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# Lambert, Kant and solidity: a matter of method

## 1 Introduction: a matter of method

Ernst Cassirer pointed out that Lambert had introduced a »peculiar and new point of view in the problem of knowledge«, that is, the idea that we can take empirical concepts and then, without questioning their »psychological origin«, discover in them »certain universal relations« and thus set the basis for a priori knowledge concerning these concepts.<sup>1</sup> As Lambert puts it, experience »provides at best an occasion [*Veranlassung*], in order to see whether and how far one can prove a priori«. <sup>2</sup> Gereon Wolters has focused on this topic in his seminal study on Lambert's theory of scientific knowledge, maintaining that »as far as I can see, Lambert is the first in the history of exact sciences and their methodology to establish the *program of a protophysical basis*«. <sup>3</sup> This program concerns the formulation of definitions and/or postulates concerning the unities of measure in the exact sciences (e.g. extension, duration, mass), leading from the basic sensations corresponding to these magnitudes to the first scientific propositions. For example, Lambert asks »whether the first propositions of mechanics can be proved [*erweisen*] necessarily and a priori, as Euclid has done with regards to the geometrical propositions.« <sup>4</sup> This investigation takes place in a section of mechanics that Lambert calls »Dynamics«, starting from the concepts of »solidity« and »force«, and it provides an opportunity to test the limits of Locke's empiricist methodology. »Solidity«, listed by Lambert among the *Grundbegriffe* of science, had been already considered by Locke as a simple idea derived from experience. While recognizing the importance of Locke's analysis, Lambert objected that the latter »had looked for the simple concepts, but he missed

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<sup>1</sup> Ernst Cassirer: *Das Erkenntnisproblem in der Philosophie und Wissenschaft der neueren Zeit*. Zweiter Band. In: ders.: *Gesammelte Werke*. Hg. von Birgit Recki. 26 Bde. Hamburg 1998–2009, Bd. 3, p. 453.

<sup>2</sup> Johann Heinrich Lambert: *Gedanken über die Grundlehren des Gleichgewichts und der Bewegung*. In: ders.: *Beyträge zum Gebrauche der Mathematik und deren Anwendung*. Bd. 2.2. Berlin 1770, § 6. On the a priori and a posteriori investigation concerning propositions and properties see Johann Heinrich Lambert: *Neues Organon oder Gedanken über die Erforschung und Bezeichnung des Wahren und dessen Unterscheidung von Irrthum und Schein*. Leipzig 1764 (LPS 1), *Dianoilogie*, §§ 634ff.

<sup>3</sup> Gereon Wolters: *Basis und Deduktion. Studien zur Entstehung und Bedeutung der Theorie der axiomatischen Methode bei J. H. Lambert*. Berlin, New York 1980, p. 85.

<sup>4</sup> Lambert: *Gedanken über die Grundlehren* (see fn. 2), § 1.

the application of the method of establishing doctrinal systems [*Lehrgebäude*].<sup>5</sup> Locke »proceeds entirely a posteriori« with his »anatomy of concepts«,<sup>6</sup> and thus misses the a priori moment in the foundations of empirical science, which can be conceived following the model of geometry:

*italics* Es scheint ihm an der Methode, oder wenigstens an dem Einfalle gefehlet zu haben, das was die Meßkünstler in Absicht auf den Raum gethan hatten, in Absicht auf die übrigen einfachen ebenfalls zu versuchen.<sup>7</sup>

Now, it is well known that Lambert's foundational attempt provided a substantial inspiration for Kant's analogous investigation on the possibility of a metaphysics of nature at the time of their correspondence, between 1765 and 1771, and beyond. Kant himself would recognize the authority of Lambert for the »claims subsequently presented in the *Kritik der reinen Vernunft* in their whole context«. <sup>8</sup> Alison Laywine has convincingly argued that Lambert's conception of postulates and their use in the foundations of natural science may have been a model for Kant's transcendental analytics.<sup>9</sup> But if we take the cue from the concepts of solidity and force it makes all the more sense to consider Kant's own account of »pure physics« in the *Metaphysische Anfangsgründe der Naturwissenschaft* (MAN), published in 1786, as a late assessment of the issues formulated by Lambert. Starting from a puzzling reference to Lambert, I will compare the latter's and Kant's accounts of solidity as alternative methodological solutions to the same foundational problem concerning concepts and principles of natural science.

<sup>5</sup> Johann Heinrich Lambert: *Anlage zu Architectonic oder Theorie des Einfachen und des Ersten in der philosophischen und mathematischen Erkenntniß*. Riga 1771, Bd. 1 (LPS 3), § 14.

<sup>6</sup> Lambert: *Neues Organon* (see fn. 2), *Alethiologie*, § 29.

<sup>7</sup> Lambert: *Anlage zu Architectonic* (see fn. 5), § 10 (*italics mine*).

<sup>8</sup> AA X, p. 278. Indeed, Kant was planning to dedicate the *Critique* to Lambert. See Immanuel Kant: *Reflexion 5024*, AA XVIII, p. 64: »(zur dedication.) sie haben mich mit ihren Zuschriften beehrt. Die Bemühung, auf Ihr Verlangen einen Begriff von der Methode der reinen Philosophie zu geben, hat eine Reihe von Betrachtungen veranlaßt, den mir noch dunkel liegenden Begriff zu entwikeln, und, indem die Aussichten sich mit dem Fortschritt erweiterten, die Antworten einem unaufhorlichen Aufschub ausgesetzt. Diese Schrift kann statt einer Antwort dienen, was den speculativen Theil betrifft. Da sie ihren Aufforderungen und Winken zuzuschreiben ist, so wünschete ich, daß die Ihnen ganz angehörte durch die Bemühung, sie in Ihre Bearbeitung zu nehmen«.

<sup>9</sup> Alison Laywine: *Kant and Lambert on the geometrical postulates in the reform of metaphysics*. In: Mary Domski (ed.): *Discourse on a new method. Reinvigorating the marriage of history and philosophy of science*. Chicago 2010, pp. 113–133.

## 2 ~~##Titel ergänzen##~~ Kant on Lambert and solidity

Kant's critical reference to Lambert's account of solidity appears in the *Remark to Theorem 1* of the »Dynamics« chapter of the *Metaphysische Anfangsgründe*.

Lambert und andere nannten die Eigenschaft der Materie, da sie einen Raum erfüllt, die *Solidität* (ein ziemlich vieldeutiger Ausdruck), und wollen, man müsse sie an jedem Dinge, *was existiert* (Substanz), annehmen, wenigstens in der äußeren Sinnenwelt. Nach ihren Begriffen müßte die Anwesenheit von etwas *Reellem* im Raume, diesen Widerstand schon durch seinen Begriff, mithin nach dem Satze des Widerspruchs bei sich führen, und es machen, daß nichts anderes in dem Raume der Anwesenheit eines solchen Dinges zugleich sein könne. Allein der Satz des Widerspruchs treibt keine Materie zurück, welche anrückt, um in einen Raum einzudringen, in welchem eine andere anzutreffen ist. Nur alsdann, wenn ich dem, was einen Raum einnimmt, eine Kraft beilege, alles äußere Beweglich, welches sich annähert, zurück zu treiben, verstehe ich, wie es einen Widerspruch enthalte, daß in dem Raum, den ein Ding einnimmt, noch ein anderes von derselben Art eindringe.<sup>10</sup>

The concluding sentence refers to Kant's own alternative view, exposed in the theorem. Rather than to »solidity« (an expression that he considers suitable for »rigid« bodies),<sup>11</sup> Kant refers to the empirical property of »impenetrability« (*Undurchdringlichkeit*), manifested by a resistance to penetration (*Eindringen*). According to the theorem, »matter fills space not by its mere *existence*, but through a *particular moving force*«. It is useful to quote Kant's »proof« (*Beweis*) of this theorem, as an example of how he moves from the empirical property of impenetrability to dynamics by means of a priori inferences.

Das Eindringen in einen Raum (im Anfangsaugenblick heißt solches die Bestrebung einzudringen) ist eine Bewegung. Der Widerstand gegen Bewegung ist die Ursache der Verminderung, oder auch Veränderung derselben in Ruhe. Nun kann mit keiner Bewegung etwas verbunden werden, was sie vermindert oder aufhebt, als eine andere Bewegung. Also ist der Widerstand, den eine Materie in dem Raum, den sie erfüllt, allem Eindringen anderer leistet, eine Ursache der Bewegung der letzteren in entgegengesetzter Richtung (Phoron. Lehrs.). Die Ursache einer Bewegung heißt aber bewegende Kraft. Also erfüllt die Materie ihren Raum durch bewegende Kraft und nicht durch ihre bloße Existenz.<sup>12</sup>

Given the sensory experience of resistance to penetration (empirical element), Kant applies the phoronomical theorem of the composition of motions (mathematical element),<sup>13</sup> thus inferring the need to introduce a cause of this resistance, which

<sup>10</sup> Immanuel Kant: *Metaphysische Anfangsgründe der Naturwissenschaft*. Riga 1786, AA IV, pp. 497f.

<sup>11</sup> *Ibid.*, p. 527.

<sup>12</sup> *Ibid.*, p. 497

<sup>13</sup> For its proof see *ibid.*, p. 490.

turns out to be, by definition, a moving force.<sup>14</sup> Kant will successively qualify this force as a fundamental repulsive force.

This argumentative context can help us understand why Kant decides to single out Lambert among those who argue for the fundamental solidity of matter. Besides Locke, who was Lambert's source, these »others« include a large number of mechanistic natural philosophers.<sup>15</sup> From the physical point of view, indeed, this conception corresponds to the attribution to matter of an »absolute impenetrability«, which is »nothing more nor less than an occult quality. For one asks what the cause is for the inability of matters to penetrate one another in motion, and one receives the answer: because they are impenetrable.«<sup>16</sup> Absolute impenetrability, together with »absolute homogeneity«, forms the basis of the »mechanical philosophy of nature«, which »under the name of *atomism*, or the *corpuscular philosophy*, always retained its authority and influence on the principles of natural science, from Democritus of old, to Descartes and even to our time.«<sup>17</sup> This philosophy has the advantage of representing empty spaces and vacuum in bodies with mathematical evidence, but pays this advantage with several shortcomings for mathematical physics besides its empty explanation of impenetrability (e.g., it gives too much power to the imagination in positing these empty spaces for the explanation of different densities). Kant's »dynamical mode of explanation«, on the contrary, is »much more appropriate and conducive to natural philosophy, in that it leads directly to the discovery of matter's inherent forces and laws«,<sup>18</sup> whereby resistance can be traced back to a cause and »estimated in regard to its degrees«.<sup>19</sup>

The mechanical philosophy with absolutely hard particles, empty spaces and no inherent forces could be attributed to major physicists of the time. In the first *Critique*, indeed, Kant writes that this is the way »most mathematical and mechanical investigators of nature« explain different densities.<sup>20</sup> These scientists include Newton and Euler, who are often discussed in the *Remarks* of the MAN. After all, one of the objectives of Kant's MAN was to provide the sketch of a new »metaphysical part« to be included in treatises of mathematical physics.<sup>21</sup> It is puzzling, in this regard, that Kant names Lambert in his *Remark* about solidity. As I will argue, this

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<sup>14</sup> For a detailed account of Kant's general methodology in the MAN see Paolo Pecere: *La filosofia della natura in Kant*. Pagina. Bari 2009, pp. 321–391; Michael Friedman: *Kant's construction of nature*. Oxford 2013, pp. 1–33, pp. 564–580.

<sup>15</sup> For a list of alternatives see Konstantin Pollak: *Kants »Metaphysische Anfangsgründe der Naturwissenschaft«*. Ein kritischer Kommentar. Hamburg 2001, pp. 229–231.

<sup>16</sup> Kant: *Metaphysische Anfangsgründe* (see fn. 10), AA IV, p. 502.

<sup>17</sup> Ebd., p. 533.

<sup>18</sup> Ebd., p. 533.

1787 (2nd ed.),

<sup>19</sup> Ebd., p. 503.

<sup>20</sup> Immanuel Kant: *Critik der reinen Vernunft*. Riga 1787, AA III, p. 156.

<sup>21</sup> Kant: *Metaphysische Anfangsgründe* (see fn. 10), AA IV, p. 478.

suggests that Kant is raising a *methodological* rather than a *physical* issue, concerning his new conception of a metaphysics of corporeal nature. In order to introduce this argument let us first consider Lambert's view.

### 3 Lambert's principles of solidity

Lambert's accounts of solidity in the *Neues Organon* and the *Architektonik* present an intertwining of empirical and rational elements, which will form the starting point of Kant's successive rethinking. In the *Neues Organon* Lambert introduces the empirical concept of matter as follows: »Der Begriff der *Materie*, den wir unmittelbar durch das *Gefühl* haben, macht, daß wir der *Materie* eine *Solidität* und *Festigkeit* oder *Undurchdringlichkeit* beylegen«. <sup>22</sup>

He argues that, given simple concepts, which can be thought for themselves, we can immediately deduce a corresponding set of principles (*Grundsätze*). In this particular case, we get principles of »solidity« and »force«, including the principle stating that »every solid excludes any other solid from the place where it is«. <sup>23</sup> This suggests that the latter principle can be derived by a pure logical inference and thus be grounded on the principle of contradiction.

A similar and more detailed account can be found in the *Architectonic*. Here Lambert lists different *Grundsätze* which can be applied to »material solids« with no contradiction (*ohne Widerrede*):

Der Begriff *Solidität* gibt uns ebenfalls einige Grundsätze, die bei dem materiellen Soliden ohne Widerrede angewandt werden.

1. Das Solide füllt einen Raum aus, so weit es geht.
2. Das Solide schließt anderes Solides von dem Orte aus, da es ist.
3. Das Solide hat drei Dimensionen des Raumes.
4. Der Raum kann mit Solidem nicht mehr als ausgefüllt sein.
5. Das Solide hat eine absolute Dichtigkeit, und daher ist es eine Einheit, die unveränderlich ist. <sup>24</sup>

In Lambert's text we find a principle of impenetrability (n. 2 above) and more striking correspondences with Kant's later account:

- These propositions can be derived by »the collection and immediate comparison [*Vergleichung*] of simple concepts«, and thus merely depend on the principle of contradiction. <sup>25</sup>

<sup>22</sup> Lambert: *Neues Organon* (see fn. 2), *Alethiologie*, § 19.

<sup>23</sup> *Ibid.*, § 94.

<sup>24</sup> Lambert: *Architectonic* (see fn. 5), § 88.

<sup>25</sup> *Ibid.*, § 76.

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<sup>66</sup> Lambert: Architectonic (see fn. 5), § 94.

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addresses the issue of the method of metaphysics, arguing that Wolff was mistaken in granting a fundamental role to definitions without investigating the possibility of the corresponding objects. A better model is the method followed by Euclid in geometry, where definitions are just a kind of »nomenclature«, while the possibility of the corresponding objects (geometrical figures) is merely hypothetical and has to be proved »synthetically«:

Definitionen sind bei Euclid gleichsam nur die Nomenclatur, und der Ausdruck *per definitionem* gilt bey ihm nicht mehr als der Ausdruck *per hypothesin*. Wolf scheint auch nicht genug darauf gemerkt zu haben wie sorgfältig *Euclid* ist, und wie sehr er selbst die Ordnung des Vortrages dazu einrichtet, die *Möglichkeit* der Figuren zu beweisen und ihre *Gränzen* zu bestimmen. Dabey [with metaphysical concepts] muß man wohl nicht anfangen, wenn man sich nicht in einer endlosen *Analysis* verlieren und verwirren sondern nach *Euclidens* Art synthetisch gehen will.<sup>39</sup>

Kant replies that there was indeed »a lucky agreement in our methods«,<sup>40</sup> mentioning the similar role played by constructions in mathematics according to the *Deutlichkeit*. The agreement concerning metaphysics is not clearly spelled out, but Kant mentions his project to write a book on the »proper *Method of Metaphysics*«: this ambitious project is temporarily shelved because he lacks »examples, of how the correct method should work«, and he has decided to »give precedence to smaller works«. Then he mentions two »ready« writings, the »*Metaphysische Anfangsgründe der natürlichen Weltweisheit*« and the »*metaph. Anf. der praktischen Weltweisheit*«, which will present examples of the new method. By this separate exposition »the main work will not be burdened with too many and inadequate examples«. <sup>41</sup>

Lambert (December 3, 1766) replies that Kant's procedure of introducing the new method by the exposition of positive and negative examples is a good one, and that he has followed the same method in the *Dianoilogie*, e. g. in the illustration of the relation between form and matter of knowledge. While these concepts do not raise issues in their logical meaning, when applied in metaphysics they have led to »controversies and hypotheses«. In this regard, Lambert submits a number of propositions concerning the transition from simple to complex concepts:

1) Die Form giebt *Principia*, die Materie aber *Axiomata* und *Postulata*.

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<sup>39</sup> Ibid., p. 338. That Lambert consider Euclid, rather than Wolff, as the »true auctoritas« for realizing his foundational project has been highlighted by Paola Basso: *Filosofia e geometria. Lambert interprete di Euclide*. Firenze 1999, in part. pp. 1f. For the proximity of Lambert's project to the Leibnizian idea of the *ars characteristica* see Enrico Pasini: *L'altra faccia dell'uomo della Luna. Leibniz e l'»Erfindungskunst«*. In: Massimo Mori, Stefano Poggi (eds.): *La misura dell'uomo. Filosofia, teologia, scienza nel dibattito antropologico in Germania (1760–1915)*. Bologna 2005, pp. 49–70.

<sup>40</sup> Lambert: *Briefwechsel* (see fn. 38), p. 341.

<sup>41</sup> Ibid., p. 342.

2) Die Form fordert, daß man bey einfachen Begriffen anfangt, weil diese für sich, und zwar weil sie einfach sind, keinen innern Widerspruch haben können, oder für sich davon frey und für sich gedenkbar sind.

3) *Axiomata* und *Postulata* kommen eigentlich nur bey einfachen Begriffen vor. Denn zusammengesetzte Begriffe sind a priori nicht für sich gedenkbar. *Die Möglichkeit der Zusammensetzung* muß erst aus den Grundsätzen und *Postulatis* folgen.<sup>42</sup>

In the following passage, Lambert explains in more detail this transition and the role played by axioms and postulates:

Nach diesen Sätzen trage ich kein Bedenken zu sagen, daß Locke auf der wahren Spur gewesen, das einfache in unserer Erkenntniß aufzusuchen. Man muß nur weglassen, was der Sprachgebrauch mit einmengt [...] Der Begriff *Dauer* und eben so die Begriffe *Existenz*, *Bewegung*, *Einheit*, *Solidität*, usw. haben etwas einfaches, das denselben eigen ist, und welches sich von den vielen dabey mit vorkommenden Verhältnißbegriffen sehr wohl abgesondert gedenken läßt. Sie geben auch für sich *Axiomata* und *Postulata* an, die zur wissenschaftlichen Erkenntniß den Grund legen und durchaus von gleicher Art sind, wie die Euclidischen.<sup>43</sup>

According to Lambert, metaphysics begins with simple concepts derived from experience. These simple concepts can be listed in any order («in der Ordnung, wie es mir einfällt»), but it is crucial to separate their different meanings and to exclude those who can find no empirical support and are merely suggested by the corresponding word – as we have seen above with «solidity».<sup>44</sup> Here Lambert follows Locke's teaching on language and definitions. Given the refined list of simple concepts the corresponding axioms and postulates can be logically derived. Axioms and postulates guide the formulation of propositions from simple concepts and hence they are the »ground« of scientific knowledge, just as it happens in geometry: on this point Lambert departs from Locke and introduces a domain of a priori inference in philosophy.

An important difference between philosophy and geometry lies in the potentially misleading form of language with regards to reference: contrary to geometry, in philosophy we face the risk of formulating judgements with a predicate which is not uniformly applied to the subject, e. g. »the watch is made of gold« when only the watch-case is made of gold. In this regard Lambert hopes that Kant's contributions will help and will be published soon. He is optimistic concerning the development of this new method of philosophy, underscoring that examples will play a crucial role in this enterprise. He then focuses on the analogy between geometrical figures and philosophical examples, arguing that

<sup>42</sup> Ibid., p. 348 (italics are mine).

<sup>43</sup> Ibid., p. 349.

<sup>44</sup> Ibid.

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Kant's abandonment of monadology in the 1760s, the dynamical theory – with its methodological background – would need a complete rethinking. Let us now elaborate on these hypotheses, starting from Kant's methodical framework of the MAN.

## 6 Metaphysics of nature: from Lambert to Kant

Let me review the main steps of Lambert's scientific method. First, there is an empirical moment, consisting in the collection of simple concepts, derived from sensation (e. g. solidity and force from the sensation of touch). Second, by following Euclid's model, principles and postulates are derived from simple concepts. These establish the »possibility of composition«, or the »conditions of possibility« of concepts. Third, these principles and postulates are grounds of scientific propositions. E.g., from solidity we get principles of dynamics, such as the law of inertia. This inference is grounded on »logical truths«, which in turn presuppose – in a Wolffian fashion – the »metaphysical truth« of the existence of God, lest that logical truth becomes an »empty dream«. This is the also ultimate ground of the solidity of bodies:

Demnach zieht der Satz, daß es nothwendige, ewige, unveränderliche Wahrheiten gebe, die Folge nach sich, daß ein nothwendiges, ewiges, unveränderliches *Suppositum intelligens* seyn müsse, und daß der Gegenstand dieser Wahrheiten, das will sagen, das Solide und die Kräfte, eine nothwendige Möglichkeit zu existiren haben.<sup>53</sup>

Of course Kant breaks with this metaphysical approach in criticism.<sup>54</sup> Still, he retains much of Lambert's original insights when introducing his new »metaphysics of nature«, in the MAN. Kant separates a transcendental part of this doctrine from a second more specific part.

Sie beschäftigt sich mit einer besonderen Natur dieser oder jener Art Dinge, von denen ein empirischer Begriff gegeben ist, doch so, daß außer dem, was in diesem Begriffe liegt, kein anderes empirisches zur Erkenntnis derselben gebraucht wird (z. B. sie legt den empirischen Begriff einer Materie, oder eines denkenden Wesens zum Grunde und sucht den Umfang der Erkenntniß, deren die Vernunft über diese Gegenstände a priori fähig ist).<sup>55</sup>

So far, there is a close analogy with Lambert's method: Kant starts with empirical concepts – e. g. impenetrability of matter – and then derives knowledge a priori. But here we find an entirely different way of conceiving the role of mathematics, which provides not merely a methodological model, but also a necessary element of the new metaphysics. This change depends on the role of pure intuition for scientific

<sup>53</sup> Ibid., § 299.

<sup>54</sup> For this transition compare Cassirer: *Das Erkenntnisproblem* (see fn. 1), Bd. 3, p. 457.

<sup>55</sup> Kant: *Metaphysische Anfangsgründe* (see fn. 10), AA IV, p. 470.

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from the empirical concept of matter, »that make the concept of their proper object, namely, matter, a priori suitable for application to outer experience, such as the concept of motion, the filling of space, inertia, and so on.«<sup>60</sup> These metaphysical principles include the explanation of the filling of space through the action of a fundamental force.

Let me examine in more detail the connection of these three elements with special regard to the example examined above in § 2 (*Dynamics, theorem 1*). Kant points out that the concept of impenetrability is given »by means of the sense of feeling«, which »provides us with the quantity and figure of something extended, and thus with the concept of a determinate object in space, which forms the basis of everything else one can say about this thing.«<sup>61</sup> The transition from the *sensation* of impenetrability to the *concept* of the filling of space requires the application of the category of quality, and the corresponding principle of intensive magnitudes (degree): thus we get the representation of the filling of space as a magnitude that can have a determinate degree. The possibility of constructing this concept, in turn, can be examined a priori in pure intuition by schematizing resistance as a motion opposing penetration. The result is one of Kant's non-pure, a priori synthetic principles of metaphysics: »matter fills space, not through its mere *existence*, but through a particular *moving force*«.

This is the proposition to which Kant's remark about Lambert is appended. We can now draw some conclusions about Kant's remark.

First, Kant's insistence on the ambiguity of the word »solidity«, while evoking Lambert's views on terminological clarity – originally meant to avoid transcendent meanings –, also implies a number of corrections to the latter's analysis of the concept. Sense experience of impenetrability, which is a first meaning of »solidity«, is not sufficient to establish a primitive concept of science. Only by the understanding of solidity as the filling of space, as a special case of intensive magnitude, does resistance to penetration become accessible to mathematical analysis. Kant's account contributes to the issue whether density is originally variable or not – a question that Lambert rightly considered unsolvable on the ground of sensation, but then left open – by developing a model of matter with originally variable density. Thus Kant's remark can be considered as both a critique and an original development of Lambert's idea that experience can provide the »occasion« for the »a priori reasoning«, based on the fundamental concept of solidity (see above § I).

But solidity is just an example – albeit a fundamental one, due to the empirical precedence of the corresponding experience. The formation of the concepts of inertia and mass, which Lambert derived as well from the experience of resistance to motion, requires the application of principles of relations in the pure part of me-

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<sup>60</sup> Ibid., p. 472.

<sup>61</sup> Ibid., p. 510.

chanics. In the *Mechanics* chapter Kant first introduces the conditions to represent a material substance as a quantity of matter (mass) which is constant in time and manifests itself in impact and resistance to force. Here the application of the transcendental principle of causality leads to the metaphysical principle that the cause of motion must be external to the moved substance, the *lex inertiae*. Thus material substance and inertia (as lack of activity), through the combination of metaphysics and mathematics, appear as new concepts derived from the original experience of touch.

On the whole, Kant's new »principles for the construction of the concepts that belong to the possibility of matter«<sup>62</sup> – meant to connect a priori sense experience and mathematical physics – can be considered as a rethinking of Lambert's idea of »principles and postulates« dealing with the »possibility of composition«. The difference is that Lambert thinks to an elaboration of empirical concepts by means of logical inference which is *analogous* to mathematical construction, but does not require the use of spatial intuition, while Kant, after having defended the idea of an entirely analytical metaphysics in the *Deutlichkeit*, now introduces synthesis in pure space-time as the procedure that has to connect empirical concepts and metaphysical principles, thus establishing the possibility of mathematical constructions in physics.

Kant's view of the systematical meaning for general metaphysics of these examples concerning bodies also echoes Lambert's ideas. Remember that Lambert had repeatedly argued that his new principles would provide metaphysics with »examples«, which would play the same role of figures in Euclidean geometry, that is, to establish the possibility of defined objects. In the MAN Kant assigns a strikingly similar role to examples in metaphysics:

Die allgemeine Metaphysik in allen Fällen, wo sie Beispiele (Anschauungen) bedarf, um ihren reinen Verstandesbegriffen Bedeutung zu verschaffen, diese jederzeit aus der allgemeinen Körperlehre, mithin von der Form und den Principien der äußeren Anschauung hernehmen müsse und, wenn diese nicht vollendet darliegen, unter lauter sinnleeren Begriffen unstät und schwankend herumtapse. Daher die bekannten Schwierigkeiten, wenigstens die Dunkelheit in den Fragen über die Möglichkeit eines Widerstreits der Realitäten, die der intensiven Größe u. a. m., bei welchen der Verstand nur durch Beispiele aus der körperlichen Natur belehrt wird, welches die Bedingungen sind, unter denen jene Begriffe allein objective Realität, d. i. Bedeutung und Wahrheit haben können. Und so thut eine abgesonderte Metaphysik der körperlichen Natur der *allgemeinen* vortreffliche und unentbehrliche Dienste, indem sie Beispiele (Fälle in concreto) herbeischafft, die Begriffe und Lehrsätze der letzteren (eigentlich der Transzendentalphilosophie) zu realisiren, d. i. einer bloßen Gedankenform Sinn und Bedeutung unterzulegen.<sup>63</sup>

<sup>62</sup> Ibid., p. 472.

<sup>63</sup> Ibid., p. 478.



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