouvèe par l'experience respond a peu prés a celle de Galilee, et en la veritable raison du peu qui s'en manque, ce que vostre R. a fort bien observé en son livre de *Questions curieuses* Q. 4" (Mersenne 1634b, Question 4,16).

was therefore the only true one, depending on a rigorous causal explanation of natural motion (impetus and the atoms of time). Father Fabri concluded by mentioning the imminent publication of his *Metaphysica*, wherein the conformity of the causes of motion with metaphysical principles would have appeared evident (ibid., 293–295).[45]

Illustrating the analysis of motion of his teacher Fabri, Mousnier, in the *Tractatus physicus de motu locali* of 1646, confirmed that although usable on practical grounds, the proportion adopted by Galileo was intrinsically false: "igitur haec esto clavis huius difficultatis; progressio simplex principium physicum habet, non experimentum; progressio numerorum imparium experimentum non principium, utramque cum principio et experimento componimus" (Mousnier 1646, 108).

Therefore, on the level of truth, the Galilean theory could not be admitted: motion had to be explained "per causas" and physics presupposed metaphysics.

Father Fabri's position undoubtedly presented many novelties and differences in comparison to those of Le Cazre (Father Fabri will, in fact, reject his continuously double geometric proportion).[46] It appeared, above all, much more subtle and articulated. Fabri did not expect Gassendi and the supporters of the new ideas to recognize Galileo's doctrine of motion as absurd and abandon it. Galileo's theory was instead acceptable as a perfectly useful instrument for physics research. Even if he is never mentioned in the letter from Fabri to Mersenne, it is absolutely clear that Gassendi is the main target of his reflections. Gassendi had proposed the Galilean analysis of motion as an essential ingredient of the Copernican cosmology. And the consequences of this operation menaced, besides the dogmas of faith, the whole foundation of traditional knowledge.

It is probably not by chance that Fabri avoided presenting these subtle analyses in the letter written a few days before to Gassendi, whereas, for quite some time, he had been keeping Mersenne informed about them. Mersenne had in fact shown some hesitation in accepting the Galilean theory and laws of motion. Besides, he was not at all willing to follow Gassendi in using the reformed Galilean dynamics as the supporting structure of a new philosophy and cosmology.[47]

Father Fabri privileged his relationship with Mersenne not only in order to bring him over to his side, but also to use the Father Minim as an effective channel of communication and transmission. He knew that Gassendi would have been

[45] The subordination of *physica* to metaphysical principles is emphasized as necessary: "Or comme l'extension peut estre plus parfaite ou plus imparfaite, je dis le mesme de la duration mais cecy est une pure metaphysique, a laquelle il appartient d'expliquer tous ces effects formels des raisons universelles, c'est â dire qui conviennent esgalement a l'estre materiel et au spirituel. Par exemple, estre, estre substance, estre accident, quantité, qualité, rapport, estre au lieu, au temps, se mouvoir, ou plus viste ou plus tardivement, agir, patir, et caetera, ce que la veritable physique doibt supposer."

[46] "reicitur sententia illorum qui volunt hanc progressionem fieri inxta proportionem geometricam, quam vides in his numeris 1.2.4.8.16 quae licet initio minus recedat a vera, in progressu tamen multum aberrat, nec est ulla ratio quae pro illa faciet" (Mousnier 1646, 111).

[47] For Mersenne's position in reference to the Copernican hypothesis, see: Lenoble [1943] 1971, 454ff.; Hine 1973; and Dear 1988, 32–34, 113–114.

immediately informed by Mersenne. Moreover, he counted on testing the reactions of the main European interlocutors in correspondence with Mersenne, before making public his own hypothesis.

The Controversy Reaches Italy

Mersenne did not betray Father Fabri's expectations. On the occasion of his journey to Italy between the end of 1644 and the first months of 1645, Mersenne had the opportunity to intensify his ties with Torricelli with whom he had been corresponding since 1643.[48] To Galileo's successor in Florence and to Michelangelo Ricci, his customary interlocutor in Rome, he described the animated discussions that the Galilean laws of motion were causing in France and the criticism they were subjected to, not only by the Jesuits, but also by Roberval. He did not even refrain from informing the most authoritative of the Galilean disciples, Evangelista Torricelli, who had just finished publishing a *De motu* which was completely "Galilean" in its principles (Torricelli 1644), about the doubtful results of the tests to which he had submitted the Galilean laws of motion. Mersenne had made public the tests in the *Ballistic* section of the *Cogitata* of 1644.

From Italy, and later, after his return from Paris, Mersenne continued to keep Torricelli informed of Le Cazre's oppositions (Mersenne to Torricelli, 15 March 1645, in Galluzzi et Torrini 1975, 1:222–224; Tannery et al. 1945–1988, 13:399–404) of the passionate defense of Galileo held by Gassendi[49] and of the objections that he himself, incited by Roberval's severe criticisms, had formed against Galileo's doctrine of motion, even in the Torricellian reformulation (Mersenne to Torricelli, 13 December 1645, ibid., 553–556).[50] Lastly, he communicated to Torricelli that the Jesuit Onorato Fabri had entered into the controversy about the Galilean proportion of acceleration: "putat se demonstrasse proportionem accelerationis motus gravium Galilaei geometrice falsam esse, licet in praxi bonam; suam vero per numeros naturales 1, 2, 3, 4, 5 esse veram" (Mersenne to Torricelli, 1 March 1647, ibid., 350–352; ibid., 15:116–120). And he stated that the new interlocutor was learned and talented and deserved to be taken seriously: "vocatur Honoratus Fabri, estque Gesuita ... Est ad modum acutus et totam philosophiam quatuordecim voluminibus pollicetur" (Tannery et al. 1945–1988, 15:118–119).

Galileo's disciples in Florence and Rome probably suspected from the very beginning that the attack on the laws of motion was a renewal, or an appendix, to the Galilean *affaire* of 1633. This explains their extremely cautious attitude.

[48] The first letter of Mersenne to Torricelli is of August 1 1643 (Galluzzi et Torrini 1975, 1:71; Tannery et al. 1945–1988, 12:268–269).

[49] "Gassendi strenue refellit scriptum Jesuistae Cazrei" (Mersenne to Torricelli, 10 October 1645, in Galluzzi et Torrini 1975, 1:287–289; Tannery et al. 1945–1988, 13:492–496).

[50] Together with the letter of 13 December 1645, Mersenne sent to Torricelli the letter in which Roberval explained his own radical reservations on the Galilean science of motion and on Torricelli's *De motu* (Roberval's letter in Torricelli 1919–1944, 3:349–356).

Torricelli, in particular, tried in every way to avoid the insistent solicitations of Mersenne, whom he did not trust, above all because of the Minim's active personal participation in the critical discussions on the Galilean laws of motion.[51]

Compelled by his official position to assume the role of Galileo's defender, Torricelli moved with extreme caution, continuously inviting Mersenne not to divulgate his rebuttals as he specified at the end of his letter of the end of June, 1645, where he stated that Le Cazre's hypothesis was absurd: "Oro Paternitatem Vestram ne quis videat hanc epistulam; neque enim respondere est animus neque talia me movent."[52] When transmitting to Mersenne in Rome an earlier letter with the illustration of two experiments that confirmed the Galilean laws of *de motu*, Torricelli took care to specify that he would not have responded to further objections. And he begged the Father not to make public his thoughts except "solis tuis amicis" (Torricelli to Mersenne, 25 December 1644, in Galluzzi et Torrini 1975, 1:174–175). Faced with Mersenne's asphyxiating insistence, surprised as he was at the disciple's hesitation to enter the field of battle in the venerated Master's defense, Torricelli ended up removing the very object of contention, bitterly declaring that he did not care whether the principles *de motu* were true or false; in any case, it was legitimate for a geometer to assume them as true principles and derive from them all consequences ("che i princìpi della dottrina *de motu* siano veri o falsi a me importa pochissimo — si sfogò col Ricci — poiché, se non son veri, fingasi che sien veri conforme abbiamo supposto, e poi prendansi tutte le altre specolazioni derivate da essi principi, non come cose miste, ma pure geometriche" (Torricelli to Michelangelo Ricci, 10 February 1646, ibid., 276).

It was a retreat dictated by reasons of opportunity, not the renunciation of his own convictions. Not by chance, Torricelli will insist with force on the truth of the Galilean principles of *de motu*. Just a few months later in a letter of August 8, 1647 to his trusted friend G. B. Renieri he carefully rejected Fabri's proportion according to natural numbers (Torricelli to Renieri, 8 August 1647, ibid., 391–394).[53] It is worth noting that Torricelli carefully avoided sending his confutation of Fabri's proportion to Mersenne.

To the Italian disciples of the Pisan scientist it was evident from the beginning that the discussion on the Galilean laws of motion was not a candid intellectual

[51] Torricelli and the other disciples of Galileo had little sympathy for Mersenne, probably because of his diligence in collecting and transmitting critical remarks on the Galilean science of motion. The highly-colored representation of Mersenne that Carlo Dati gave later is symptomatic of the Galileans' suspicious attitude. Mersenne is represented as one who is more fit for collecting and promoting other people's inventions than for communicating his own: "come quei mercatanti che per iscarsezza di loro avere, malamente potendo far negozi, sfogano il genio loro guadagnando pure assai nel contrattare e mettere in vendita le merci altrui" [like those merchants who, because of lack of their substance, being able to do business with difficulty, express their mind in earning still much by bargaining and putting other people's goods up for sale] (Dati 1663, 6).

[52] Torricelli also declared the untenability of the experiment of the balance, proposed by Le Cazre and considered by him as conclusive (Galluzzi et Torrini 1975, 1:247–249).

[53] For Torricelli's attitude towards critics of the Galilean doctrine *de motu* and, especially, towards Mersenne, see Galluzzi 1976, 73–84.

debate, but rather an attempt to summon a new lawsuit against Galileo.[54] And this awareness explains their hesitations and caution. Torricelli and Ricci presumably ignored the role played by Gassendi at the beginning of these discussions with the publication of the *Epistulae de motu impresso*. They probably had not read this work, notwithstanding that Mersenne had punctually and repeatedly informed them of the noble and effective defense of Galileo's ideas assumed by Gassendi.[55]

It has also to be noted that the Italian situation was substantially different, because of the more effective capacity of control on scientific debate by the ecclesiastic authorities. Besides, as we shall see, the Italian Jesuits will soon follow the example of their French colleagues, directing severe criticism against the Galilean science of motion.

From France to the Netherlands

1. Le Tenneur

Father Fabri's theory of motion, already anticipated with explicit reservations by Mersenne in the *Ballistic* section of the *Cogitata* of 1644 "sententia philosophi subtilissimi qui statuit accelerationem pro diversis temporibus in eadem ratione qua numeri serie naturali disponuntur" (Mersenne 1644a, 52), caused animated reactions after the publication, by his pupil Pierre Mousnier (Mousnier 1646)[56] in 1646, of the collection of the Jesuit's lessons. It was of course Mersenne who in timely fashion informed the supporters of the Galilean theory *de motu* of the Jesuit's work and about his criticism of Galileo's conception of motion: "Insinuavit mihi Mersennus noster — Jacques-Alexandre Le Tenneur wrote to Gassendi on January 16, 1647 — esse aliquem alium quem totius Societatis acutissimum vocant, qui aliquid etiam adversus Galilaeum molitur, gloriaturque se demonstrasse spatia aequalibus temporibus in descensu gravium emensa esse inter se ut series naturalis numerorum 1.2.3.4. etc." And Mersenne had obviously urged Le Tenneur to reply: "monuit autem bonus ille noster ad illam me pugnam accingerem." The invitation to contend was passed on to Gassendi by Le Tenneur, who was convinced that — as in the case of the earlier attack by Le Cazre — this was a new attempt by the Jesuit Order, not only against Galileo but also against the *Epistulae de motu*

[54] By sending from Rome to Torricelli a summary of Le Cazre's *Physica demonstratio* (he had had a copy of it from Mersenne), Ricci emphasized the weakness and the absurdity of the remarks directed against Galileo. However he denounced the animosity of the French Jesuit towards the Pisan scientist: as he said, the Jesuit shows himself as light in his behaviour as he is in his doctrine: "con mille vanti di sé medesimo e scherno di Galileo si dimostra non meno leggero nei costumi che sia nella dottrina" (Ricci to Torricelli, 26 March 1645, in Galluzzi et Torrini 1975, 1:229).

[55] It is possible that Torricelli did not know Gassendi's *De motu impresso a motore translato*. Torricelli will declare to Mersenne in July 1646 that he had not read any of Gassendi's work: "Nihil enim ex eius [Gassendi] operibus vidi praeter vitam D. De Peiresc" (Galluzzi et Torrini 1975, 1:309).

[56] The *Liber secundus* was dedicated to discussions "de motu naturali" (Mousnier 1646, 74–132).

impresso by Gassendi: "fac igitur ut cum novo illo hoste dimicare victoriamque reportare possis" (Tannery et al. 1945–1988, 15:49; Gassendi 1658, 6:505). In his reply of March 11, Gassendi, however, declined the invitation for reasons of health and because of his engagement in other studies.[57] However, he urged Le Tenneur to assume the role of Galileo's paladin: "tradita tibi lampas iam est ut hunc quasi cursum absolvas" (Gassendi 1658, 6:266).

Mersenne's decision to invite Le Tenneur to reply to Father Fabri, was probably the consequence of his awareness of Gassendi's unavailability. Probably disturbed by the exhausting dispute with Father Le Cazre and seriously preoccupied by the relentless attacks coming from the Jesuit Order, Gassendi decided to retire officially from the controversy. However, from his letters we learn that he went on soliciting other authoritative friends, as, for example, Fermat,[58] to enter the field. Moreover, he did not tire of encouraging and offering advice to Le Tenneur.[59]

The latter had already had occasion to distinguish himself in the *affaire Galilèe* of the laws of motion. At the end of 1646 he had sent to Gassendi his *Disputatio physico-mathematica* (Le Tenneur 1646),[60] in which he offered a new criticism, based on acute mathematical analyses, of Father Le Cazre's continuously double geometric proportion. In the *Disputatio*, which is still unpublished, Le Tenneur stressed the necessary convergence of new Galilean mechanics and Copernican cosmology as had Gassendi, and dedicated considerable attention to the problem of the plausibility of recourse to the texts of the Sacred Scriptures in the disputes about the systems of the world. He skillfully demonstrated in many places that the Scriptures seem to belie even the Ptolemaic hypothesis. He asked, on this part of his writing, the opinion of Gassendi who hurried to send him his own approval.[61]

With a series of observations and demonstrations circulated in Mersenne's epistolary network, Le Tenneur showed that he had earned the trust granted him

[57] Gassendi was completing the *Institutio astronomica iuxta hipothesim tam veterum quam Copernici et Tychonis*, published in 1647 (Gassendi 1647).

[58] The Senator of Toulouse, solicited by Gassendi, set up a rigorously geometrical deduction of the Galilean proportion of the acceleration of natural motion almost certainly in 1646. Gassendi's solicitation must be related with his polemic with Father Le Cazre, as clearly emerges from the end of Fermat's letter: "Haec succinte et familiariter, Clarissime Gassende, scripsimus ne tibi in posterum fascescant negotium aut Cazreus, aut quivis alius Galilei adversarius et in immensum excrescant volumina quae unica demonstratione vel fatentibus ipsis authoribus aut destruentur aut inutilia et superflua efficientur" (Gassendi 1658, 6:543).

[59] No specific work has been devoted to this important personage. He animated Mersenne's correspondence after 1646, especially about topics *de motu* and in relation to debates on the existence of vacuum. For Le Tenneur, see Drake 1970b, 1973, 1974, 1975. For his participation in the discussion about vacuum, see Middleton 1965, 40.

[60] The manuscript, dated 1 November 1646, is in the National Library of Paris, Ms. Fonds Lat. 6740. The codex, which belonged to Melchisedec Thevenot, contains some letters of Father Le Cazre.

[61] In his letter of 24 November 1646, Le Tenneur had informed Gassendi of his having written some reflections on the presumed incompatibility between the Copernican doctrine and the Holy Scriptures: "Visum autem haec qualiacumque sint tibi communicare et censurae iudicioque tuo submittere, ut pote quorum author praecipue extitisti et quibus ortum dedit incundissima scriptorum tuorum lectio" (Tannery et al. 1945–1988, 14:628; Gassendi 1658, 6:504). Gassendi replied, expressing his own enthusiastic approval of the *Disputatio*; see Gassendi to Le Tenneur, 1 December 1646, in Gassendi 1658, 6:260–261).

by Gassendi, whom he kept constantly informed about the developments of the controversy. We are, in fact, in the presence of an important figure unjustly neglected. Le Tenneur is one of the many talented gentlemen of science who populate Mersenne's correspondence not only in France but also in Italy, England, and in the Low Countries.

His notable worth as a mathematician emerges in the *Traité des quantitez incommensurables* (LeTenneur 1640)[62] and in the *De motu naturaliter accellerato* (Le Tenneur 1649).[63] In a letter to Mersenne full of autobiographical references written on July 9, 1647 (Le Tenneur to Mersenne, 9 July 1647, in Tannery et al. 1945–1988, 15:287–299), Le Tenneur would proudly proclaim himself an amateur and self-educated person. He has carefully studied Galileo's *Dialogues* and *Two new sciences*, while he acutely and passionately defends the *De motu* by Torricelli from Roberval's objections (Le Tenneur to Mersenne, 9 July 1647, ibid., 289).[64] Le Tenneur appears as a convinced "Galilean" full of admiration for Gassendi's atomism. Of Gassendi he particularly appreciates the insertion of scientific ideas into an organic philosophical background as well as his talent as experimenter. As many others in those years, Le Tenneur was fascinated by Descartes' physics, but, as he wrote to Mersenne, he admired Descartes' insightful arguments, but did not find them at all convincing "je demeure plustot esblouy de la lumiere des ses raisonnement que je ne m'en trouve exclairé" (Le Tenneur to Mersenne, 9 July 1647, ibid., 295).

Thanks to these qualities Le Tenneur ended up assuming a central role in the conclusive phase of the *Galilée affaire* of the laws of motion. In a long letter-treatise to Mersenne on April 13, 1647, Le Tenneur in fact produced an effective rejection of Father Fabri's hypothesis, strongly reaffirming the truth and absolute accuracy of the Galilean analysis of motion (ibid., 173–199).[65] First of all, Le Tenneur demonstrated the fragility and impracticality of resorting to "physical" instants, or atoms of time, as suggested by Fabri (ibid., 175–177). He also vindicated the full legitimization of the Galilean definition of accelerated motion in the *Two new sciences*, insisting on the concept of acceleration as a continuous process and on

[62] For an analysis of this work, see Drake 1973, 267.

[63] See Drake 1973, 268.

[64] Le Tenneur is particularly severe towards Roberval and criticizes Mersenne because he was constantly appealing to his presumed authority and, above all, seemed to consider Roberval as Le Tenneur's teacher: "Vous prenes plaisir a apeler le braue Roberual mon ancien maistre. Qui donc vous en a tant dit? Se vante t'il de m'auoir apris beaucoup de choses? Certes sy cela est, il a grand tort, car je vous proteste que je ne tiens quoy que ce soit de luy. Ce n'est pas qu'en effect, il ne m'en peut monstrer beaucoup et que je ne me tienne bien inferieur a luy en science, mais il faut parler des choses comm elles sont. Et a fin que vous scachies comme la chose s'est passee. Il est vray qu'il me prit fantaisie vn jour de me faire expliquer par luy quelque theorique de planetes que je n'entendois pas. Mais, ayant recogneu apres quelques peu de visites qu'il auoit sy bien le don de s'expliquer que j'en faisois tout autant moy seul et que je n'auancois pas plus pour l'entendre parler, ie luy enuoiay de l'argent et le priay de ne plus prendre le peyne de venir" (Le Tenneur to Mersenne, 9 July 1647, in Tannery et al. 1945–1988, 15:291).

[65] The confutation concerns the presentation of Fabri's theses *de motu naturali* by Mousnier in the *Liber Secundus* of the *Tractatus Physicus* (Mousnier 1646).

the direct proportionality between acceleration and time (ibid., 182–186). He furthermore pointed out with clever demonstrations the absurd consequences that came from Father Fabri's hypothesis, offering at the same time an intelligent illustration of the Galilean theory of acceleration (based on the integration of infinite ever increasing degrees of velocity with the passing of time) and showing that from that theory derived necessarily the proportion of odd numbers, opposed by Father Fabri;[66] Le Tenneur proclaimed the hypothesis of the Jesuit as being simply false, while reasserting his full confidence in Galileo's conception of motion (ibid., 194–195). He finally declared that he had entered into the controversy on the insistence of a few friends and of Mersenne, and not because he had any faith in the possibility of changing the opinions of his stubborn interlocutors: "Quod scilicet de sua fama detrahi arbitraretur, si aliquando recantarent" (ibid., 174). In fact, Father Fabri replied defending his own theory point by point.[67]

Mersenne's correspondence records in detail the development of this phase of the *affaire* of the Galilean laws of motion. Le Tenneur nurtured the conviction that both Fathers Fabri and Le Cazre, even if with different approaches, were motivated by a common goal: to discredit Galileo and Gassendi, his prophet in France.[68]

On the other hand, Le Tenneur was aware that a too passionate intervention in defense of the Galilean laws of motion could have produced dangerous consequences. Thus, it is not by chance that he implored Mersenne not to over-emphasize his role as Galileo's paladin: "Ca esté en effect ma seule intention de decouvrir les erreurs de ces deux personnages [Le Cazre and Fabri] et non pas d'estaller l'opinion de Galilée" (Le Tenneur to Mersenne, 9 July 1647, ibid., 292).

The letters from Le Tenneur to Mersenne in 1647 (unfortunately Mersenne's replies are lost) have considerable importance because they allow us to follow the evolution of Mersenne's behavior in the *Galilée affaire*. It is evident that the fascination with the theory elaborated by Father Fabri, together with his reservations on the bold reproposal of Galileo's conceptions expressed in the condemned *Dialogo* (that is, the full integration between mechanics and cosmology) in the *Epistulae di motu impresso* by Gassendi, pushed Mersenne to reconsider the

[66] "Monendum autem est Galilaeum per omnes tarditatis gradus aliud nihil intelligere quam infinitos" (Tannery et al. 1945–1988, 15:196). Moreover, he confuted Fabri's thesis on the increase of velocity as a discontinuous process.

[67] Le Tenneur's letter was transmitted by Mersenne to Fabri and to Mousnier without revealing the author. In a letter to Mousnier of May 1647, Fabri recognizes the worth of the anonymous interlocutor and of his arguments. He left the task of answering to his own disciple, since the *Tractatus*, against which Le Tenneur had railed, "invito me, in lucem edidisti" (Tannery et al. 1945–1988, 15:235). The long answer, prepared by Mousnier but surely elaborated or, at least, approved by Father Fabri, was sent by Mousnier to Mersenne on 1 October 1647. It was inserted later in Mousnier-Fabri's *Metaphysica demonstrativa* (Mousnier Fabri 1648, *Appendix*, 3:609–659).

[68] In his letter to Mersenne of 21 May 1647, for example, Le Tenneur unites Father Le Cazre and Father Fabri because of their common engagement in demolishing Galileo's reputation: "Car l'on reproche a Galilée que sa definition du mouvement acceleré n'est pas bonne et luy objecte que l'acceleration ne se doit pas faire dez le commencement; l'autre dit, que c'est mal a propos qu'il suppose une infinité d'jnstants et que le grave tombant doive passer par tous les degrez de tardité" (Le Tenneur to Mersenne, 21 May 1647, Tannery et al. 1945–1988, 15:227–228).

favorable attitude towards the Galilean laws of motion manifested since 1633 (Mersenne 1637, 1:85–92, 125–128)[69] and substantially reaffirmed in the *Cogitata* of 1644 (Mersenne 1644a).

His initial timid doubts on the plausibility of the Galilean definition of naturally accelerated motion, on the sustainability of the principles on which it depended, and on the possibility of experimental verification of Galileo's laws of motion were, with the passing of time, progressively increasing. Le Tenneur was fully aware of this trend and for this reason, in letters to Mersenne in 1647, he took every possible step to avoid the Minim ending up by radically denying the Galilean analysis of movement. Such fears appear particularly evident in the letter to Mersenne on September 13, 1647 (Tannery et al. 1945–1988, 15:417–424). Mersenne had sent Le Tenneur the proofs of the *Tomus III* of his own *Novarum observationum* requesting his opinion on the book. Le Tenneur insisted on the necessity of attenuating the criticism that the Minim addressed to various aspects of the Galilean theory of motion. And he explicitly beseeched him not to mix with the group of the Pisan scientist's detractors: "voila sans doute ce qui se peut dire la dessus sans nier absolument l'opinion galiléenne comme font nos beaux docteurs sourcilleuz" (ibid., 420).[70]

2. *Huygens*

The letters that Mersenne exchanged with the young Christiaan Huygens between 1646 and 1647 confirm that Le Tenneur's impression of a progressive retreat by Mersenne from Galilean positions was anything but unfounded. Mersenne had been informed by Constantin Huygens of the demonstration that his son Christiaan had given of the Galilean odd numbers proportion (Mersenne to Costantin Huygens, 12 October 1646, ibid., 15:527–529). The demonstration was contained in the very important *De motu naturaliter accelerato* of 1646 (Huygens 1646),[71] in which Christiaan, just seventeen years old, criticized the theories exposed by Caramuel in his work on motion of 1644 (Caramuel 1644).[72] This text shows that Huygens had read very carefully the *De motu impresso* by Gassendi from which he had most probably obtained information about the Galilean theories and demonstrations on motion which he will be able to learn directly from the *Two new sciences* only later on.[73] From the *De motu impresso* by Gassendi, Huygens also

[69] See also n. 2.

[70] The two "doctors" are obviously Father Le Cazre and Father Fabri.

[71] See D'Elia 1985, 33–46.

[72] Caramuel rejects the Galilean proportion of space traversed in equal times from rest. He opts indeed — like Fabri — for the series of natural numbers that he finds confirmed by repeated and accurate experimental verifications. Caramuel's tone towards Galileo was particularly disdainful.

[73] The first of the two parts into which the *De motu naturaliter accelerato* is divided was written by Huygens without having been able to consult the *Two new sciences*. He read this work at the end of 1646, drawing inspiration for the second part of his work (Huygens 1888–1950, 11:68 n.1).

drew the theory of attraction as the cause of motion, from which he had inferred with rigorous geometrical procedures the necessary truth of the odd numbers proportion.[74]

On 13 October 1646, Mersenne manifested to Christiaan his own scepticism on the possibility of giving a rigorous demonstration of the Galilean proportion. With a resolute tone he affirmed that the principles which Galileo used "dans tout ce qui'il a dit du mouvement ne sont guère fremes." He then challenged the young correspondent: "si nonobstant cete consideration vous croyez que votre demonstration soit ancore valable vous me ferez plaisir de me la communiquer" (Tannery et al. 1945–1988, XIV, 538–541; Huygens 1888–1950, 1:558–559).[75] In his letter of 28 October 1646, Christiaan Huygens showed how weak were the foundations on which Father Mersenne's confidence relied. He dissolved, point by point, with shrewd demonstrations, Mersenne's doubts (ibid., 567–573; ibid., 24–27). He peremptorily concluded that, in the vacuum, the Galilean laws of motion would prove absolutely true. And this was for Huygens decisive evidence in favor of Galileo, given that the rigorous and precise knowledge of motion had to be founded not on uncertain experiments, as Mersenne claimed, but only upon mathematical reasoning.[76] Mersenne replied on November 16, declaring himself stupefied at the shrewdness of the analysis. I believe, he wrote to Christiaan, that "Galilée eust esté ravi de vous avoir pour garand de son opinion." And yet, he reaffirmed that he still had many doubts (ibid., 612–614; ibid., 30–31) regarding the Galilean hypothesis.

These doubts are still, in fact, expressed in the *Tomus Tertius* of the *Novarum observationum* (Mersenne 1647, chap. 15–19:131–169) published in 1647. However difficult it is to distinguish Mersenne's personal views from the tangle of opinions of other authors that he records with scrupulous faithfulness, it emerges as evident the effects of his progressive distancing between 1646 and 1647 from the Galilean science of motion. In the *Novarum observationum*, Mersenne inserted a lengthy review of the diverse conceptions of motion, recalling his initial position in favor of Galileo's doctrine, especially as a consequence of a series of substantially positive experimental verifications of it (ibid., chap. 15:131). He alluded to Gassendi's *De motu impresso* and to Le Cazre's objections "quem Gassendi copiosissime refutavit" (ibid.). He recalled the discussions between Le Tenneur and Father Fabri;[77] he introduced Roberval's objections and Torricelli's counter-deductions (ibid., 132); he furthermore faced the problem of the cause of motion, informing

[74] See Gassendi's demonstration of acceleration (founded on attraction) adopted by Huygens in the *De motu* (Huygens 1888–1950, 11:69).

[75] See also Dear 1988, 210.

[76] "Et ie ne trouve point d'autre progression qui ayent quelque regularité et la proprieté requise que cellecy. Et pour cela je croij qu'il n'y a point d'ordre du tout, ou que c'est celuy de ces nombres impairs" (Tannery et al. 1945–1988, 14:572; Huygens 1888–1950, 1:27).

[77] "Est et alius vir ingenio praeclarissimo qui numeros ab unitate naturaliter consequentes 1.2.3.4. etc. maluit adhibere gravium casibus ... quam etiam Clariss. Tennerius amicus singularis scripto nondum vulgato refellit" (Mersenne 1647, chap. 15:131–132).

the reader of the Gassendian proposal of attraction as the cause of motion (about which he expressed doubts), and of the Cartesian explanation of motion as the consequence of the pressure of subtle matter in a "full" universe.[78] He then put forth a relevant series of reservations on the Galilean definition of motion and on the admissibility of the postulate of the *Two new sciences* (ibid., 133–141), stressing how experimental verifications showed only approximate correspondence between Galilean laws and real phenomena. On the other hand, he resignedly admitted that to effect precise observations and experiments in this field was extremely difficult, especially because of the impossibility of having an exact measurement of time, even using pendulums, to the perfection of which Mersenne himself had contributed considerably (ibid., chap. 19:152–159).[79]

The conclusions that he deduced were bitter: without knowing its cause, motion cannot be an object of science. Since the cause of motion is unknown,[80] it can only be affirmed that the proportion of odd numbers proposed by Galileo describes with some approximation the real conduct of heavy bodies, and only in the initial part of motion from rest. Whoever tried to affirm Galileo's theories as real science went beyond legitimate limits, given that of motion we can at most claim a "docta ignorantia."[81] For Mersenne, the issues of motion once again called for the same embarrassing situation experienced with cosmological issues: "quemadmodum neque rationes quae hactenus allatae sunt in gratiam utriusque motus Terrae quidquam demonstrant ... etiam si plures vellent eam moveri ob rationum praestantiam quod id innurere videtur" (ibid., chap. 15:135). It was like admitting that in the *affaire* of the laws of motion, exactly as in the *affaire* of the world systems, someone had cheated, claiming to possess the truth without however putting forth necessarily demonstrative arguments.[82]

This analysis and these conclusions ended up by putting the good Father Mersenne objectively on the side of those who contrasted the operation proposed in Gassendi's *De motu impresso* and developed by his emulators. In short, what occurred was exactly that which Le Tenneur had intuited and tried to avert. If he did not explicitly side with Father Fabri, Mersenne reinforced however objectively his position; be it because he refused to consider Galilean doctrines of motion as a theory capable of accounting for real phenomena, be it because he vindicated the

[78] "Quid si [gravia] neque trahantur a Terra, neque propria gravitate ferantur, sed expellantur ab aere aut alia materia subtiliore, eo fere modo quo suber et alia corpora leviora sub aquam immersa expelluntur ab aqua, non aliqua peculiari aquae vi aut qualitate, nisi ea quae locum suum repetit" (Mersenne 1647, chap. 15:132).

[79] For Mersenne's experiments on pendulums, see Koyré 1953.

[80] "Vides igitur de his casibus corporum, quae vulgo gravia dicuntur, nihil penitus demonstrari posse donec innotescat principium, seu vera et immediata causa ob quam versus centrum haec et illa corpora suum iter instituant, quantunque iuventur aut impediantur in toto itinere ab omnibus aliis corporibus occurrentibus aut circumstantibus" (Mersenne 1647, chap. 15:133).

[81] "Quod si dixeris nos igitur ea ratione nullam scientiam istorum motuum habituros, quidni doctam ignorantiam ignoranti scientiae praeponas?" (Mersenne 1647, chap. 15:134).

[82] "Hinc fit ut in isto negotio, aliisque similibus, etiamnum cum D. Paulo possimus asserere: si quis autem se existimat scire aliquid, nondum cognovit quemadmodum oporteat eum scire" (Mersenne 1647, chap. 15:141).

necessity of that explanation per causas, on which the Jesuit had particularly insisted.

Not at random, exactly as happened in the Copernican affair, also in this case the proposal was made for a purely "hypothetical" conception of the Galilean doctrine of motion, to be considered as a practical tool — again it was Fabri who suggested it first — but not as a principle to act as a pillar of the new conception of the universe, delineated by Galileo in the condemned *Dialogo* and reproposed by Gassendi in the *De motu impresso a motore translato*. One could therefore say that for the theory of motion as well a kind of "Osiander argument" was put forth. Mersenne had more than a marginal part in it, certainly to the full satisfaction of the Fathers of the Company of Jesus. The explosive potential of the *Galilée affaire* of the laws of motion could, in this way, be finally defused. Mersenne might have been induced to accentuate his criticism by his hesitations before the audacious welding of Copernicanism and Galilean dynamics proposed by Gassendi. He could, moreover, have felt the fascination of the more "philosophical" explanations proposed by Fabri, or been affected by pressures of the Jesuits, or, finally, have been influenced, in the last years of his life by Descartes' strong reservations on Galileo's science of motion.[83]

It appears evident, in any case, that many authoritative members of the Company engaged in a process of systematic demolition of the Galilean theory of motion. With the exception of Father Riccioli, who had confirmed the Galilean laws via experiments but deriving from them an anti-Copernican argument (Koyré 1955; Galluzzi 1977), the Jesuit scientists systematically and neatly marked their distances from the principles and theorems illustrated by Galileo in the *De motu naturaliter accelerato* of the *Two new sciences*.

Some of them, like Le Cazre, and, later on, Father La Loubère (La Loubère 1658),[84] tried to force the "organic" supporters of the Galilean ideas, like Gassendi, into silence, with violent and threatening attacks, underlining the absolutely false character of those doctrines and their inevitable heretical implications. Others, like Father Fabri, assumed a more skillful and subtle attitude, by limiting themselves to emphasizing that the proportions between spaces and times in free fall proposed by Galileo could be replaced by other rules that had obtained in

[83] The final accentuation of the critical tones of Mersenne towards the Galilean science *de motu* has been stressed by Peter Dear. Dear remarks in Mersenne the passage from an initial pragmatic adherence to a refusal of the "principles" on which the Galilean vision was founded (Dear 1988, 215). For Dear it is evident that Mersenne suffered the influence of Father Fabri. However such an influence is not enough to explain Mersenne's change of attitude (Dear 1988, 216–217). Dear's opinion is that Mersenne was pushed to search for an explanation of motion "per causas" because of the influence of Descartes' *Principia philosophiae* (Dear 1988, 218–219). Dear also attributes Mersenne's sceptical attitude towards Christiaan Huygens (Mersenne to Costantin Huygens, 12 October 1646, in Tannery et al. 1945–1988, 14:527–529) to the influence of the explanatory model of physical phenomena contained in the *Principia* of Descartes. A different view of the reasons behind the evolution of Mersenne's attitude towards Galileo's laws of motion has been recently proposed by C. R. Palmerino (see Palmerino 2000).

[84] La Loubère again proposed Le Cazre's hypothesis against the then late Gassendi.

experimental tests a comparable degree of confirmation. These rules — like the continuously double proportion of Father Fabri — had the added value of not compelling that the whole structure of traditional knowledge be unhinged. The supporters of this second line of action legitimated the practical use of the Galilean laws generally avoiding open insinuations regarding their connection to the Copernican system. Moreover, they tried to win over some of the most influential and illustrious protagonists of the Galilean *affaire* to their cause — stressing the reasons of opportunity and caution. This strategy, however, did not produce successful results with Gassendi who after 1646, kept silent on these matters. Much better results were obtained with Mersenne, who in the last years of his life came substantially to satisfy their expectations.

Back in Italy

Precise evidence shows that continuous pressure was exerted by Fabri and other Jesuit Fathers on another illustrious protagonist of research on motion, the Genoese patrician Giovanni Battista Baliani, to distance himself from the Galilean position. It has to be stressed that, just between 1646 and 1647, Baliani proceeded with a relevant revision of the first edition of his *De motu* (Baliani 1646),[85] published in the year 1638 (Baliani, 1638), the same year as Galileo's *Two new sciences*. The first edition of the work presented an analysis of motion substantially convergent with that of Galileo, as Gassendi himself had underlined, recognizing however that Baliani achieved analogous results to the Pisan scientist in an independent way.[86] Serge Moscovici, in a book on Baliani written over 30 years ago, tried to free the Genoese patrician from the accusation, broadly recorded in historical tradition, that he, animated by a strong spirit of emulation, had deliberately distinguished his position from Galileo's in the second edition of the *De motu* (Moscovici 1967).[87] It is, in any case, indisputable that the second edition of Baliani's work introduced noteworthy modifications (Baliani 1646 and 1998).[88]

[85] On Baliani, see Drake 1970a; Grillo 1963. See also Moscovici 1967; Costantini 1969; Baliani 1998 (*Introduction* by G. Baroncelli).

[86] On 11 October 1640, Gassendi wrote to Girolamo de' Bardi of his having received Baliani's *De motu* one year before. He had, above all, appreciated Baliani's method of demonstration. Gassendi compared it with Galileo's *Two new sciences*: "Si Balianus solo ratiocinio eam proportionem [of the acceleration in natural motion] invexerit, quam primus, quod sciam, Galilaeus est experiundo assecutos" (Gassendi 1658, 6:100). To be noticed at first, here, is the clear position of Gassendi in favor of Galileo as to the priority of the discovery. Moreover, Gassendi — still referring to a friend of Baliani — made it explicitly clear that he did not subscribe to Baliani's statements on the unreliability of the experiments: "Et postulat quidem concedi nonnulla quae quispiam forte abnueret, quod Naturae subtilitas hebetudinem sensus non sequatur" (Gassendi 1658, 6:100).

[87] For the reception of Baliani's *De motu*, see: Moscovici 1967, 79–84 and Baliani 1998 (*Introduction* by G. Baroncelli). Traditionally a severe opinion has been expressed about the way in which Baliani behaved towards Galileo. This attitude has been attributed to the envy and to the spirit of emulation of the Genoese patrician.

[88] The work that was published in 1647 was considerably increased by the insertion of two books on "solids" (*De impetu* and *De motu super pluribus planis diversimode inclinatis*) and three books on

Claudio Costantini's important book, *Baliani e i Gesuiti* (Costantini 1969), provides a series of documents and remarks that help us to understand the real reasons for the reformulation of the laws of motion made by Baliani. Costantini has shown that a group of Jesuit scientists, among whom are Fathers Grassi, Confalonieri and Cabeo, tried from 1648 onwards, to put every possible pressure on Baliani to induce him to join the Company in the battle against the supporters of the vacuum (ibid., 92–94). In the eyes of the Jesuits the goal of obtaining explicit support for their cause from Baliani came to be of a very special value, since the Genoese patrician was considered one of the most authoritative representatives of the new scientific ideas (ibid., 75–76). Even more important, it would have therefore appeared that Baliani, abandoning his original positions, would have assumed a critical attitude against Galileo's laws of motion.[89]

In effect, the revision of 1647 radically changed Baliani's original approach, transforming the book into a work in which the hypothesis of Father Fabri took an absolutely central position. Baliani sustained, in fact, that in free fall the spaces grow in equal times from rest according to the natural numbers from the unity. He followed with an explanation of Fabri's theory of the "indivisible instants," or atoms of time; he declared that on the experimental ground there was perfect equivalence between his own hypothesis and the Galilean one, by referring to the same arguments as the French Jesuit (Baliani 1646, 108–140).[90] Again, like Father Fabri, and in full accord with the final phase of the evolution of Mersenne in the *de motu* debate, Baliani claimed, in opposition to Galileo, the necessity of a causal explanation of motion, as a consequence of the unreliability of experimental verifications.[91]

It was not a case of plagiarism, but rather the acceptance of the pressure and constant suggestions received from the Jesuits with whom he was in direct and friendly contact. And in fact nobody accused Baliani of having presented, as flour from his own sack, a hypothesis taken from an author, Fabri, who was not even quoted in the Genoese's *De motu*.

"liquids." A critical edition of Baliani's *De motu* has been recently published by Giovanna Baroncelli (Baliani 1998).

[89] Moscovici who defends the good faith of Baliani — admits that he was the object of instrumentalization of some Fathers of the Company of Jesus: "Certain Jésuites ont peut-être utilisé les remarques de Baliani comme un machine de guerre contre Galilée" (Moscovici 1967, 80).

[90] Baliani's analysis follows step by step that of Mousnier-Fabri, sometimes also in the terminology. Baliani proposes the argumentation of the Jesuit of Lyon both in reference to the reasons that induce to prefer the series of natural numbers instead of the Galilean odd numbers proportion, and in remarking the impossibility of experimentally determining which of the two hypotheses is true (Baliani 1646, 110–111). The close correspondence between the illustration of the laws of motion in the second edition of Baliani's work and Fabri's exposition has escaped Moscovici. On the contrary, S. Drake has remarked the strict analogy between the two positions, but he has considered it a purely accidental coincidence (Drake 1974, 50–51). On the basis of Drake's works, Dear has pointed out the convergence between the Jesuit of Lyon and the second edition of the *De motu* of the Genoese patrician, but without giving any explanation for it (Dear 1988, 215–216).

[91] "Hic pariter peragere libuit, videlicet naturam motus pro viribus investigare, causas nimirum et principia a quibus hae demum motus passiones proveniant" (Baliani 1646, 98). And again, in criticizing the Galilean proportion of the odd numbers: "Hanc ... propositionem inniti experimentis sensui deceptioni obnoxiis; quibus insensibilis error detegi nequit" (Baliani 1646, 110).

In Baliani's letter to Mersenne of 13 March 1647, from which it is possible to deduce that at that time the printing of the second *De motu* was still not completed (Tannery et al. 1945–1988, 15:145–151), we find very important evidence of the Jesuits' pressure on the Genoese patrician. In this letter Baliani informed Mersenne of having received, in preceding weeks, a visit from Father Fabri who was en route to Rome: "E' stato qui il P. Onorato Fabri con cui ho trattato con molto gusto e mi pare un uomo molto dotto e vedo che in molte cose habbiamo dato nell'istessi pensieri" (The honorable Father Fabri was here and I have talked with him with great pleasure, and he seems, to me, a very learned man and I see that in many things we share the same thoughts) (ibid., 147). Father Fabri, for his part, would declare triumphantly that his own hypothesis had met with the approval of Baliani.[92] Regarding Fabri's hypothesis, moreover, we have a long letter, not dated but most probably from the year 1647, from the notorious Father Orazio Grassi no less, which, on a request of Baliani's, comments upon some aspects of the *de motu* theory of Father Fabri,[93] as reported by Mousnier in the *Tractatus Physicus*.

Moreover, in the year 1646, another Italian Jesuit, who was also very familiar with Baliani, Father Nicolo' Cabeo, who had for a long time taught in the Jesuit Seminar of Genoa,[94] introduced in his monumental comment to the *Meteorologica* of Aristotle a long and resentful review of the Galilean doctrine of motion. In this bitterly critical review are echoed the objections Le Cazre made to Gassendi's *Epistulae*, and the analyses and arguments of Father Fabri (Cabeo 1646). Cabeo insisted energetically that Galileo was preceded in his presumed discoveries by Giovanni Battista Baliani. Cabeo praised the modesty of the Genoese patrician, modesty that had induced him not to follow Galileo in the pretension of putting forward as *scientia* a series of propositions dependent upon clearly false principles.[95]

[92] In the answer of Mousnier to Mersenne, inserted into the *Metaphysica demonstrativa*, the underlining of the adherence of Baliani to Fabri's theory was skilfully matched with the praise on his scientific and moral authority: "vir certe maxima apud omnes gloria, sive res praeclare ab illo gestas in publicis numeribus, quibus egrege defunctus est, sive luculentissime ingenii et doctrinae monumenta, quae in publicam lucem edidit, sive demum singularem humanitatem consideres, ad quam natura illum munifice finxit" (Mousnier-Fabri 1648, 587).

[93] The letter, of February 5 but without indication of the year, has been published by Moscovici with the date 1649 which is surely incorrect (Moscovici 1967, 256–263). Father Grassi's references to Fabri's propositions are, in fact, constantly referred to the *Tractatus physicus* (Mousnier 1646). Hence, the letter seems to mirror Baliani's effort to assimilate Fabri's hypothesis on natural motion with the help of Father Orazio Grassi. The second edition of the *De motu* was not yet completed at the beginning of 1646. Between the end of January and the beginning of February the Genoese patrician was still setting up the pages of the *Liber Quartus*, where he inserted the hypothesis of Fabri. Father Grassi's letter brings to light that the difficulties of Baliani in reference to the *Tractatus physicus* concerned Fabri's concept of *impetus*. It has to be underlined that Baliani, being fully aware of the notion of conservation of movement (that he calls "naturalis motus continuatio," a principle not taken into account in Fabri's theory of motion) did not propose impetus as the cause of acceleration. (Baliani 1646, 101–108).

[94] For the relations between Baliani and Father Cabeo, see Costantini 1969. For Cabeo, see Frajese 1971; Ingegno 1972.

[95] Father Cabeo inserts his own violent criticisms against the Galilean doctrines *de motu naturali* in the context of the explanation of the dynamics of "driving rains." A "driving rain" was the fall of a great quantity of water, kept in the firmament, caused by the will of Providence: "intolerabilis

Thus the Jesuits flattered Baliani and urged him to oppose Galileo.[96] As Baliani's intense exchange of letters with Mersenne between 1646 and 1647 shows, it seems that even the Father Minim had an active role in encouraging the Genoese to distance himself from Galileo's position. Moreover, in 1645 Mersenne stayed for a long time with Baliani in Genoa, and most probably the two had occasion to discuss Fabri's hypothesis. Mersenne's correspondence helps us to understand why Baliani was tempted by these interested pressures. In fact, he was flattered by the prospect of gaining an important position in the gallery of the heroes of science, removing himself from the shadow projected by the personality of Galileo, by which his first edition of the *De motu* had remained substantially darkened. This spirit of emulation and of vindication is evident in the conclusive statements of the introduction to the *Liber Quartus* of the second edition of his *De motu* in which he had introduced as his own the hypothesis of Fabri regarding the arithmetic progression of spaces in accelerated motion "Augetur, igitur, ni fallor, motus iuxta progressionem arithmeticam, non numerorum imparium ab unitate ... sed naturalem. Ego ... detexisse spero causam ... a qua huiusmodi proportio emanat aperuisse et insuper quales errores fuerint in suppositionibus et experimentis huc usque habitis ... neque enim is sum qui tantum mihi tribuam ut rerum arcana intimius caeteris rimari nihi videar ... Nec inutiliter me laborasse existimavero si credar vitam silentio non pertransisse" (ibid., 114; Baliani 1998, 187).

A few months later, Baliani would make a lively protest against Mersenne who, in the Tomus III of the *Novarum observationum* of 1647 (Baliani to Mersenne, 1 October 1647, in Tannery et al. 1945–1988, 15:462–465), had presented him as a disciple of Galileo. Invoking Father Cabeo's testimony registered in his commentary to the *Metereologica*, Baliani proudly claimed, not only his priority regarding Galileo, but also gave evidence of his substantial autonomy, emphasizing that his

quaedam Galilaei iactantia, qua se solum ab orbe condito hanc turpem ignorantiam ab hominibus sustulisse profitetur ... stomachum enim ne dum risum excitant ejusmodi jactantiae. Certe illo, ipso anno quem prodiere Dialogi Galilaei, dum essem Genuae, narravit mihi Ioannes Baptista Balianus, nobile genuensis, vir ingenio et eruditione illustris, se incrementum velocitatis multis ab inde annis quam quidquam de Galilaeo audiret" (Cabeo 1646, 423–424). Later, Cabeo, denying that the propositions *de motu* of the *Two new sciences* demonstrate anything, since they were founded on purely experimental evidence, praised Baliani, who did not consider such propositions as demonstrated, but simply as "suppositum ex experientia, ex qua deinde, tamquam ex principio experimentali deducit pulcherrimas consequentias ..." (Cabeo 1646, 424). In fact, Cabeo opposed animatedly even the hypothetical admissibility of the Galilean laws of motion, by reproposing the arguments of Father Le Cazre and Father Fabri: that is the untenability of the postulate of the *Two new sciences*; the increase of velocity according to the series of odd numbers; acceleration as discontinuous process (beginning with a determined velocity) and proportional to the distance from rest; and, finally, the necessity of submitting physical discussion to metaphysical principles.

[96] In the field of cosmological ideas as well, the Jesuits contrasted the *pietas* and the opportune steadiness of Baliani with the conceitedness and the lack of responsibility of Galileo. The same was done by Father Riccioli, in the *Almagestum*. He affirmed that he exposed the selenocentric hypothesis "non tam ut viri iudicium contra Galilaeum adiungerem, quam ut exemplo ipsius discant reliqui conceptus mentis propriae, si forte sacrarum literarum aut ecclesiasticarum sanctionum authoritati minime congruant, aut non parere, sed pio ac prudenti ideoque foecundo abortu eos comprimere, aut si forte peperint intra merae hypothesis fascias et incunabula coercere" (Riccioli 1651, 1, *Pars Secunda*: 381).

De motu did not depend on the disputable principles of Galileo: "Valde gauderem quod dicas viros doctos censere me optime demonstrare de gravium motu ne adderes ex hypothesi positionum Galilaei, nam aliud est me cum Galilaeo in pluribus convenire, aliud meas demonstrationes ex eius principiis pendere, quod significari videris qua ductus ratione non percipio" (Baliani to Mersenne, 1 October 1647, ibid., 463). And he concluded, adding that at most he could be considered an admirer of Galileo — Fabri defined himself in the same way[97] — but not his *sectator* (Baliani to Mersenne, 1 October 1647, ibid., 464).

Mersenne promised to give him satisfaction as soon as possible. And in fact, the Minim's authoritative certification of Baliani's independence and autonomy from Galileo will be inserted, in Italian translation, in the edition of the *Works* (Baliani 1666, 10)[98] of Baliani of 1666:

> Ho gran gusto che V.S. mi habbia imparata per l'ultima sua che Galileo non sia il primo che ha osservato la proportione del moto de i corpi gravi che cascano giù, perché io pubblicherò a tutti quanti che in ciò siete stato il primo Osservatore, come l'ha confermato il P. Cabeo nel luogo citato da voi nelle sue Meteore. [I was very pleased in reading in your last letter that Galileo was not the first one to observe the proportion of the motion of falling heavy bodies, and I will tell the fact publicly that you were the first observer of this phenomenon, as Father Cabeo has confirmed in the statement quoted from you in his Meteore.] (Tannery et al. 1945–1988, 15:504–505)

So Baliani, flattered by interested friendships and spurred by a strong sense of emulation towards Galileo, made a mistake which will seriously compromise his reputation, as the generally and constantly negative judgments of the historians on the second edition of his *De motu* confirm (Caverni 1891–1900, 5:28; Moscovivi 1967, 79–84). Baliani was, therefore, the involuntary victim — as a matter of fact it was an intellectual suicide — of the Galilean *affaire* of the laws of motion.

The affair of the laws of motion has by now assumed the aspect of a second "trial," in which — along with legitimate and sometimes well-founded reservations on the coherence and plausibility of the *De motu naturaliter accelerato* in the *Two new sciences* — played a decisive role intellectual incompatibility and obscure intrigues. The awareness of the role played by the Jesuits in the *affaire* of the trial and of the condemnation of Galileo, induced many of the protagonists — in Italy as well as in France — to intuitively recognize, beyond the attacks directed at *de motu* doctrines, a new subtle intellectual strategy of the Jesuit Order. We lack definite proof that would allow us to state that the polemical initiatives of the

[97] In the *Metaphysica demonstrativa* Mousnier stressed Fabri's admiration for Galileo.: "Galilaeum vestrum magnifacimus et saepius a nostro Philosopho [Father Fabri], tum in privatis colloquiis, tum in publicis praelectionibus accepi magnum Galilaeum (sic enim illum vocabat) eo ingenio praeditum fuisse cui vix simili a multis retro saeculis extitisset" (Mousnier-Fabri 1648, 658–659).

[98] The original of Mersenne's letter, dated 25 October 1647, is lost.

different Jesuits were inspired by an homogeneous and coherent plan, as Tenneur and the Galileans in Tuscany took, however, for granted. More probably, Father Le Cazre on the one side, and Father Fabri on the other, developed two different strategies, which nevertheless had in common the purpose of contrasting the integration of Galileo's *Dialogo* and the *Two new sciences* — that is of the Pisan dynamics and of Copernican cosmology — clearly proposed by Gassendi in the *Epistulae de motu impresso* of 1642.

As soon as the Copernican *affaire* came to an end, with the death of Galileo, a second one was opened, which was less dramatic in its results, but no less delicate or important. The close alliance, suggested by Gassendi, between acceleration, the analysis of the infinite, attraction, atoms and the void, on one side, and Copernican cosmology, on the other, in the framework of a rigorously mathematical treatment, but open to experimental controls, produced extraordinary consequences in natural philosophy; at the same time, it represented an extremely effective vehicle of promotion of Galileo's image in the European context. This alliance, and the affair to which it gave rise, stimulated, in fact, the maintenance of an intense interest in Galileo in the second half of the century, up to Newton and beyond.

The awareness of the decisive role played by Gassendi in the transmission of Galilean ideas found clear expression in the introduction to the Florentine reprint of the Lyonnais edition of the works of Gassendi (Gassendi 1727). Niccolò Averani, a later and not exceptional heir to the Galilean tradition, who had promoted and edited the work,[99] exalted in the introduction with its solemn expressions, the continually effective defense of Galileo's scientific reputation by Gassendi, proudly emphasizing — and not without foundation — that Gassendi also owed much to Galileo:

> Pace enim Gallorum hoc sit dictum, quidquid laudis in Gassendum confertur, in Florentinorum laudem reflecti videtur; nam qui Gassendum laudant et immortalem Galilaeum totius Italie lumen extollunt ... Quod libenter doctissima Gallorum natio concedere non detractabit, quum Gassendus ipse primas concederet viro de se optime merito; cum quo tantae amoris caussae studiorum similitudine altae intercedebant, virtutisque aeternum suspiciendae appellaverit ("Tipographus" to "philosophiae studios" 1713, ibid., I, VII).

[99] For Niccolò Averani and for the motivations behind the Florentine reprint of the *Opera omnia*, see Carranza 1962 and Ferrone 1982, 155–160.

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