

The individuation of physical bodies in the letters Leibniz-Hartsoeker and in the Monadology

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The most creative period of Leibniz's physics ends at the beginning of the last turning point of his metaphysics, which is marked by the assumption of the monad theory. His effort to build a new science, that he labelled with the new term "dynamics", evidently left him satisfied with the achievements we can find in the works he composed or conceived in the Italian period, in particular the *Phoronomus* (1689) and the large *Dynamica, sive de potentia* (1689-90), and with the later systematization proposed in the *Specimen dynamicum* (1695) and in the *Essay de dynamique* written in 1700. After this year no essay of comparable breadth is to be found and his work on physical matters is mainly contained in his letters to various correspondents, among which those to Burchard de Volder, Nicolaas Hartsoeker and Samuel Clarke are of particular interest.

With regard to the metaphysical foundations of physical notions, Leibniz's relentless activity of rethinking theoretic arguments and of essaying new solutions, a peculiarity of his whole life, does not come to an end in the last years, but his properly physical assumptions did not significantly change in the period devoted to the construction of the monadological theory. The application of the architectonical principles to the problems of motion and matter, in particular, did not produce a new output within the specific domain of the definition of the laws of motion, a field in which he was convinced to have said the final word in the last decades of the XVIIth century. In his eyes, the science of nature strenuously sought at least since his first encounter with Huygens's and Wren's memories on impact in 1669, was fundamentally sound and fully consistent with the metaphysical theories he was developing after the monadological turn. In this paper I shall try to consider the correctness of this claim and to test his views on body and motion in the light both of his metaphysics and of the evidence to be found in the works of other scientists, in particular Huygens and Newton. I will devote my attention in particular to a problem pertaining to the domain of both metaphysics and mechanics, that is the individuation of physical bodies, which implies an analysis of the cause of firmness.

In *Monadology*, §8 Leibniz argues that, in spite of their simplicity, the monads must be endowed with qualities; he gives us three different reasons for this claim: 1) there are no beings without qualities; 2) if the monads had no qualities, they could not be distinguished from one another, since they do not differ by quantity; 3) if the monads could not be distinguished from one another, it would be impossible to perceive any change in things. Leibniz reinforces his point by proposing an argument drawn from physics: «le plein étant supposé, chaque lieu ne recevoit tousjours dans le mouvement que l'Equivalent de ce qu'il avoit eu, et un état des choses seroit indiscernable de l'autre»¹. This passage leaves many open questions concerning the properties of bodies in Leibniz's last philosophy: is there a way to differentiate the constituents of matter? How is change in a plenum to be understood? Is the theory of *motus conspirans* meant to solve the difficulty above proposed? Are there sound physical reasons to rule out atoms at the phenomenic level? Let us begin with the question of the individuation of a physical body.

In order to understand the problem, we must first make a distinction between two different meanings of "hardness" or "solidity"; on the one hand there is the impenetrability of the last elements of matter, which does not allow the compresence of more parts in the same place; on the other, there is the phenomenon of cohesion, which makes their separation difficult, but not impossible. The

¹ Gottfried W. Leibniz, [*Monadologie*], in GP, VI, p. 608.

atomists think that the hardness of the elementary particles is originary and absolute; in their opinion, the last parts of matter, albeit extended, cannot be divided in any way. The individuation of a body depends thus on the fact that its shape and size are unchangeable, since impenetrability (i.e. *antitypia*) does not allow any division or internal motion. On the contrary Leibniz, who does not admit the existence of "last" parts of matter, poses himself even outside the corpuscular paradigm; he admits *antitypia* but is very careful in distinguishing it from the sensible quality of firmness and refuses to think of it as of a form of hardness, stating that it is rather an attribute spread in space:

materia in se sumta seu nuda constituitur per Antitypiam et Extensionem. Antitypiam voco illud attributum, per quod materia est in spatio. Extensio est continuatio per spatium, seu continua per locum diffusio. Atque ita, dum Antitypia continue per locum diffunditur seu extenditur nec aliud quiddam ponitur, oritur materia in se seu nuda².

Consequently, it does not allow subjects to be individuated. The singularity of his position in the range of the theories of matter of his time is evident, as well as the analogy one could propose with the modern physical notion of "field". The Leibnizian thesis is therefore in strong opposition to atomism, a view of the world in contrast with his architectonical principles of continuity, of the indiscernibles and of sufficient reason. Leibniz's strongest argument lies in the difficulty of reconciling the absolute hardness of atoms with elasticity, i.e. with the principle of conservation of the quantity *mv*²: two perfectly hard bodies colliding with equal speed, as a matter of fact, after the collision come to rest in the place of their collision, thus losing their whole speed. In Leibniz's view, therefore, absolute hardness is as impossible as void.

In his system the problem of cohesion is solved by the operation of motion:

selon moy toute la matiere [...] est [...] parfaitement fluide par elle même, la connexion des parties ou la resistance à la separation ne venant que des mouvemens conspirans, puisqu'il n'y a que les mouvemens et leur figures qui puissent varier la matiere³.

The solution is therefore, in Leibniz's intention, fully mechanistic⁴. As we shall see, though, there are a few difficulties, which the letters exchanged with Nicolaas Hartsoeker only a few years before the *Monadology* may help us understand. In his *Conjectures physiques* Hartsoeker proposes three different solutions to the problem of cohesion: the first one is the atomistic solution, the other ones are ascribed to Descartes and Malebranche; Hartsoeker's strategy consists in reducing Leibniz's hypothesis of *motus conspirans* first to Malebranche and then to Descartes. The Cartesian hypothesis, which explains cohesion by the mutual rest of the bodies⁵, is considered by Hartsoeker «si absurde, qu'il ne merite pas qu'on y fasse la moindre attention»⁶; on this point he agrees with many contemporaries, who think that the Cartesian explanation is nothing other than a tautology. Such is

² Gottfried W. Leibniz, *Materia in se sumta*, in GP, VII, p. 328.

³ Gottfried W. Leibniz to Nicolaas Hartsoeker, 1710 [?], in GP, III, p. 497. This is true of course only in principle, since there are always conspiring motions which make matter neither completely fluid nor completely solid.

⁴ See also Gottfried W. Leibniz a Barthélémy Des Bosses, 7 November 1710, in GP, II p. 412.

⁵ See René Descartes, *Principia philosophiae*, artt. 54-55, in Descartes 1974-1986, VIII-1, pp. 70-71.

⁶ Hartsoeker 1706, p. 192.

for example, as de Buzon had already observed⁷, the judgment of Huygens, Malebranche and Jacques Bernoulli and also, later, of Newton⁸. If Huygens, after long hesitation, takes finally sides with the atomists⁹, Malebranche rather chooses a different path; in his *Recherche de la vérité* the Oratorian father disagrees with Descartes and assumes that the simple contiguity of the parts is not sufficient to explain continuity, that is cohesion or resistance to separation. The latter may have as only cause the pressure of the particles of subtle matter, which, by means of a motion contrasting the one which tends to separation, holds together the parts of solid bodies¹⁰. Against this explanation Hartsoeker objects that the motion of the surrounding particles could not allow the conservation of a body with sharp angles: under the pressure, the body would become round, as in the case of a drop of water in air or of a bubble of air in water¹¹. He adds further considerations, probably less efficacious, aimed at showing that the innumerable collisions of the particles would cause a perpetual disorder which experience does not show; it is enough to think of the bodies which remain solid for a very long time, like for example diamonds¹². Once discarded Descartes's and Malebranche's hypotheses, Hartsoeker chooses the atomistic solution, that is the existence of elementary bodies «durs par eux-mêmes & de leur nature»¹³, thus ascribing the cohesion of compound bodies to the infinite hardness of their last parts.

Leibniz's alternative solution, that is *motus conspirans*, is first of all an explanation of the phenomenon of cohesion but he adopts it also as an antiatomistic argument, in order to show that an originary hardness is inconsistent and useless.

The contemporaries' reaction to the theory of *motus conspirans* was very critical; see for example Huygens, who wrote to Leibniz:

je vous prie de [...] me dire comment vous concevez que les parties des corps tout simples et primitifs coherent. Seroitce par Vostre Motus conspirans de ces mesmes parties, considerees comme reellement separees, et voudriez vous comprendre les corps simples aussi bien que les composez dans l'article de vos objections contre des Cartes. J'avoue que je ne comprends nullement comment vostre pensée puisse subsister ni dans les uns ni dans les autres. Voulez vous que les particules d'une barre de fer aient au dedans un Motus conspirans, et que non obstant cela on ne trouve pas que rien se derange dans cette barre? Qui peut entendre cela?¹⁴.

⁷ See De Buzon 2005, pp. 110-112.

⁸ See below.

⁹ It has been maintained that Hartsoeker's atomism derives from Huygens (see Sebastiani 1984, p. 52); in the *Discours de la cause de la pesanteur*, published in 1690 and without doubt well known by Hartsoeker, Huygens had written: «pour ce qui est du vuide, je l'admets sans difficulté, & mesme je le crois necessaire pour le mouvement des petits corpuscules entre eux. N'estant point du sentiment de Mr. Des Cartes, qui veut que la seule étendue fasse l'essence du corps; mais y adjoutant encore la dureté parfaite, qui le rende inpenetrable, & incapable d'estre rompu ni écorné» (Huygens 1888-1950, XXI, p. 473). Yet, I do not think that we have here a real influence, since Hartsoeker refuses void and has a different opinion regarding the collision of hard bodies; on Huygens's atomism see Mormino 2012a.

¹⁰ See Malebranche 1974, II, p. 439.

¹¹ See Hartsoeker 1706, p. 193.

¹² See *ibidem*, pp. 193-194.

¹³ *Ibidem*, p. 194.

¹⁴ Christiaan Huygens to Gottfried W. Leibniz, 11 July 1692, in AK, III-5, p. 340.

Totally negative was, of course, Newton's judgment¹⁵: in his *Opticks* he proposes the hypothesis that cohesion must be ascribed to attraction, which increases proportionately to the inverse of the square of the distance and is therefore very strong when the bodies are very near to each other.

The history of the Leibnizian theory of *motus conspirans* is too complex to be considered here; I would only like to stress that at its origin there is an evident influence of Hobbes's *De corpore*¹⁶. At the time of his correspondence with Hartsoeker, Leibniz had already defined his final position, stating that the *motus conspirans* — which he represents with the image of «fleuves ou [...] jets»¹⁷ — is not at all a relative rest, since the parts of the solid bodies are not at rest¹⁸ but rather endowed with a movement which allows them to actively resist to separation¹⁹; this is exactly the point which remains incomprehensible to his contemporaries. Hartsoeker notes firstly that the Leibnizian mechanism of cohesion is similar to the one proposed by Malebranche²⁰. Leibniz replies²¹ that the theory had already been proposed by him in the *Theoria motus abstracti*²², before the publication of the *Recherche de la vérité*, and that John Wallis, at that time, had remarked that a similar explanation had already been proposed by William Neile in 1669²³. Leibniz's remark is historically correct

¹⁵ «The Parts of all homogeneal hard Bodies which fully touch one another, stick together very strongly. And for explaining how this may be, some have invented hooked Atoms, which is begging the Question; and others tell us that Bodies are glued together by rest, that is, by an occult Quality, or rather by nothing; and others, that they stick together by conspiring Motions, that is, by relative rest amongst themselves» (Newton 1730, pp. 388-389). The reference to the *motus conspirans* was added in the 1717 edition; it is therefore highly plausible that Newton made acquaintance with Leibniz's theory thanks to the letters to Hartsoeker. On February 18th 1713, as a matter of fact, Cotes informs Newton that in Leibniz's letter to Hartsoeker of February 6th 1711 (in GP, III, p. 518), published in 1712 in the «Mémoires pour l'Histoire des Sciences & des beaux Arts» (the so called *Journal de Trévoux*), Newton is blamed of having made recourse to a sort of miracle with the hypothesis of attraction; it is exactly in the same letter that we find the reference to conspiring motions.

¹⁶ Which de Buzon omits to say. The evidence of this statement can be found in Mormino 2012b, pp. 136-141; the Hobbesian influence was already remarked in Lasswitz 1963, II, pp. 466ff. and in Millington 1945, pp. 261-263.

¹⁷ Gottfried W. Leibniz to Nicolaas Hartsoeker, 30 October 1710, in GP, III, p. 505.

¹⁸ Needless to say, the Leibnizian system does not admit a complete rest in the physical world.

¹⁹ «Je tiens que les corps ont de la cohesion à mesure que les mouvement qui s'y trouvent sont troublés par la separation et s'y opposent» (Gottfried W. Leibniz to Nicolaas Hartsoeker, 30 October 1710, in GP, III, p. 505); see also Gottfried W. Leibniz, *De firmitate, vi elastica, explosione, attractione*, in AK, VI-4C, p. 2079.

²⁰ See Nicolaas Hartsoeker to Gottfried W. Leibniz, 8 July 1710, in GP, III, p. 498.

²¹ See Gottfried W. Leibniz to Nicolaas Hartsoeker, 1710 [?], in GP, III, p. 500.

²² See Gottfried W. Leibniz, *Theoria motus abstracti*, in AK, VI-2, p. 269 (theoremata 17).

²³ English mathematician, died at the age of 32 in 1670; the writing to which Wallis alluded is the *Theory concerning motion* (published in Huygens 1888-1950, VI, pp. 465-470), a short treatise sent by Oldenburg to Huygens in June 1669. Neile wrote: «there is an innumerable variety of motions in ye small particles of all Bodies, which is ready to oppose any External impulse, yt shall happen to ym, wheresoeuer they are struck, they have a resistance; which inferrs a different motion in ym from ye motion of ye Impellent; And this resistance working every way, inferrs almost an infinite variety of motion in ye particles, which in firme Bodies are so close sett to one another as they cannot extricate ymselves from one another by this variety of motion, which hinders ye dissolution of ye Body» (ivi, VI, p. 467); on the dispute Neile-Huygens see Mormino 1993, pp. 53-57. The way Leibniz refers to the unpublished *Theory* by Neile (see also the letter to Johann Bernoulli of

(though Leibniz omits to mention Hobbes's influence²⁴, probably because of the scant credit enjoyed by the scientific work of the English philosopher) except for the very important fact that Malebranche ascribes solidity to the pressure of *the external bodies*, whereas Leibniz (like Neile) rather refers to the coherent movement of the parts of *the solid bodies themselves*. Such motion, Leibniz adds, strives to continue, «comme fait tout mouvement»²⁵; but it is not easy to understand how this statement is compatible with the principle of inertia; the conspiring movements, insofar as they take place in the plenum, are as a matter of fact tendentially circular, therefore they cannot go on indefinitely by themselves²⁶.

Hartsoeker, having understood the internal nature of the *motus conspirans*, obviously objects that it would be impossible to distinguish a coherent and shared movement from rest²⁷; it would seem that Leibniz revives the Cartesian thesis of cohesion as relative rest²⁸. Leibniz's answer, as we already saw, consists in saying that the parts of solid bodies «sont troublés par la separation et s'y opposent»²⁹; in order to explain this resistance he even makes use of an unexpectedly Spinozian-flavoured idea³⁰, stating that bodies are in a continual flux and that the «ruisseaux ou jets [...] font paroître le même corps, tant qu'ils sont semblables»³¹. Far from being at rest, inalterable and individuated by their matter, thus, solid bodies are in a state of perpetual reconstitution. This is exactly what the contemporaries judge unacceptable in the light of empirical evidence, since there is no appearance of movement within hard bodies. In denying that the *motus conspirans* can be seen as a relative rest, moreover, Leibniz has recourse to an absolute notion of movement, which can be founded only on metaphysical considerations of force, whereas the kinematical viewpoint (defended by Huygens as the only possible one) leads to the opposite conclusion.

But there are other difficulties: the first one, as we have seen, concerns the apparent contradiction of the principle of inertia, that is the attribution of perpetuity to a circular movement. Is there here an unconfessed revival of circular inertia? Leibniz's words themselves reveal some ambiguity: he distinguishes for example a «changement spontané»³² from a «changement violent»³³. But the difference does not lie in the kinematical properties of these motions (speed and direction), but rather in the fact the former (the *motus conspirans*) has different *effects* from the latter,

July 2nd 1707, in GM, III, p. 438) suggests that he had not read it, though it is possible that Oldenburg or Huygens had mentioned it to him.

²⁴ Neile's theory is probably influenced by Hobbes's *De corpore*, too.

²⁵ Gottfried W. Leibniz to Nicolaas Hartsoeker, 30 October 1710, in GP, III, p. 504.

²⁶ It is remarkable that Leibniz thinks that collisions only can diminish the force of the *motus conspirans*; see also the letter to Johann Bernoulli of July 2nd 1697, in GM, III, p. 438.

²⁷ «Ce que vous appelez mouvemens conspirans, Monsieur, ne seroit ce pas par hazard la même chose que d'autres appellent repos?» (Nicolaas Hartsoeker to Gottfried W. Leibniz, 30 December 1710, in GP, III, p. 511).

²⁸ This comparison of Leibniz's mechanism of firmness to Descartes's explanation is probably not far from truth: Leibniz himself, in at least one occasion, had proposed the identity between conspiring motions and relative rest (see Gottfried W. Leibniz to Honoré Fabri, 1677, in AK, II-1, p. 452 and the commentary by de Buzon, 2005, pp. 116ff.).

²⁹ Gottfried W. Leibniz to Nicolaas Hartsoeker, 30 October 1710, in GP, III, p. 504.

³⁰ See obviously the so called "little treatise of physics" contained in the Second part of the *Ethica more geometrico demonstrata*.

³¹ Gottfried W. Leibniz to Nicolaas Hartsoeker, 30 October 1710, in GP, III, p. 509 (my italics).

³² Gottfried W. Leibniz to Nicolaas Hartsoeker, 6 February 1711, in GP, III, p. 516.

³³ *Ibidem*.

since it contrasts separation. Such a position is consistent with other aspects of Leibniz's mechanics, which was never totally free from the mistakes of the vortex theory.

A second difficulty is stressed by the passage of *Monadology*, §8 we quoted above:

cependant il faut que les Monades ayent quelques qualités, autrement ce ne seroient pas même des Etres. Et si les substances simples ne differoient point par leur qualités, il n'y auroit point de moyen de s'appercevoir d'aucun changement dans les choses, puisque ce qui est dans le composé ne peut venir que des ingrediens simples, et les Monades étant sans qualités seroient indistinguables l'une de l'autre, puisqu'aussi bien elles ne different point en quantité: et par consequent, le plein étant supposé, chaque lieu ne recevrait tousjours dans le mouvement que l'Equivalent de ce qu'il avoit eu, et un état des choses seroit indiscernable de l'autre³⁴.

Apart from the metaphysical problem, the physical problem of the individuation of bodies in *plenum* is here at stake: how is it possible to explain the change caused by movement if a part of matter is replaced by an identical one? Hartsoeker suggests a possibility, by asking Leibniz whether the conspiring motions are «quelque inclination au mouvement, ou quelque mouvement intrinseque»³⁵. This is exactly the intuition from which in 1670-71 the theory of *motus conspirans* had originated, as a development of Hobbes's *conatus*. Forty years later Leibniz is still convinced that this is the right solution, as shown by his reply to Hartsoeker, where he still employs the term of *tendance*:

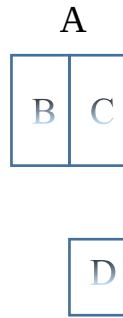
les parties des corps resistant à la separation, non pas parce qu'elles ont peu de tendance à se separer, car en ce cas elles resisteroient encor, si elles estoient en repos absolument, contre ce que je soutiens, mais parce qu'elles ont un mouvement considerable qui doit etre troublé par la separation. Si ces parties tendent à la separation d'elles memes, elles aident celui qui voudroit les separer; mais quand elles n'aident point, il ne s'ensuit point qu'elles s'opposent, et il faut quelque raison positive pour cela³⁶.

The last part of the quotation reaffirms the difference between a simple contiguity, which cannot cause cohesion, and a movement opposed to separation. Leibniz is therefore convinced that his solution is entirely different from Descartes's one and consistent with the mechanical philosophy. If D impacts the part C of a solid body, which is the cause of the *liaison* by which also B moves together with C?

³⁴ Gottfried W. Leibniz, [*Monadologie*], in GP, VI, p. 608.

³⁵ Nicolaas Hartsoeker to Gottfried W. Leibniz, 30 December 1710, in GP, III, p. 511.

³⁶ Gottfried W. Leibniz to Nicolaas Hartsoeker, 6 February 1711, in GP, III, pp. 516-517.



Il faut [...] quelque autre raison icy que le repos, ou la situation de l'un aupres de l'autre, et comme cela doit venir du mecanisme, je ne le saurois trouver que dans un mouvement conspirant, commun à des parties des corps B et C, qui fait passer des parties de l'un dans l'autre par un [*sic*] espece de circulation, et doit etre troublé par la separation des corps³⁷.

Leibniz even thinks of a sort of self-organization caused by the nature of the moving fluids, the result of which is the «mouvemens les plus accommodans»³⁸; nevertheless he cannot prove this hypothesis, which suggests the presence of vaguely teleological elements in his mechanics.

The recourse to *conatus*, in any case, can hardly solve the problem of differentiation in *plenum*, if we consider that it does not alter anything in the way the bodies are made and therefore cannot make them discernible in themselves, as the Leibnizian theory of individuation would require. Leibniz has a metaphysical answer to this problem but we are left with the sensation that his mechanics has come here to a dead end, being unable to explain very common phenomena without a heavy ontological commitment. One might of course conclude with him that a kinematical explanation is unable to understand the deepest level of reality and that one cannot properly make use of imagination: reality can be grasped only by reason, which leads to the existence of a primitive and derivative force, irreducible to simple extension. But this move is paid for very dearly by the German philosopher, with the incomprehension of his mechanics by his most important contemporaries and with a slow but unstoppable exclusion of his works from the body of scientific literature.

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³⁷ *Ibidem*, III, p. 517.

³⁸ *Ibidem*.

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