Michel Serres and the *Rhuthmoi* of the Flow – Part 2

Wednesday 4 December 2019, by Pascal Michon

Sommaire

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Rhuthmic ontology

Having set up the larger scientific frame, Serres introduced Lucretius' ontology. He did not pay attention to the atoms themselves but it is worth noticing that Lucretius described them as endowed with various size, weight, and "shape" *(figura)* which was an accurate translation of the Democritean *rhuthmós*. (*De rerum natura*, 2.748-482)

Serres started from Book 2 where the concept of *clinamen* – declination was introduced as *"depellere paulum, tantum quod momen mutatum dicere possis"* (2.219-220): atoms, in free fall in space, deviated, drove away, from their straight trajectory "a little, just so much that you can call it a change of movement." Their deviation was as small as possible, and the alteration in their movement was as small as description allowed. Serres claimed that this definition of the *clinamen* was exactly what posterior mathematicians in the 17th century called "differential" or "fluxion."

> Anyone who has ever read any Latin texts on mathematics, and more specifically on differential calculus will recognize here two canonic definitions of the potential infinitely small and the actual infinitely small. This is not an anachronism; the relationship of atomism to the first attempts at infinitesimal calculus is well known. From the outset, Democritus seems to have simultaneously produced a mathematical method of exhaustion and the physical hypothesis of indivisibles. We can see here one of the earliest formulations of what will be called a differential. The clinamen is thus a differential, and properly, a fluxion. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 4)

The vortex – *dinê*/*dînos* in Greek – *turbo* in Latin – was, Serres claimed, the primitive form of the "construction of things," of "nature in general," "according to Epicurus and Democritus."

> Now this vortex *[tourbillon]*, *δίνη – dinê* / *δῖνος – dînos*, is none other than the primitive form of the construction of things, of nature in general, according to Epicurus and Democritus. The world

> is first of all this open movement, composed of rotation and translation. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 6, same idea p. 50, 91)

And this idea was to be taken up and elaborated further by posterior atomists, ancient as well as modern.

> For Lucretius, as for us, the universe is a global vortex of local vortices. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 127)

As we saw above, this attribution to Democritus was a questionable claim, but it did not matter here. The question was: how does rotation appear in the laminar cascade constituted by the fall and flow of atoms? Lucretius' stunning answer was: by the *clinamen*, which was the Latin name he gave to the unpredictable swerve of atoms.

> When atoms move straight down through the void by their own weight, they deflect a bit in space at a quite uncertain time and in uncertain places, just enough that you could say that their motion has changed. But if they were not in the habit of swerving, they would all fall straight down through the depths of the void, like drops of rain, and no collision would occur, nor would any blow be produced among the atoms. In that case, nature would never have produced anything. (*De rerum natura*, 2.216-224, trans. Brad Inwood)

Serres underlined the basic ontological assumption that supported this statement. The agglutination of atoms by which natural things came to be—and, I shall add, took their impermanent shape or *rhuthmós*—was the result of a *turbo* which was itself triggered by a *clinamen* in the constant atomic cataract which constituted the metaphysical dynamic background of the world as it appeared to us.

> The clinamen is the smallest imaginable condition for the original formation of turbulence. In the *De finibus*, Cicero wrote that *atomorum turbulenta concursio*. Atoms meet in and by turbulence. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 6)

As many other specialists, Serres noticed that this concept presupposed a critique of straight determinism. Declination appeared in the laminar flow of atoms *"incerto tempore, incertisque locis"* – "at an indefinite time and place," (2. 218-219) i.e. by chance.

> What Lucretius says, however, remains true—that is, faithful to the phenomenon: turbulence appears stochastically in laminar flow. Why? I don't know. How? By chance, with respect to space and time. And, once again, what is the *clinamen*? It is the minimum angle of formation of a vortex, appearing by chance in a laminar flow. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 6)

Then Serres emphasized the difference in Latin between *turbo* – "a round form in movement like a spinning top, a turning cone or vortical spiral," and *turba* – "a large population, confusion and tumult." But from a rhythmic perspective, this difference was clearly reminiscent of an older, now well-known, Greek opposition between something intrinsically mobile but "no longer disorder," which precisely was called *rhuthmós*, and "the mad dancing of Bacchic festivals," that was commonly considered as *arruthmía*.

> The first designates a multitude, a large population, confusion and tumult. It is disorder: the Greek *τύρβη – túrbê*, is also used of the mad dancing in Bacchic festivals. But the second is a round form in movement like a spinning top, a turning cone or vortical spiral. This is no longer disorder, even if the whirl is of wind, of water or of storms. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 28)

The process of generation, duration, and corruption of things was thus entirely determined by the change from *turba* into *turbo* and vice versa, and could be accounted for by what he called "a general theory of turbulence" (p. 81).

> The world in its globality may be modeled by vortices. The origin of things and the beginning of order consist simply in the narrow space between *turba* and *turbo*, an incalculable population tossed by storms, by unrest, in vortical movement. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 28)

The genesis of a thing started stochastically with a *clinamen – deviation* and developed through a *turbo – vortex*. Once a minimal angle or deviation occurred in the atomic fall, the atoms started, by their interactions and the new deviations they provoked in the flow, to organize themselves into a vortex.

> The clinamen is indeed the smallest deviation and the optimal slope. Here is the descent, the *thalweg*, the *creode* [neologistic porte manteau coined by C.H. Waddington meaning "necessary path"]. It is the optimized road to constitution. A track opened trough which the flow is swallowed up, a funnel for atoms towards conjunctive existence. Here is the bed of the river: designed, calculated, set down, as the condition of genesis. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 33, my expl.)

Serres insisted on the fact that this process was "statistically of extreme rarity" and, because it only occurred "by chance," it had been rejected by classical physics, which sought to enforce the concept of universal law.

> Yes, it holds by a miracle. And by a miracle I mean the case statistically of extreme rarity. […] Hence the scandal of declination in the eyes of classical and modern physicists: it interrupts the universality of the laws. It opens the closed system. It places the physical law under the rule of exception. Under the protective roof of its solid angle. And yet, that is the way it is. Lucretius is

> right. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 77)

Each vortex grew more or less rapidly, stabilized, lasted for a certain amount of time, then regressed and faded away.

> The stochastically distributed exception in the cataract, under the differential cones of declination, where the flow inclines, returns in [a waterspout/a rush] *[revient en trombe]*, diversifies, develops locally *[se noue localement]* and constructs an aggregation that is temporarily stable because unstable. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 78, my mod.)

Surprisingly, Serres did not use at first the term *rhuthmós* although it was clearly a process generating *rhuthmoi*, in the pre-Platonic sense. A *turbo* was characteristically an impermanent form. But some pages below, clearly alluding to the pre-Socratic terminology without yet citing his source, I mean Benveniste, he finally proposed the term "rhythm" as the most adequate term to name the basic ontological phenomenon of vortex.

> A word is needed to express the simple elements: a word like *rhème*. When the vortex constitutes it in form, it is called rhythm. […] Everywhere there are models of the most general theory, that of floods and paths, of elementary *rhèmes*, capable of intertwining, here and there, into syrrhèmes, connective rhythms. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 89)

At the end of his essay, Serres claimed as his own the discovery that the pre-Platonic "*rhuthmos*" was actually a "vortex in the flow," a form "adopted by atoms in conjunction in the first *dinos*."

> Direct physical experience, simple practice, reveal the *rhuthmos* in the *rhein*, or the vortex in the flow, or the reversible in the irreversible. Rhythm is a form, yes, it is the form adopted by atoms in conjunction in the first *dinos*. In the beginning is the cataract, the waterfall: here is the reversibility to this irreversibility: thus *rhuthmos*. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 154)

We have already seen that *rhuthmós* was not used, contrary to Serres' claim, by Democritus to designate the first *dînos* nor any other smaller *dînos*, although it was, with great probability, used for atomic compounds, i.e. any generated thing. Therefore, it was no marvel that posterior atomists like maybe Epicurus—of which we have very few texts—and with more likelihood Lucretius have used their own concept of *turbo* at least partly in the pre-Platonic sense of *rhuthmós.*

I should now add that Benveniste, contrary to what Serres bluntly asserted, clearly anticipated this ulterior use. I'll recall here some elements deduced from his analysis.

1. A pre-Platonic *rhuthmós* was not a "Form," an "Idea," an εἶδος – *eîdos*, but a shape "as it presents itself to the eyes" of the observer. Far from being outer-worldly, it belonged to the phenomenal world. 2. It was not fixed, immobile, and eternal; it had a life of its own. 3. It did not "designate the fulfillment of [the] notion [of shape] but the particular modality of its fulfillment." And Benveniste concluded: 4. That was the reason why it was "appropriate for the *pattern* of a fluid element" and commonly denoted an "improvised, temporary, changeable form."

There was not a single word in that four-part description that did not apply to Lucretius' *turbo*. A *turbo* was not an *eîdos* but an observable shape; it was not fixed, immobile and eternal and had a life of its own; since it was constantly moving yet having a certain consistency, it did not designate that peculiar shape as something fulfilled but the particular modality of its fulfillment; last but not least, it was particularly appropriate for the *pattern* of a fluid element.

However, we see that there was a slight difference between the older concept of *rhuthmós* and the one that we may induce from Lucretius' concept of *turbo*, probably the same as between the proto-infinitesimal calculus developed in the 5th century and the more elaborated mathematics of the 3rd up to the 1st century. Whereas the former was an impermanent and changeable form, observed at a certain moment of time, which was very loosely defined and had still a certain duration, the latter was now intrinsically moving and changing. It was a form that was constantly in-forming, per-forming and de-forming itself. Therefore this undetermined moment of observation was now reduced to a minimum, i.e. to the infinitesimal moving time-length or "limit" between two segments of time.

It was as if—to recall Benveniste—the meaning of *rhuthmós* would not any longer be determined by its older uses (as impermanent shape) but only by its morphology (as sheer mode of fulfillment), getting thus closer maybe to the core of the ancient atomist doctrine. Since this moment of suspense was entirely overcome, the last link with the Platonic paradigm was definitively severed. *Rhuthmós* might now be taken as a pure *way of flowing*, a mode of fulfilling a process (generation, existence, decay, disappearance) or an action (dancing, playing music, performing, reading poetry). But this did not mean a break or an unbridgeable gap with the ancient atomist tradition. Lucretius' *turbo* was clearly a direct heir of Democritus' *rhuthmós*.

In other words, Serres was right when he claimed that the Lucretian *turbo* was tightly related to the pre-Platonic *rhuthmós*. It undoubtedly appeared as a refined version of this concept. But he was clearly wrong and even dishonest when he claimed that Benveniste did not anticipate this ulterior use and appropriated his discovery without citing him.

Rhuthmic Individuation Theory

Let us stick though to the positive part of Serres' contribution which allowed to elaborate further the meaning of this conceptual kinship. We will see below, when we deal with Lucretius' theory of knowledge, that in Book 4 Lucretius famously opposed any skeptic stand by deploying a self-refutation argument. Our senses never lied, only our interpretations of their data. To deny that we have access to knowledge through the senses—its only possible entry route—was a philosophical stance that disqualified its own adherents by depriving them of any possible grounds for its assertion (4.469–522).

But Serres' reading of this passage emphasized a different aspect of Lucretius' argument which staged a building built on inaccurate and *deviating* lines that represented reason if "the senses from which it arises are false." Serres summarized verse 4.513 to 4.522 as follows.

> Take a building. To begin with, if the measuring-stick is false and the square inaccurate thanks to a deviation from right angles (in the plural, of course, and not only for the particular case of the verticals), if the level (of a plum-line or water level) is off one way or the other (either by the angle of the line or a deviation of the bubble), then by virtue of this defect and this inclination everything will be built leaning, askew, sloping to the front, pushed backwards, discordant; the building already seems to want to collapse, it collapses, betrayed by errors in the initial judgment. And so it is that reasoning is necessarily false and irregular when the senses *[sens]* from which it arises are false. End of quote. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 44)

According to Serres, apart from his argument against skepticism, this example was chosen by Lucretius to suggest that any human artifact and more generally any natural being are *naturally* "in danger of collapse" the constant and unpredictable swerve of atoms.

> Every concrete Latin term that reproduces the deviation from equilibrium, the angle of asymmetry, or the inclined slope, around the κανών – *canôn*, the canonical, the rule of the Epicurean mason, is here brought together all at once. […] The earth shakes and the house falls. All conjunctive tissue is sapped by the void. Nothing is full but the heart of the atom, that is to say the atom. And only the void is immortal, like particles. Death is this return to particular clouds, the crumbling into dust and for dust. […] So if these buildings, which is to say all of nature, are in danger of collapse, it is simply because they were, at the manifold dawn of times, erected, built, on a deviation of equilibrium. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 44-45)

But the metaphor bore yet another meaning that came to light by contrast with Vitruvius' architectural concept of *eurhythmy* (see Michon, 2018a, chap. 6). As a matter of fact, in the very next line Serres reversed Lucretius' argument to show that, although the *clinamen* was always destroying existing beings, buildings do stand up, living beings do live, things do have shapes, at least for a certain period of time *that depends on the magnitude of the "original declination."*

> Their duration even increases as the angle grows smaller. […] Consequently, the model is compatible with the canon. Nothing crumbles except by pronation and supination, by original deviation. […] The canon, far from suppressing declination, requires it, and requires that it be small and original. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 45)

Everything was born from a vortex but any vortex depended for its ephemeral existence both *on its rotation and an infinitesimal angle that sustains it*. Buildings do stand stiff not because they are symmetrical, well balanced and built according perfect verticals—"eurhythmic" in a Vitruvian sense—but because they integrate tiny angles and are dynamic centers or kinds of cone where myriads of fluxes reach for a time equilibrium.

> Now underground rivers erode the earth, hurricanes tear off the roof. The wall threatens to give way, it leans, it is going to fall. No, the flow, reversed, soon straightens it and pushes it back. By the unevenly starred wind rose, it slowly describes a very small solid angle. […] This small differential cone saves the building from collapse. It marks the bordered, limited space, in which such an aggregation is temporarily removed from the universal legislation. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 75)

To hold on in equilibrium needed a tiny disequilibrium. Any regular or symmetrical figure rested on infinitesimal irregularity or dissymmetry.

> Why does it hold? Simply because it does not hold completely. Every case will be a minimum degree [out of plumb] *[il faut un minimum de faux aplomb]*. There has to be a minimally open solid angle. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 77, my mod.)

According to Serres, atomists, especially Lucretius, did bridge, with this peculiar concept of *equilibrium by disequilibrium*, the divide between Heraclitus and Parmenides, flow and form, without depending for individuation on Plato's solution by "participation to ideal Forms."

> Physics, at this time, seemed to have to chose between the mobility of Heraclitus and the base of Parmenides. At least Plato formulated the problem this way. And resolved it otherwise. The atomists founded, and for all time, the science of things themselves, in the absence of dynamics, by saying *yes* to both sides: everything flows, there is a *canôn*. By a rigorous statics of movement. By a canonics of fluency. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 45)

Infinitesimal declination thus provided the generative concept that allowed to bridge and synthesize rest and movement.

> Declination is a tremendous physical and mechanical discovery. It breaks with the common antithesis of rest and movement, of Parmenides and Heraclitus, much more completely than Plato did. […] Through declination, it is movement that is stable, in the path of its flow, in its general direction and its passage point by point. It is what ensures the most profound and exact invariance, although tradition down to the present day has seen only paradoxes there. For it is the condition of a great synthesis between statics and dynamics. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 129)

But one could add that Lucretius' synthesis was also at odds with Aristotle's "hylomorphic" solution. Whereas Aristotle claimed that any being was the result of the action of a form that allowed, essentially by providing an end, the potential of a certain amount of matter to actualize itself through its in-formation, Lucretius strongly denied the existence of such forms. Forms did appear by themselves through stochastic gatherings of atoms in vortices. (4.823-857)

Serres emphasized that Lucretius' infinitesimal theory of becoming and individuation was much closer to the truth—and to current modern physics—than the gross dialectic of being and non-being that developed in the West up to Hegel.

> Two hundred years of philosophy have accustomed us to different arrangement. It seems clear to us that movement is produced by being and non-being, as though by thesis and antithesis. Now, moving has nothing to do with being or nothingness; the idea reflects a crucial confusion between mechanics and something else. Or rather, it is the admission that everything is projected onto kinematics. Ontology conceals itself behind the theory of movement. This is an outdated thesis: all of physics reduces to mechanics. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 60).

Lucretius' way to insert a principle of movement and change into the being itself did not resort to such massive principle as the Hegelian negation. It consisted only in an infinitesimal angle that deviated the atomistic flow and created the turbulences that we observe in nature and history.

We may even think, since there was for Lucretius no distance between thought and reality, that the logic that supported reasoning as much as nature was itself a turbulent or rhuthmic dialectic in which classical logic based on syllogism and law of excluded middle was not replaced by a Hegelian dialectic articulating, through time, being and non-being, affirmation and negation, truth and error, but a whirling play between matter and void, arguments curling back upon themselves from some tiny original deviation and truth winding around error.

Serres then recapitulated Lucretius' theory of individuation. By clearly specifying the concepts of *clinamen* and *turbo*, he gave a better comprehension of that of *rhuthmós* as well—or maybe I should write now: that of *rhuthmos* because it transferred it into our world. Something quite significant for our rhythmology was introduced here for the first time: the possibility of a physics which would not be based on Plato-style concepts of repetition, periodic movement, oscillation, briefly on metrics, but on fluxes, declinations and vortices, i.e. on *rhuthmoi*.

> Let us return to the cataract. It rains down universally, everywhere and all the time. Declination is the minimum solid angle that introduces a change in the general movement. […] An instant later, turbulence forms a pocket in the three-dimensional flow. A local pocket where the flows, adrift, go back upon themselves. In this place of singularity, these flows change their direction, their force, their volume. And this exchange can be, by chance and temporarily, homeorrhetic. The world as we know it, for example, is such a pocket. […] This pocket, this seed, this island, this turbulence, holds a certain time before disintegration, before being carried away by the cataract, the current of atoms that wear it out and break it. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 76-77)

Rhuthmic Physics and Space-Time Theory

Serres identified in Lucretius' physics two kinds of original chaos, two kinds, so to speak, of *turba*: the "streaming-chaos" and the "cloud-chaos." At first, he argued, the processes ordering these two different kinds seemed comparable; they both resulted from a *dînos* – vortex.

> Lucretius describes two forms of chaos: the streaming-chaos, the laminar flow of elements, a parallel flow in the void, drawn out like fibered space; the cloud-chaos, a disorganized fluctuating, Brownian mass of dissimilarities and oppositions. […] [but] the solution is unchanged, the original figure and movement remain the same, it is the Democritean *dinos*. The vortex is thus the pre-order of things, their nature, in the sense of nativity. Order upon disorder, whatever the disorder may be; the vortex arises by a *fluxion* in the first hypothesis, which is that of chaos-flow, and by *fluctuation* in the second, which is that of fluctuating chaos. There are indeed no stabilities except in a universe in which everything flows, unstable. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 31)

But on second thought, he felt that those two views on chaos eventually led to two very different traditions in physics: a classical tradition ending in positivism; a repressed tradition—which I proposed to call "baroque" by analogy with other sciences and arts in the same period (Michon, 2015a)—which bravely addressed the problems of "chaotic multiplicity" and "order by fluctuation" and anticipated "our problems."

> Yes, the solution is the same; yet, it is not the same, neither for epistemology nor for the history that will follow. The first of these hypotheses opens a classical knowledge, in which disorder is minimized: it is the path which leads from Archimedes to Pascal and Newton, mechanics and hydraulics, and an infinitesimal calculus, the science of fluxions. Here, coherence is preserved between the local and the global. During the course of this history, which goes up to Laplace, and up to a dominant positivism, the second hypothesis is dormant. Today, it is reawakening, out of some of Leibniz' dreams and from the other side of Laplace, where chaotic multiplicity slept. Order by fluctuation has become our problem, and our world has become that in which the local and the global no longer harmonize. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 31)

I won't discuss here this claim because it would need more than a few lines and take us too far from our current argument. But it certainly was an important suggestion that we will have to remember. Let us focus on Lucretius' physics. Serres distinguished three layers in its construction. The first was "local and original" and started with a *clinamen* which triggered a vortex.

> The first model is local and original. It simply simulates the look of a fluid. Atoms cascade in a laminar flow down an infinite channel without banks. The void is a generalized hollow body. Inclination, then, imposes itself, the precursor of turbulence. It is produced, as experience shows, in an aleatory manner, at indefinite times and places. Every nascent object is initially a vortex, as indeed is the world. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 50)

The second was "global" and accounted for the "duration" of the things that had been generated in this way—despite their essential dynamism and impermanence.

> The second model is global. It takes the whole path into account. To the inclination, defined as minimal, there necessarily corresponds a maximal descent. The law of formation, the law of the duration of things and of the world. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 50)

The third, which was a theory of the *"natura naturata,"* i.e. a physics of the world as it is, was proposed by Serres to synthesize the first two, which accounted for the *"natura naturans,"* i.e. for the metaphysical dynamism that makes the world and the things appear, become and disappear (p. 51).

By insisting on this "third model," Serres wanted to show that Lucretius' was quite close to our most recent model of nature as complex and open system of systems. Lucretius did not content himself with the model of the atomic cascade, the *clinamen* and the vortex; he contemplated a much larger and more powerful model of the world as "vortex of vortices, interlacings or networks of waves."

> Let us now construct the third model. Every object, naturally, emerges like Aphrodite from a flux of elements. By the above-mentioned models. Born from this and, as soon as it is born, complex, twined, twisting its long thick hair, it begins to transmit, in floods and in all directions, a star of flow: its wear and its time. It radiates various waves: heat, odors, sounds, simulacra, subtle atoms. In the same way or inversely, it receives the flow emitted around it, from the vicinity and the edges of the open universe alike. […] At birth the singular cascade is transformed: no longer here and there, in and for some local object, but integrally and for its global flow, in a multiplicity of rivers, streaming by all paths, transverse, diagonal, intersected, complex. The summation of the dispersed inclinations in space and time in the cataract produces, in the maximal descent, a complex weave of flows that begin from the unified nappe. The world is a vortex of vortices, interlacings or networks of waves. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 50)

Nature was thus seen as a complex system whose elements never stopped moving and changing. It was, so to speak, fluent but not entirely liquid. It was composed of crisscross intertwined fluxes which generated things and living beings that lasted a certain amount of time before disappearing again. All vortices were in relation with one another. All rhythms were interacting with each other.

> If nature, that is to say an ensemble of linked things, not an incoherent or chaotic ensemble of objects, but a communicating ensemble that functions as outlined, is to exist, *it is absolutely necessary that these vortices [tourbillons] be in relation one to another*. It is necessary that, in a certain manner, they be chained together or lead to each other. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 94)

Since Lucretius used the theory of the four elements and established between them a cycle of transformation, he seemed to support the view of a global equilibrium. Nature seemed thus "an equilibrium in the midst of the fluencies" and a "fluency through equilibrium." *Adsidue quoniam fluere omnia constat – In constant flux do all things stream* (5.280). Contrary to what Barthes believed, the "homeostasis" was balanced by a "homeorrhesis."

> In general, nature seeks an equilibrium in the midst of the fluencies, and seeks fluency through equilibrium. We would say today that there are fluctuations, homeostasis [tendency towards a relatively stable equilibrium between interdependent elements, especially as maintained by physiological processes], then homeorrhesis [steady flow, term introduced in the 1940s by

> Waddington]. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 56, my clarif.)

But this re-use of the four-elements physics cycles should not be over-interpreted. The concept of "system" which was presupposed by Lucretius was actually different from the Stoics' because it did not entail any "hierarchy" or "tight order."

> Invariance is global. Physics describes a system, but not one that is hierarchic, deductive, or tightly ordered *[monté serré]*, as in the series of the Stoics: it is a set *[il est ensembliste* – like in modern mathematics*]*, its general equilibrium a balance sheet that takes account of the stochastic. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 58, my expl.)

It was also different from the most common concept that had been popularized in some disciplines in the 20th century—according to a kind of late Platonic worldview—as closed mechanic system in perfect equilibrium. Here, at least two reasons made perfect equilibrium impossible. There were always new *clinamen* that stochastically introduced disorganization as well as new constructions and orders. Moreover, there was always entropy, loss of energy that provoked change, wear, decay and death. After a certain amount of time, each local vortex as our world's global vortex itself faded away.

> Nature, that is to say birth, that is to say death, is the line inclined by the angle that produces a global vortex, which the wear of time brings back to the straight. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 58)

This was the reason why the circulation of fluxes in nature never occurred as "perfect circles" and rather followed spiral and vortex patterns.

> If these circulations are perfect circles, then the movement finds its equilibrium, the world is immortal, it proceeds to eternity. This is the stroke of genius in atomist physics: there is no circle, there are only vortices. No exact rounding off, no pure circumference, [only] spirals that shift, that erode. The circle winds down in a conical helix. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 58, my clarif.)

This conclusion explained why Serres glimpsed in Lucretius a theory of time that was clearly at odds with Plato's. In the *Timaeus*, the latter considered time as "an image of Eternity moving according to number" and with Aristotle who, in his *Physics*, defined time as "number of motion in respect of 'before' and 'after'." Given the crucial role played by the *turbo* in Lucretius' ontology and physics, time itself might be defined, Serres suggested, as "the fluctuation of turbulences."

> Turbulence is the functional figure of constitution and formation, everything happens as if it integrated declination. This is the *dinê* of Democritus. It then becomes the global figure of

> transformation in general, as the *clinamen* was its minimal or local operator. Things, and so nature, are formed by atomic conjunction in and through this very vortex; but, what is more, they exist and continue in and through it; finally, they destroy themselves, come apart, as if it were dwindling to nothing. Time is the fluctuation of turbulences, which make time, maintain it in their implications, set it going and finally allow it to disappear. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 91)

One basic assumption of the Platonic/Aristotelian paradigm, which tended to equate rhythm with meter (in the sense of measure and number), was then replaced by a much more supple conception of time. The latter was not any more considered as a completely regular and numbered course reflecting eternity or only measuring movement, but already as a turbulent flow providing accelerations, decelerations and returns, generations, stabilizations, mutations and disappearances. Time was "implicated" in the various ways of flowing, the *rhuthmoi*. It was itself *rhuthmic*.

Another feature of the Lucretian theory of time—as the most recent theories, as a matter of fact—was that the latter was "irreversible," whereas modern Newtonian time was, at least theoretically, "reversible."

> Newtonian time, reversible, is the mark of resistance to the irrevocable. It is absent from this physics, and this is why our forefathers could not imagine for a single moment that there might exist a Lucretian physics. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 125)

According to Serres, who was aware of contemporary research on "irreversibility"—Ilya Prigogine won the Nobel Prize in 1977, the very same year *The Birth of Physics* was published—Lucretian time was thus closer to a "Bergsonian thermodynamic time."

> Pardon me, but the clock that Lucretius sets right in the middle of nature cannot tell Newtonian time; because it [*elle* – the clock] is the whole of things, between their birth and their collapse, it records a Begsonian, that is to say a thermodynamic, time. An irreversible, irrevocable time, pointing like the endless flow of atoms, flowing, rushing, crashing towards fall and death. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 125)

Parallel to this new conception of time, Lucretius developed, Serres argued, a new conception of space whose originality we better understand if we compare it with that common in 17th century science. Classical physics simplistically opposed, Serres remarked, "space" as an abstract and empty room and "figures" as limited and "metred and masterable" entities furnishing this empty and neutral space. Lucretius' physics instead considered form as "simplex" and space as "rich in complexities." In other words, exactly as time, space was not homogeneous nor uniformly measurable. Space was not metric. It was also clearly *rhuthmic*.

> Form, here, is a simplex; space is rich in complexities, it is divided, it bifurcates, it is filled with knots and confluences, it is the conjunctive web of the topology and of the *ars combinatoria*, it is

> the tattered strips of the *ars coniectandi*, of the event, of circumstance. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 51)

The metrical space, exactly as the Platonic rhythm when it was applied to space—for instance in Vitruvius—depended on an "algebra of proportions." From Euclid to Descartes, this was the same concept of space. Euclidean geometry was consistent with metrics and opposed to *rhuthmics*.

> The Cartesian figure refers back to Euclid's geometry, it is a metrics, dominated by algebra of proportions. [Measurable, mastered] *[métrisable, maîtrisée]*. The master and possessor of nature metricates his space. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 51, my mod.)

Even if it still lacked the concept of force and any consistent dynamics, the ancient atomist physics thus suggested a combine *rhuthmic* conception of time and space—what Serres prudently called a "vectorial space"—which anticipated them both by more than two thousand years.

> Atomist physics is based much more upon a vectorial space than on a metric space. (*The Birth of Physics*, 1977, trans. Jack Hawkes, 2000, p. 62)

As far as we are concerned, thanks to Serres' analysis, Lucretius' physics appeared clearly as an expression of a rhythmological or better yet, *rhuthmological* perspective and, at the same time, it enriched it with new concepts such as intertwined fluxes, interacting *rhuthmoi* and open systems as well as new fluent concepts of time and space.

Next chapter