Lucretius' arguments on the swerve and free-action

Abstract:

In his version of atomism, Lucretius made explicit reference to the concept of an intrinsic declination of the atom, the atomic swerve (*clinamen* in Latin), stressing that the time and space of the infinitesimal atomic vibration is uncertain. The topic of this article is the Epicurean and Lucretian arguments in favour of the swerve. Our exposition of the Lucretian model of the atomic clinamen will present and elucidate the respective considerations on the alleged role of the swerve in the generation of free-action.

1. Fall and *clinamen*

The Greek alchemists distinguished two models of material analysis: either the traditional method of the research for the four basic elements, respectively earth, water, fire and air; or the competing model that suggested that all material substances consist of atoms. The advantage of the atomist model was that it explained the phenomena that we classify under the general term of secondary qualities, for instance, color, taste, smell and sound, which were still not measurable as the primary qualities, namely, solidity, extension, motion, number and figure. Color, according to Democritus, was the effect of the turning and inclination of the shapes of the atoms. This declination of the atomic shape obtained more significance with Epicurus and Lucretius.

Philodemus, Cicero, Lucretius, Plutarch, Aetius, Diogenes of Oenoanda, Galen, Plotinus and Augustine, conveyed that Epicurus introduced the model of the atomic *clinamen* (*παρέγκλισις*), as an impulsive indeterminacy in the motion of the undividable atom. This atomic swerve should be regarded as an internalization of the universal atomic motion in every single solid and indestructible atom, causing collisions and joining compounds and bodies. With the form of the smallest rare particles of the mind, the atomic swerve is also responsible for the generation of volition.

Epicurean atomism was sorely conjoined with an ethical training that placed freedom and spontaneity at the center of human morality, as Farrington (1965) noted. The natural principle of the atomic declination (swerve) was considered as a prerequisite of free action. Therefore, the swerve of the atoms that constitute the minds and bodies of the agents was taken as the cause of agents' volitions, whereas alternative interpretations either insisted to a temporal only relationship between volition and swerve, or dismissed any kind of significant relationship (Purinton, 1999).

The official proponent of the atomic swerve model is Lucretius, while Epicurus is related to the doctrine only through secondary resources, such as Cicero and Plutarch. Lucretius, however, regarded Epicurus as his respectable master and proclaimed that he followed his teachings. Given this claim of Lucretius, the Epicurean proposition on the atomic swerve could be taken as the mature outcome of reflection on the natural knowledge of the atoms and the void, while in the extant writings of Epicurus we find only implicit reference to the atomic swerve:

> *The atoms move continuously forever, and some separate far from each other, while others remain vibrating, whenever they happen to be locked in by interweaving or encased by atoms that tend to interweave.*
> *This is because the nature of the void separates each of them and is unable to provide resistance, and their actual solidity makes the rebound from the collision*

extend as far as the surrounding entanglement allows the return from the collision. There is no beginning to these (rebounds), since the atoms and the void are eternal (Epicurus, *LH*, 43-44).

The dynamic interplay between the void and the atoms might have always been a hidden premise of atomism. From the early stages of atomic theory, Leucippus had made clear that the building of the worlds is the result of the entanglement of sinking bodies in empty space, while the light of the sun and the stars is caused by their velocity (Diogenes Laertius, 1921b). Aware of substantial regularities in nature, the philosophers Anaxagoras, Empedocles and the Atomists proposed the conservation of matter, as one of their principles of natural knowledge. They also discovered one of the boldest and most interesting riddles in the history and philosophy of science, namely, the hypothesis of the void. According to Melissus, void would equal to nothing, therefore, it does not exist. On the other side, the Atomists Leucippus, Democritus and Epicurus accepted the existence of the void between atoms (Furley, 1987). Void, according to Leucippus and Democritus, can neither touch nor be touched.[1] The endless fall of the atoms into infinite void and the different weights of the atoms cooperate to the production of collisions and vortices that give birth to new worlds.

The objection raised by Aristotle was that in a vacuum all bodies must fall with equal velocity. In such a case, not only collisions but also motion in itself would be impossible, since motion is primarily the effect of the impulse and the shape of a body.[2] Epicurus answered to this problem by postulating a swerve of atoms (*παρέγκλισις*) that causes sideway motion and lateral collisions rather than vertical ones. Furthermore, Lucretius used the thought experiment of fall into the void with equal speed as a proof for the existence of the Epicurean swerve (*DRN*, 2.216-250). A different opinion had been expressed by Aetius[3] and Cicero,[4] who suggested that Democritus ascribed only size and shape to the atoms, whereas Epicurus added weight in order to explain atomic motion. While Democritus explained motion exclusively as the outcome of collision (*παλμόν*), Epicurus introduced two additional motions, one on account of the weight and one of the swerves, as Aetius (I, 23, 4) believed. Cicero also maintained that Democritus would never use the terms "top" and "bottom" to describe the movement of the atoms in the void. Aristotle, however, in the fourth book of *De Caelo,* claimed that if atomic weight were determined by the amount of solid or the scarcity of void, then the atoms should move downward. If atomic weight were determined by the amount of void or the scarcity of solid, then they should move upwards (*De Caelo*, IV 2, 309a33–b4). With that argumentation, Aristotle wanted to criticize the indifference of the single-edged atomic principle for diversification of natural movement to more than one direction, which would permit elements to be either absolutely light, as fire, or absolutely heavy, as earth, or relatively light, as air, or relatively heavy, as water. Contrary to the atomists, Aristotle supposed that "fire in any quantity will be lighter than earth in any quantity, while equally any quantity of air, no matter how large, will move downwards more slowly than any quantity of water, no matter how small" (O'Brien, 1981: p. 28). The Epicurean and Lucretian version of atomism needed, therefore, to consider Aristotle's critique.

[1] On the contrary, Aristotle considered that void does not exist, while the first principle can touch but cannot be touched.
[2] *Phys.* IV, 8, 216a12-21; Letting & Urmson, 2014: p. 204
[3] I, 3, 18; I, 12, 5-7 (Diels, 1879; Kirk & Raven, 1957)
[4] *De fato*, 20, 46; *De finibus*, I, 6, 17

1.1. Lucretius' arguments on the spontaneous atomic swerve

In the second book of *De rerum natura*, Lucretius developed two arguments in favour of the atomic swerve,[5] a natural force that justifies collisions, the formation of macroscopic bodies, and the initiation of free-action. The first argument is a cosmological one: if the swerve did not exist, the atoms, "as their own weight bears them down,"[6] would plumb "like drops of rain, through the deep void" (*DRN*, 2.216-224). The swerve evokes a slight declination from the background gravitational condition of nature, changing the atomic movements and allowing to produce the collisions and blows of the primal elements of nature. The most general form of the cosmological argument is a modus tollens from the observable (*ἐναργές*) to the unobservable (*ἄδηλον*) that begins with the premise: "If the atoms did not swerve, there would be no collisions and no macroscopic bodies" (O'Keefe, 1996, p. 307).

The second argument is a causal one: the motion of the swerve can sunder the covenants of fate and, "besides all blows and weight," may urge creatures to follow the desires of mind and free-will (*DRN*, 2.251-293). As nothing can arise from nothing, according to Epicureans, the spontaneous nature of free-action provides evidence for the existence of the swerving motion. This *clinamen* is a "change of direction in the movement of an atom," according to Deleuze (1994: p. 184). The swerve of the atoms occurs at uncertain times and places; otherwise Nature would never have created anything, as Lucretius suggested (*DRN*, 2.216-293). The swerve is a small (*paulum*) deviation, just to the extent as to call it merely a change of trend.[7] The atomic deviation is invisible and infinitesimal, it cannot extend the limits of *ἐλάχιστον*, since oblique motion is, in principle, incompatible with gravity. As Serres (2000) observes, the Lucretian clinamen is, potentially and actually, infinitely small, a differential, a fluxion, "not more than the least possible" (*DRN*, 2.244).

Lucretius agreed with Democritus and Epicurus that the sporadic disturbance of the gravitational atomic cascade appears as a turbulence and vortex. The argumentation of Lucretius originates entirely from Epicurus, as Farrell (2007) remarks, while the critiques focus mainly: a) on the supposed linkage between atomic swerve and human free-will, and b) the Lucretian interpretation of the cosmological argument that the swerve provides a start for atomic collisions. Nevertheless, Epicurus, in his *Letter to Herodotus* (43-44), stated clearly that the atomic motion is everlasting. The alleged start of the collisions, therefore, may only refer to each one of the infinitely many worlds, everytime a world emerges to reality.

In the following chapters we analyze the conceptual problems of the swerve and free-action. The research focuses on the significance of the swerve and free-action in the atomist philosophy of Lucretius - do they belong to the main principles at all? Further on, we examine the argumentation that connects the atomist principles with the swerve and free-action, the relationships between the notions of swerve, spontaneity, and chance, and the significance of the swerve for sign inference. The central research question inquires the compatibility of the swerve with moral responsibility.

We advance the research on this Lucretian thematic with a discussion and analysis of the given definitions and interpretations of the "swerve" or "*clinamen*" in relation to "free-action," and their basic origins and influences, such as from Epicurus. We present the arguments and criticize their positioning in the general framework of the atomic concepts, the different attempts to judge them, and the probable solutions to problems that appeared, such as the limited divisibility and finite analysis of matter, the rejection of both material and structural continuum (Sedley, 1999), and the method of exhaustion, which motivated the discovery of the atomic theory. The Lucretian *clinamen*, as an inclination and free will of the atomic swerving

[5] Latin: "clinamen," "declinare," "depellere," "inclinare"
[6] Both Epicurus and Lucretius explain that the term "down" is only relative, as the universe has infinite size.
[7] *tantum quod momen mutatum dicere possis*; *DRN*, 2.219-20

(Johnson, 2017), constitutes a thought-provoking question for philosophical research. Below, I will present primary and secondary references on this outstanding Epicurean topic, making also the respective critical examination clearer and more distinct.

1.2. The questions of atomic movement and causation

The concept of the atomic swerve may have its origin in the property of the turning of the atomic shapes, which was introduced by Democritus. The whirling movement of the atoms had been identified by Democritus as necessity, as Diogenes Laertius conveyed. In his work *On Mind,* Leucippus contended that: "Nothing occurs at random, but everything for a reason and by necessity."[8] Leucippus and Democritus treated the atom and the void as the material causes of things. The rareness and the density of the underlying substance corresponds, according to the first Atomists, to the cause of all other qualities.

Thus, the elementary differences are three; shape, order, and position. "For they say the real is differentiated only by 'rhythm' and 'inter-contact' and 'turning'; and of these, rhythm is shape, intercontact is order, and turning is position; for A differs from N in shape, AN from NA in order, M from W in position," as Aristotle (*Meta*. 1, 4) suggested. Hence, the perceived colors of the objects, according to Democritus, are only appearances that result from the turning of the shapes of atoms (*GC* 1, 2). It is no coincidence, I think, that Hugh Tredennick gave another translation of the aforementioned passage of Aristotle (1933): "These differences they say are three: shape, arrangement, and position; because they hold that what is differs only in *contour, intercontact,* and *inclination.*" Turning, therefore, is nothing else but inclination, synonymous to the Lucretian atomic swerve.

However, Aristotle criticized the first Atomists, because they casually neglected the question of movement, as all other earlier thinkers. Epicurus agreed with his precursors "that the atoms possess none of the properties of phenomenal objects except shape, weight, and size, and whatever necessarily goes along with shape" (Epicurus, *LH,* 54). He also insisted on causal explanations and terms that are actually in use in modern quantum mechanics theory, for instance, the terms "collision," "rebound," "entanglement," "vibration," and "interweaving." The subject matter of atomic motion was analyzed by Lucretius in the verses 62-332 of the second book of *De rerum natura.* The swerve of atoms is the beginning of a new movement at no determinate time and place (*DRN*, 2.218–19), contravening any sequence of antecedent causes (2.251–5). At a first stage, the whole idea of the atomic swerve doctrine, according to Epicurus and Lucretius, presupposes a background of a vertical gravitational motion inherent to every atom, while any other kind of motion, aside from gravity, is conceived as an infinitesimal swerve at directions other than the gravitational. This diversification of motion diminishes the likelihood of deterministic effects.

The refutation of determinism is the most significant consequence of the introduction of the doctrine of the atomic swerve, as Sedley (1983) remarked. Comparing the remnants of a part (probably XXXV) of the Epicurean work *On nature,* found at Herculaneum, and the passage 4.469-521 from *De rerum natura,* Sedley pointed out that Epicurus did not believe that the seeds of human character have a deterministic impact on our future development. We ourselves are responsible for our behaviour, by issuing praise and blame in everyday social action. Instead of wild animals, moral agents are not predetermined by any kind of congenital disposition, or the constraints of the environment.

The argument of both Epicurus and Lucretius is based on the self-refutation of the opponents, either sceptics or determinists, who stand upside-down back-to-front, turning a

[8] Aetius, I, 25, 4 (Diels, 1879; Kirk & Raven, 1957)

somersault. The defence of scepticism presupposes knowledge; the defence of determinism presupposes undetermined agents; therefore, both pertain to self-refuting commitments, while the preconception is taken as criterion: "What created the preconception of true and false?" asks Lucretius (4.473-7), allowing thus for a cognitive faculty of the swerving bodies. Similarly, Epicurus shows that the determinist cannot prove the falsity of our preconception of human agency. For these reasons, the impulse and the auxiliary element in us is considered by Epicurus as the cause within us, which is denied by determinists.

None the less, the swerve of the atoms was criticized by the opponents of the Epicureans as an "uncaused motion." The leader of the platonic Academy Carneades had tried to escape determinism and simultaneously refute the validity of the Epicurean theory of the swerve. Carneades thought that the Epicurean swerve did not offer any satisfying solution to the problem of free action, since randomness is not the form of human freedom, as Hankinson (1999b) remarks.

A long-winded argumentation against the atomic swerve doctrine had been developed by the Stoics and Cicero, as well. If every Stoic proposition (*axioma*) were either true or false, then everything would take place by preceding causes and uncaused motion could not exist. But the Epicureans rejected the validity of causal determinism and fate, by preferring to give up bivalence, that is to say, rejecting the requirement for truth-falsity of propositions regarding the future, because the opposite opinion that everything is caused by fate would be intolerable. It would be, however, ignorance of logical method, as Cicero (*De fato,* 21; 37) conveys, to agree with Epicurus that not every proposition is either true or false. Accordingly, Cicero rejected the views of Epicurus on the swerve:

> *But Epicurus thinks that the necessity of fate is avoided by the swerve of an atom; and so, in addition to gravity and impact there arises a third form of motion, when the atom swerves sideways a minimal space (termed by Epicurus* elachiston*). Also, he is compelled to profess in reality, if not quite explicitly, that this swerve takes place without cause* (Cicero, *De fato,* 22).

Taking the argumentation of Carneades seriously, Cicero complained that he could not accept an uncaused motion, as the swerve of the atoms. Cicero did not agree that universal motion, the solidity of the atoms, and the lack of resistance from the vacuum, were sufficient explanations of the generation of the atomic swerve. He suggested that Epicurus introduced this theory because of his fear lest, if the atom was always carried along by its natural and necessary gravity, no freedom would be left for us, since the mind will move under compulsion from the atoms (Cicero, *De fato,* 23). In the first book of *De finibus,* Cicero blamed the model of the atomic swerve, with the following words:

> *he [Epicurus] said that the atom makes a very tiny swerve, - the smallest divergence possible; and so are produced entanglements and combinations and cohesions of atoms with atoms, which result in the creation of the world and all its parts, and of all that in them is. Now not only is the whole of this affair a piece of childish fancy, but it does not even achieve the result that its author desires. The swerving is itself an arbitrary fiction; for Epicurus says the atoms swerve without a cause, - yet this is the capital offense in a natural philosopher, to speak of something taking place uncaused* (Cicero, *De finibus,* 1.19).

Pointing out to counter arguments in favor of divine providence, Cicero stated that the cohesion of the atoms and the beauty of the world could not be explained by the riotous hurly-burly of the alleged atomic swerve. Furthermore, Cicero believed that the infinite divisibility of matter was an indispensable natural principle (op. cit.). He also contended that the swerve was only a device to escape from determinism and save freedom of will (*De natura Deorum,* 1.69). Cicero regarded Carneades' theory of causation as much more successful, since it allowed for a special voluntary power of the mind rather than the arbitrariness of the atoms. Since there is still

something in our own power, it is not the case that whatever happens, happens through fate (Cicero, *De fato*, 31).

In general, universal causation, fate, and determinism have strong linkages with each other, although they are not identical. Responsibility is still conceivable in the frames of universal causation, but its meaning becomes more restricted with determinism and vanishes with fatalism. The related deterministic conundrums obtain their severest expression in the case of the likelihood of future contingents. Carneades and Chrysippus did not accept necessitation for future events, with the exception of the ones that may be caused and thus fated. Democritus yet preferred, according to Cicero's opinion, to explain the natural movements in a deterministic manner. Democritus, Heraclitus, Empedocles and Aristotle were all fatalists, as Cicero (*De fato,* 29) believed. The atomic swerve doctrine, on the contrary, would propose a libertarian resolution to the problem of future contingents, permitting uncertain timing and placing of the atomic movements.

1.3. *Elachiston*, variation and the adventitious

The discussion of the paradoxes of the continuum and the related method of exhaustion played a significant role to the introduction of the atomic swerve doctrine. Through successive attempts to approximate the magnitude of observed phenomena, ancient science discovered the concepts of the minimum (*ἐλάχιστον*) and the limit. The development of the concept of the limit was an Epicurean contribution, according to Lucretius. The "lively intellect" of Epicurus prevailed, as he brought "report of what can be and what cannot, and in what manner each thing has a power that's limited, and deep-set boundary mark" (*DRN*, 1.75-77) and "with words of truth he purged men's hearts and set a limit to desire and fear" (*DRN*, 6.24-5). Hence, the philosophical conception of the indestructible atoms revealed, as a principle, what is possible and what is impossible, "how everything has finite power and deep-set boundary mark" (op. cit. 1.594-6; 5.88-90; 6.65-7). The Lucretian concept of the limit is applied both to ethics and physical philosophy:

> *Again, since a limit has been set*
> *For the growth of things and for their hold on life,*
> *Each after its kind, and since it stands decreed*
> *What each by nature can do and cannot,*
> *And nothing changes, but all things are constant…*
> *They must for sure consist of changeless matter.*
> *For if the primal atoms could suffer change,*
> *Under some strange compulsion, then no more*
> *Would certainty exist of what can be*
> *And what cannot, in a word how everything*
> *Has finite power and deep-set boundary mark*
> (*DRN*, 1.584-595).

Limit, therefore, complies with the principle of the conservation of matter, the indestructibility of atoms, and the possibility to obtain scientific certainty. The necessity for a limit (*finis*) is a substantial argument for Lucretius, since he blames his opponents, like Anaxagoras, that "they acknowledge no limit at all to the splitting of things, nor respite to their breaking, nor any least of things, the primal atoms" (*DRN*, 1.746-8; 1.844).

The differentiation of the shapes of the bodies is the result of the addition of minimal parts, for example, from the top to the bottom and from the left to the right, as Lucretius (*DRN*, 2.488) remarks. Limit's counterpart is *variation*, corresponding to the concept *παραλλαγὴ*

according to Epicurus[9] and Philodemus,[10] and the term *ποικίλος* according to Philodemus (*De signis*, 20; 25-26). This ubiquitous phenomenon of variation, the perceived instability of things and events that are found enclosed by the boundaries, can undermine traditional philosophical endeavours to transcendence and put questions on the validity of inductive inference. However, it does not sacrifice necessity to arbitrary chance. The fundamental reality of the atomic swerve is a blending of instances of free-action, encounter, alteration and counterfactual interconnection with determinate causality and deep-set regularity. Lucretius, that is, connected the introduction of the infinitesimal swerve with the impossibility of oblique vertical motion, insisting on the contribution of the *adventitious*, as the swerve was called by Plutarch (*Stoic self-contradictions, Moralia,* 1045 ff.), rather than a literal interpretation of the atomic inclination:

> *that the atoms must swerve slightly, but only to an infinitesimal degree, or we shall give the impression that we are imagining oblique movements - a hypothesis that would be contradicted by the facts. For it is a plain and manifest matter of observation that objects with weight, left to themselves, cannot travel an oblique course when they plunge from above - at least not perceptibly* (*DRN*, 2.243-9).

The *adventitious* variation of the atom, namely, the swerve, has a limit. As we see, Lucretius stated that "atoms must swerve slightly, just the very least - no more" (*DRN*, 2.244). On account of the infinitesimal size of the swerve of the atom, Sedley (1976) supposed that Epicureans developed an alternative Geometry based on the concept of the "*elachiston*" (*minimum*), which was absent from the Euclidean Geometry. The term *minimum* (*elachiston*) was related with the concept of limit as *finita potestas,* a unifying principle that confines the variety of atoms, their size, the behaviour of atomic compounds and the possible atomic combinations, the possible shapes and magnitudes of a cosmos, as De Lacy (1969) observed. The concept of the limit (*peras*) is introduced by Epicurus in relation to the circumference and the boundary of a world; it points out the limitedness of the shape, location, and duration of a world and its material components. In his *Letter to Pythocles* (88–9), Epicurus defines a world as "a particular encompassment of a heaven, encompassing astronomical bodies and earth and all the phenomena. It is cut off from the infinite, and terminates in a limit." The universe as a whole, however, it is impossible to have such an extremity (*extremo*), because, in that case, it would need something outside of it, some clear point beyond to limit it (*DRN*, 1.960). In the Lucretian poem the corresponding notions "limit" (*finis; finiat*) and "boundary-mark" (*terminus haerens*) denote the regularity of nature. They are conceived in an abstract manner that does not forbid the infinity of the atoms and the infinite universe, as logical exception and absolute variation.

The terms *variety, variable, variation, vary,* are used by Lucretius in *De rerum natura* for the signification of differences of the names of primal things, of their habits, of the shapes of the body, of the power of substances to support life, which varies from one animal to the other, in every kind of herbage and every river, differentiated in the various shapes of the seeds, which may be mixed in many ways, through varying paths and intervals, as atoms blow through infinite time, massed by their own weights, combined in every way, trying every variation. Nevertheless, the variety of the shapes of the atoms cannot be very large, there must be a finite number of shapes, because of the small size of the atom. From a general point of view, natural diversity, as Deleuze (2017) observes, appears in *De Rerum Natura* mainly in three different macroscopic levels: as specificity of the natural species, as individuality of the members of the species, and as heterogeneity of the parts that compose an individual. Furthermore, the imperceptible deviation of the swerve introduces the radically new philosophical conception

[9] *LH*, 55; 63; *Letter to Pythocles*, 95; 98; 113
[10] *De signis*, 6.12; 17.26; 19.20; 21; 23-24; 34.31; 35; 36.17-21; 38.5

that "everything is an encounter." The atomic swerve as an encounter is considered as able to give rise to the creation of the world, as Althusser (2015) states.

In modern atomism, the sudden, unpredictable, uncaused atomic swerve has been assimilated to the concept of quantum. "'Quantum' is more than mere metaphor here; the evidence suggests that the swerve involves the minimal possible divergence from the atom's previous trajectory," as Hankinson (1999b) supports. Nevertheless, Aristotle, in *Physics* VI 10, had already mentioned that the motion of a part-less entity could necessarily "imply that time consists of partless instants and motion of extraordinary discrete jerks" (Bicknell, 1990: p. 246). In order to avoid this quantization, Aristotle proposed that something part-less could only have moved incidentally to the motion of a larger body. Epicurus firstly followed Aristotle on this interpretation, but later changed his mind and the Epicureans accepted the staccato motion of part-less entities, according to commentaries of Simplicius (*On Aristotle's Physics*, 934, 23-30: "the Epicureans… say that magnitude, motion and time are [all] made of partless things, and that a moving thing does move over the whole magnitude that is constructed of partless things, but does not move along each of the partless things"), Themistius (*On Aristotle's Physics*, 184, 9-28), and Sextus Empiricus (*Adv. Math.* X 142).

2. Lucretian universe and the swerve: a closer look to the text

The quest for the ultimate constituents of matter focused not only on the concept of atom, but also on the concepts of the seed and the *minimum*. The atoms are invisible *primordia rerum*, which are alternatively described by Lucretius as *semina, genitalia corpora,* and *materies*.[11] Lucretius rejected Anaxagoras' view of the seed (theory of *homoeomeria*), proposing instead that change is caused, when seeds common in many things are mingled together in many ways (*DRN*, 1.895). The unpredictable element and the extent of the improvisation of the inanimate atomic *concilium* build up and cultivate multifarious material situations. Therefore, living matter, soul and mind, all belong with the more general category of atomic matter.

The slight swerving of the atoms provokes clashes, rebounds and new trajectories that produce atomic complexes. The significance of the doctrine of the swerve is that not only living creatures and atomic compounds, but every individual atom is unique. The Lucretian description of the swerve as a force that amends gravity, is vindicated by the overriding conceptions of a) an infinite universe that is boundless and has no centre, and b) infinite matter. The completely solid indestructible particles of matter fly about through all eternity, having no limit to their number, wavering in a vacuum that stretches far and wide into immeasurable depths and it is not bounded in any direction.

There is nothing outside the universe, there is no limit and no end or measure of the infinite. The eternal, uninterrupted motion of the atoms is caused exactly by the limitlessness of the universe, because the atoms cannot find rest in it. If the universe was somehow confined and shut in, then all matter would have accumulated at the bottom and all movement would cease. However, the universe is an unfathomable abyss of space, where vacuum is bounded by body, and body by vacuum. Matter is also necessarily infinite, because space is. Accordingly, as Lucretius underlined, the conduct of the atoms is not the result of an act of intelligence or stipulation (*DRN*, 1.921-1051). In the same way, Epicurus thought that the universe is boundless both in the number of the bodies and in the extent of the void (*LH,* 42) and there are infinite worlds (op. cit. 45). Moreover, there can be no center in the infinity. Even if there was a center in the unlimited universe, nothing could stand fast there rather than flee from it. The

[11] Some instances of this terminology are "semina rerum" (*DRN* 1.59), "corpora prima" (1.61), "corporibus caecis" (1.328), "primordia rerum" (1.268), "minimis partibus" (1.610).

yearning for a center would be an exclusive property of moisture and earthly matter, according to the followers of Aristotle, while air and fire would find getaways to stream out, away from the center. None the less, Lucretius thought that such an imbalance between different materials would finally lead to total perdition (*DRN*, 1.1052-1113).

After assuming the significance of the infiniteness of universe and matter, for the perpetual movement of the atoms, Lucretius propounds, in the beginning of the second book, six postulates of the atomic movement: a) The world is not a plenum, the void exists, since matter diminishes and grows endlessly, yet as a sum it is conserved (*DRN*, 2.67-79). The atoms are perpetually on the move in the infinite void, either falling or rebounding, or vibrating, when they form compound bodies; those which rebound at small intervals make up stone, iron, while those which rebound at larger intervals make up air and sunlight, being the worthy vehicle of the transmission of heat (*DRN*, 2.80-141); b) Solitary solid atoms can move faster than light (op. cit. 142-166); c) There is no divine providence (2.167-183); the atoms normally slope downwards through undisturbed vacuum at equal speed; nothing can move upwards of its own force (2.184-215); d) Sometimes they swerve slightly from the vertical course at no determinate time or place, this is the *clinamen.* Without swerve there would be no collisions and macroscopic bodies (2.216-250) and no free will, as *fatis avulsa voluntas* (2.251-293); e) The atomic congestion, the density of the universe was always so big as it is now - there is conservation of the sum of matter and motion, the atomic motion has always been the same (2.294-307); f) Phenomenal immobility of matter is an optical illusion (2.308-332).

In the next verses, Lucretius puts forward six other propositions about the varieties in the size and shape of atoms and their compounds (op. cit. 2.333-1022). The atoms themselves are devoid of color (2.730-841), heat, sound, savor, and odor (2.842-864), and sentience (2.865-990). It is not, therefore, the blackness of the atoms that renders some bodies black; nor laughing atoms make humans laugh. Lucretius uses the metaphor of the poetic verses to explain how the combinations of atoms provoke temporary phenomenal manifestations (op. cit. 1.1013-14). Since the specific seeds that constitute the bodies are not identical, they must differ in their intervals, paths, attachments, weights, impacts, clashes and motions, as Lucretius contends. However, the primitive atoms of matter are essentially indestructible, hard and insentient. Nature is self-regulating, without interference from the gods (*DRN*, 2.1090-1104) and the world was created by a conflux of atoms swept along in various ways through infinite time by mutual clashes and combinations (op. cit. 5.416-508).

3. Counterarguments and alternative views

Notwithstanding the scorn of the Lucretian *ex contrario* argumentation, the model of the atomic swerve met often with disagreements. One of the obstacles to understand the theory of the atomic swerve, according to Englert (1981; 1987), is that Lucretius conjectured that the swerve explains the existence of *libera voluntas* (*DRN*, 2.216-293). Whether it would be the cause of voluntas, an instrument of it, before or after voluntas, or a prerequisite of its generation, it varies at several interpretations. Englert compared two different explanations of the connection between swerve and *libera voluntas*: a) Following the view of the nineteenth century intellectual Carlo Giussani (1896), Cyril Bailey stated that: “The fortuitous indeterminate movement of the individual atoms in the void is in the conscious complex (*concilium*) of the mind transformed into an act of deliberate will” (Bailey, 1928: p. 320). The element of spontaneity enables the meeting of atoms in their downward motion, preserves the occurrence of chance in inorganic matter, the emergence of consciousness “in the sensitive aggregate of the atoms of the mind” and of free choice in human conduct (Bailey, 1947: pp. 17-18). The swerve, even so, is not the instrument of free choice but only its precondition, as De Lacy

(1969) commends. b) A competing interpretation expressed Furley (1967): the swerve plays no direct role in voluntary action. The effect of the swerve in human soul's pattern of atoms is nothing more than a slight declination from the rigid determination due to birth. More precisely, Furley believed that the swerve was not introduced to preserve free or deliberate choice, but only as a random alteration of character. Lucretius respectively offers examples of heredity to support his views (*DRN*, 4.1209-32).

Englert dismissed both of these interpretations, because they do not explain how exactly the swerve relates to voluntary action, deliberate choice, and free choice. He insisted that the notion of the swerve allows Epicurus to distinguish between the voluntary and the forced actions of living beings. It has nothing to do with free will and deliberate choice, but only with voluntary action applicable to all living creatures. Regarding the aforementioned dispute, the supposed contradiction between the physical explanation of an atomic swerve and the ethical postulation of free action, would still remain apprehensive, if Lucretian worldview were dualistic. Lucretius, however, insisted that "the spontaneous swerve of moving matter is contained entirely in the materiality of the movement itself and does not come from outside. By contrast, modern atomism introduced the metaphysical concept of 'force' and the idealist concept of 'mind'," as Nail (2018: p. 8) remarks. Lucretian atomism was a monistic empirical theory, constructed on the basis of observations, preconceptions (*prolepseis*), and sensations of the universal turbulence (*clinamen*, swerve) of matter. In this monistic conceptual framework, the notion of the swerve could be inferred by miscellaneous phenomena of turmoil, vibration, free-action, and differentiation. From this perspective, the experiences of pain and pleasure are explained as dislocations and readjustments of atomic arrangements and motions, taking place in body and soul alike, such as the feeling of "calm that denotes atomic equilibrium" (Bailey, 1947: p. 18).

Furthermore, the assumed consequence between the atomic swerve in the perceived phenomena and the production of free choice in human soul, can be disclosed through the Lucretian Theory of Knowledge and the Epicurean Ethics of a personal way of life. In the fourth book of *De rerum natura*, Lucretius refers to the fine particles of external objects that strike our senses (*DRN*, 4.26-214). The emitted *simulacra* are extremely subtle films that move with astonishing speed and create mental images (*εἴδωλα*) that preserve the surface properties of the objects from which they emanate (op. cit. 4.215-819). The contacting and striking images of things, as foreseen by the mind, can affect will and initiate voluntary action (op. cit. 4.877-96).

The empirical and materialistic epistemology of Epicurean atomism identified truth with perception. According to Detel (1975), Epicurus' theory that all perceptions are true, was based on the proposition that a perception X is true, if there exists a small picture (*εἴδωλον*) Y, such that X is triggered by Y. Aside from perceptions, Epicurus acknowledged preconceptions (*prolepseis*) and feelings as criteria of truth, while the later Epicureans added the representations of the imagination, as Diogenes Laertius delivers. The notion of evidence (*enargeia*), based on sense perception, is the common basis of the threefold Epicurean criteria of truth (Ierodiakonou, 2011; Diogenes Laertius, 1921b, 10, 31; 33; 52). Regarding these criteria, an enlightening extant passage comes from Democritus:

> *According to him* [Democritus] *there are three criteria, namely, for the knowledge of ἄδηλα* [unobservable states of affairs], *the appearances - for the appearances allow us to see what is unapparent, as Anaxagoras says, for which Democritus praises him - for inquiry, the concept - for with everything, my child, there is one starting point: to know what the inquiry is about - for choice and avoidance, the feelings; for what we perceive as familiar is to be chosen, while what seems alien is to be avoided* (Sextus Empiricus, M, VII, 140).

The counterarguments to the Epicurean Theory of Knowledge have pointed out mainly to: a) the problems of the Epicurean solipsism arising from the principle that *all perceptions* are true, b) the required causal jump from the observable to the unobservable in the Atomistic Physics and Psychology, and c) the peculiar *quarta natura* of the Lucretian soul, corresponding to the nameless fourth and finest element of the Epicurean soul, which was also composed by wind (*aura, ventus*), heat (*vapor, calor*), and air or mist (*aer*). That quartessence should explain how the non-sentient body could obtain sensation.

Nevertheless, Epicurus and Lucretius regarded atoms as the components of everything, therefore, of soul, as well. Epicureans believed that the weight and the swerve of the atoms explain their natural movement and the formation of their compounds. Rarified bodies, such as air and fire, recoil at great distances, as they have large admixture of void. When the recoil takes place at shorter distances, there is a different interlacing between components, as either in liquids or in solid bodies. For this reason, solid bodies display a constant internal vibration of their atoms (*LH,* 43-44). Soul atoms are indispensable and inherent constituents of the whole of human body. Lucretius believed that the speed in the function of mind and soul shows that they must be composed of exceptionally small, smooth and round atoms (*DRN,* 3.177-230). The autonomy of the mind is built up, as the swerve in the atoms at an infinitesimal scale "annuls the decrees of destiny and prevents the existence of an endless chain of causation," as Lucretius (2.251-6) suggested.

From an opposite point of view, Cicero and Plutarch had rejected the doctrine of the atomic swerve, because of its dismissal of the role of first cause and providence in the world. These critics would focus on the alleged failure of Epicurus to provide a (divine) cause for the swerve. None the less, Epicureans rejected divine intervention in mundane matters. They also regarded the swerve as a prerequisite of our ability to distinguish between pure and impure pleasures. The respective Epicurean ideal of a personal way of life was based on pleasure and spontaneity. All creatures, as Lucretius contended, dispose spontaneity, as a detachment from fate:

> *What is the origin of this free will*
> *Possessed by living creatures throughout the earth?*
> *Whence comes, I say, this will-power wrested from the fates*
> *Whereby we each proceed where pleasure leads,*
> *Swerving our course at no fixed time or place*
> *But where the bidding of our hearts directs?*
> *For beyond doubt the power of the will*
> *Originates these things and gives them birth*
> *And from the will movements flow through the limbs*
> (*DRN,* 2.256-263).

Clearly, the swerving motion in the above cited verses is directly connected with voluntary action, falsifying thus Furley's (1967) interpretation. Epicurus and Lucretius did not offer an analytical account of the affection of free choice by the atomic swerve. However, in the background of their argumentation rests the belief that the spontaneous and unpredictable swerve of atoms and seeds is responsible for the limited determinacy in nature's creative work. Lucretius proposes the example of a child that may resemble one of the parents, a grandparent or a remoter ancestor (*DRN,* 4.1209–32).

Although he combined spontaneity with natural resourcefulness, Lucretius was not superfluously libertarian. He argued that the mortality of soul is fated just as everything that obeys the "deep-set boundary mark" of necessity. Lucretius would assume the immutability of the atoms as a certainty of natural order (1.584–98). However, the deviation from certainty to the relativization of fate could also be justified by the infiniteness of a world that is not *fatendum*, cannot be totally traversed by our senses (1.958-964). Hence, the Lucretian swerve

permits living beings to initiate movements that break "the bonds of fate" (*fati foedera*, *DRN*, 2.254), and "tears free will away from fate" (2.257). More vigorously, Epicurus did not want to retreat into conceptions of fate of his contemporary natural philosophers. Instead of being enslaved to fate or destiny, he would rather prefer to endorse the myths about the gods (*Letter to Menoeceus,* 134). Thus, chance is an opportunity for good, hope, and placation, according to Epicurus.

Because of the rareness of extant Democritean texts, there is also the question, whether the Epicurean and Lucretian notion of the swerve may be compatible with the basic philosophical principles of Democritus and Leucippus. On regard of this question, an alternative interpretation of the swerve is given by Johnson (2013). He overstates a Lucretian conception of *spontaneous* or *automatic* action that is not to be considered as the result of accidental, contingent, indeterminate or random causes, but rather as a natural and necessary lack of external cause, influence, purposive intention, control or domination. Homer, Herodotus, Thucydides, Theophrastus, Diodorus of Sicily, Ovid, Virgil, the Hippocratic corpus, and others, identified spontaneity with the effect of natural causation, by distinguishing automatic action from intentional inventiveness and artificial cultivation. The corresponding Latin expression for spontaneity, which is persistently used by Lucretius, is *ipsa sponte sua* (2.508, 2.190-2, 2.1158, 3.1041), as Bailey (1947: p. 96) observed. This was exactly Democritus' notion of spontaneity, as a refute of gods, chance, external compulsion, or fate, while Epicurus discriminated himself from Democritus, by allowing the role of chance that dismisses strict necessitation, as Johnson (2009) insists. The difficulty, however, is that Lucretius does not miss out worship to gods, as Venus, for instance.

An additional ground for distinguishing between Democritean and Epicurean atomism would be Aetius' opinion that Democritus did not consider weight as an atomic property, while Epicurus did. Clearly, Aristotle, Theophrastus and Simplicius testified that Democritean atoms were not weightless: "Democritus says 'the more any indivisible exceeds, the heavier it is' - to which we must clearly add 'and the hotter it is,'" as Aristotle (*GC* I, 8, 326a10-12) conveyed. Aetius yet contended that Democritus regarded only shape and size as atomic properties[12] and accepted only one kind of atomic motion, that due to collision.[13] This way, Democritus could imply an unbroken chain of causation over time, where the present motions and collisions are direct effects of the previous ones. With a contribution that deflated determinism, Epicurus introduced two original kinds of motion, as Aetius stated,[14] either because of weight (*κατὰ στάθμην*) or because of the swerve (*κατὰ παρέγκλισιν*). The bodies, according to Epicurus, are indeterminate (*ἀπερίληπτα*), the first of them simple, their compounds heavy. The atoms, in general, move on account of weight, swerve, and collision – rebound (*πληγήν - ἀποπαλμόν*).[15]

3.1. Interpretations of the swerve

In modern atomism, the indeterministic interpretation of the atomic swerve was introduced by Guyau (1910), followed by Bailey (1947), De Lacy (1948; 1964; 1969), and Rist (1972). The element of randomness or chance, in English, and *τύχη* or *μάτην*, in Greek, obtained in Democritus and Epicurus the meaning of the absence of any kind of design, end, purpose, goal, and aim in the physical world. However, Lucretius recognized that everything has a deep-set boundary mark, that is to say, the swerve cannot change the rationale of the elementary laws

[12] Aetius, I, 3, 18; I, 12, 5-7 (Diels, 1879)
[13] op. cit. I, 23 3
[14] op. cit. I, 23, 4
[15] op. cit. I, 12, 5

of nature (*DRN*, 5.88–90, 6.64–6). Furthermore, Philodemus (*On signs*, 36, 11–17), wrote that "it is not enough to accept the minimal swerves of atoms on account of what is fortuitous (*τὸ τυχηρόν*) and what is up to us; one must also show that they do not conflict with any evidence." Therefore, contingency, indeterminacy, and spontaneity may have minimal effects to the occurrence of natural events, but they influence more significantly human mind and psychology, as Long (2006) supports. This way, however, Lucretian atomism would obtain a dualistic overwriting, which goes too far against its well-known empirical monism.

A critical view against the Lucretian belief that free will originates from the atomic swerve, takes O'Keefe (2005a). He compares the well-known argument for the existence of the swerve on account of free will (*DRN*, 2.251-93) with the description of voluntary action, when we walk, stride forward, as we wish, and move our limbs in various ways:

> *I say that in the first-place images*
> *Of walking come in contact with the mind*
> *And strike the mind, as I have said before.*
> *Hence follows will: for no one ever begins*
> *Anything unless the mind has first foreseen*
> *What it wills to do (and what the mind foresees*
> *Is the image of the thing)…*
> (*DRN*, 4.881-9).

Therefore, suggests Lucretius, the mind, conceiving the wish of walking forward, strikes immediately the mass of spirit, which is dispersed through all the body and the limbs. To achieve this is easy for it, since it lives in close combination with the spirit. The spirit then strikes the body and push it forward into movement. Nevertheless, the initial stimulation comes from the external *simulacra* that impact the mind in a rather deterministic way. That is to say, the mechanistic model of atomic motion tends to reduce the swerve and the volition to the action of the *simulacra*.

As a response to mechanistic objections, the Epicurean swerve has been assimilated directly by Asmis (1970; 1990) and indirectly by Englert (1981; 1987) with the Aristotelian concept *ὄρεξις*, namely, the striving that forms the first stage of every voluntary action. Lucretius called this act of striving "will" (*voluntas*), as Asmis (1970) suggested. On regard of this problematic, O'Keefe (2005a: p. 31) distinguishes three different interpretations of the connection between the atomic swerve and voluntas. According to the internal cause interpretation, swerves can preserve free will, by breaking the intercourse of causes and effects, which otherwise would necessitate our actions and personality. On the bivalence interpretation, swerves can preserve free will, by saving the contingency of the future against the threat that everything is predetermined from the past. Thirdly, the traditional interpretation identifies swerve with volition, since our volitions are constituted by random swerves that result to random actions, which occur undetermined at uncertain times and places, simply following our desire for pleasure.

Against the traditional interpretation of the equivalence between swerve and volition, Bobzien (2000) underscored the autonomous role of our minds that move themselves as they wish. This preference to the undetermined nature of human mind instead of total randomness, has been also accepted by O'Keefe (2005). Another way to interpret the swerve is to regard it as posterior to *voluntas*, as something that *voluntas* uses after its formation, either through the so-called radical emergence interpretation or simply as a tool of *voluntas*.

From the aspect of the Philosophy of Design, Brassett and O'Reilly (2018), suggest that the concept of the Lucretian swerve is responsible for all nature's creativity, while the actualisation of the swerve as collisions, maintains high significance in models and systems of design. The introduction of the concepts of turbulence, chance, chaos, entropy, hence,

creativity, in an ordered universe, created new open systems, different than the old closed ones, as stressed by Serres (2000) and Berressem (2005).

4. Sign inference and the swerve

The empirical turn of the Hellenistic Philosophy was mainly carried on by the Epicureans, who suggested that all knowledge is based on sensory experience. They focused on evident truths that originate from experience, while distinguishing non-evident matters that stand beyond direct apprehension. The analogical argumentation of Epicurus takes the existence of evident things such as seeds, as a proof of non-evident theses, as the impossibility of creation *ex-nihilo*. With this analogical model, the fluidity is explained by the prevalence of circular atoms, the formation of ice by the prevalence of acute and scalene-angled atoms etc. In the *Letter to Pythocles,* Epicurus introduces also the "multiple" or "possible method" of natural observation, which sums up all compatible explanations of a natural phenomenon. The facts invite the epistemologist to allow for a plurality of explanations, hold fest to the facts, and take a view analogous to them. Deficient is the method that rejects possible explanations, which stay in agreement with the phenomena. Any method that refrains from the requirement to provide explanations similar to the phenomena is nothing more than myth. Moreover, Epicurus uses the criterions of attestation and non-attestation, and contestation and non-contestation, as tests of truth, but neglects the theory of consequences. The legitimacy of inferences that project beyond our experience was rigorously investigated by the Epicurean Philodemus in his work on sign inference (Allen, 1998).

Inference in Epicurus and Lucretius is always infallible, when it is established exclusively by the senses. In the verses 379-521 of the fourth book of *De rerum natura,* Lucretius indicates that false inferences are always the result of the intervention of a mental bias, not of sense perception. As an instance of appropriate inference that goes from the evident (*ἐναργές*) to the non-evident (*ἄδηλον*), Lucretius compares fall in void, thin air, and water, in order to infer that only the void exerts no resistance to falling bodies, letting them fall with equal velocity, independently of their heavier or lighter weights, disregarding Aristotle's rejection of this hypothesis. This would imply also that the intervention of the infinitesimal swerve is a necessary explanation of alleged deviations from vertical fall in vacuum, as Lucretius believed (*DRN*, 2.224-250). Moreover, the empirical method is implemented also in the inference from the experience of the feeling of free-will to the atomic swerve model.

4.1. Inference of the latent

> *For if once one says that there are infinite parts in a body or parts of any degree of smallness, it is not possible to conceive how this should be, and indeed how could the body any longer be limited in size?* (Epicurus, *LH*, 57).

Epicurus had tackled the difficulties with the paradoxes of the infinite, by pointing out, firstly, that the infinite divisibility of matter must be dismissed, since a finite body consisting of infinite parts is inconceivable, however small the parts may be: "For it is obvious that these infinite particles must be of some size or other; and however small they may be, the size of the body too would be infinite" (op. cit.). In the same basis, Lucretius opposed the pluralist physical theory of Empedocles, by confronting his false belief that "there is no end to the cutting up of bodies, and that no stop is made in their breaking, and indeed that there is no minimum at all in things" (*DRN*, 1.746-8). The spuriousness of Empedocles' belief pertains to the presupposition of motion and bodies without void, as Lucretius supported.

The recognition of the indivisible nature of the atom is the outcome of conceptual, rational deduction of the *minimum* that confines any further resolution of discriminable shape and constituent parts (Bicknell, 1990). The existence of the indivisible sensible body is an *entelecheia* in Aristotle's terminology, even if the paradoxical divisibility of the matter may still be a potentiality.[16] It is noteworthy then, how consciously Lucretius argues that the concept of the atom presupposes not only its invisibility but also its dependency from the whole body:

> *To proceed with the argument: in every body*
> *There is a point so small that eyes cannot see it.*
> *That point is without parts, and is the smallest*
> *Thing that can possibly exist. It has never existed*
> *Separately by itself, nor ever will,*
> *But only as one part of something else;*
> (*DRN*, 1.599-604).

The indivisibility of the atoms is regarded by Lucretius as a fundamental property that implicates their ontological priority. Since matter is the only reality, in the infinite void, the atoms obtain substantial significance in natural world. Their weight, shape and magnitude, alongside with their swerving peculiarity, are the intrinsic, elementary atomic properties, which cannot be further analysed, as the atoms are irreducible. The swerve permits collisions and compounds, as spontaneous, concurrent, and successive atomic combinations. The result is not only the deterministic impact of atomic collisions and rebounds, but also the generation of bodies with reasoning abilities.

Epicurean philosophy did not directly reduce human behaviour and responsibility to atomic motion, but pointed out the intermediate differentiated development that took place. This development originates with the variations of atomic size (Epicurus, *LH*, 55), whereas the finest particles belong to the soul, which is enabled with sensation, in so far as it is enclosed in the body (op. cit. 63). The endeavoured inference from a latent infinitesimal swerve would have significant consequences for human autonomy. The autonomous, *παρ' ἡμᾶς* action of the mind is a central feature of Epicurean ethics, as Mitsis (1988) stressed. Determinism is not only incompatible with autonomous mind but also self-refuting. Therefore, the interpretation of the atomic swerve as mere randomness neglects the deeper ontological content of the atomic theory.

The Lucretian argument on the swerve pertains to evidence of something that from its nature is hidden from perception. As Diogenes of Oenoanda (32.1.14–3.14) conveyed, Epicurus brought the swerve to light, "demonstrating it from evident facts" (*ἐκ τῶν φαινομένων δείκνυσιν*). The possibility to advance our knowledge of the latent (*ἄδηλα*) to the senses, through observation of evident variations, analogies, and similarities, is supported in the extant remains of Philodemus, with the example of the discernment between the variations of different fires and their common features (*De signis*, 23-24). We need to examine neither the whole amount of the phenomena nor their random appearance. We must investigate their homogeneities and diversities, in order to discover what is inseparably present in every part of the whole and allows for transition from the one part to the other (op. cit. 20-21).

[16] *Τὸ μὲν οὖν ἅπαν σῶμα αἰσθητὸν εἶναι διαιρετὸν καθ' ὁτιοῦν σημεῖον καὶ ἀδιαίρετον οὐδὲν ἄτοπον· τὸ μὲν γὰρ δυνάμει διαιρετόν, τὸ δ' ἐντελεχείᾳ ὑπάρξει* (*GC* 1, 2, 316b).

5. Spontaneity, *libera voluntas*, and necessity

The Lucretian physical system is not only based on the Epicurean idealization of the atom, but it offers a deeper, biological explanation of atomism, in the form of the seeds of material bodies, such as the seeds of liquid fire that makes clouds look golden gleaming and red lightning:

> *And also there's another reason why*
> *That rushing golden gleam of liquid fire*
> *Darts down to earth. It is that the clouds themselves*
> *Must contain very many seeds of fire…*
> *Many such seeds, so with good cause they blush*
> *And pour out fires…*
> (*DRN*, 6.204-211).

The seeds are the basis of nutrition, as well; hence, they bring prosperity and advance civilization, but they can also be responsible for calamities, as plague and pestilence (*DRN*, 6.1125 ff.). By understanding the causal role of the seeds, the humans can learn how to set limits to their desires and fears, in order to pursue a highest good, find out the laws of nature and explain the common biological causes in physical, social and cognitive phenomena. From a biological point of view, the soul, corresponding to the Latin *anima*, extends to the whole of the body. The mind, corresponding to the Latin *animus*, is found in the chest, respectively. Soul and mind are dispersive, since they consist of atoms finer and much more mobile than smoke, water or cloud, which are dispersive, as well (*DRN*, 3.425-444). Therefore, Lucretian Psychology tends to be established on a manifest biological and mechanistic explanation. But the intervention of the phenomenon of the swerve, as a discontinuous, infinitesimal sideways shift from the background atomic motion, gains a fundamental role to the generation of *libera voluntas*. The production of voluntary action has an internal origin, the deferring capacity of animal's mind (*animus*), due to the atomic swerve. The familiar delay before any initiation of voluntary animal motion proves that mind is capable of free-choice, as Lucretius insisted.

The suggestion that the slight swerve of the atoms is responsible for the production of *libera voluntas* was "the first known occurrence of the expression 'free-will,'[17] and Epicurus was apparently the first philosopher to explain 'free-will' by a discontinuity of causation," as Asmis (1970: p. 1) proposed. The same claim that the free will problem was seriously introduced by Epicurus, had been also exposed by Huby (1967). Nevertheless, Huby mistakenly translated *tautomaton* as chance, failing thus to decipher the exact meaning of the Epicurean conception of the interchange between freedom and determinism. Asmis also related free-will with chance and rejection of necessity, not with spontaneity in necessity, as Johnson (2009; 2013) contends. The fault in the views of Asmis and Huby is that the concept of chance cannot match with the autonomous element of free-will, as self-regulation, self-governing. On the contrary, the notion of spontaneity is more appropriate for the explanation of the production of free-choice. The proposition that free-will can be established on chance, sounds nonsensical; however, it does make sense to say that free-will is based on spontaneity.[18]

Regarding the introduction of the spontaneous inclination, Diogenes of Oenoanda (33.2) juxtaposed Democritus' overall rejection of free atomic motion (because atomic collisions take place with necessity), from Epicurus' exposition of the swerving atomic motion.

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[17] The simmering of the free will problem may be found in the Socratic tenet that no man does wrong spontaneously, in Plato's *Laws*, in the distinction between voluntary and involuntary actions in the third book of Aristotle's *Nicomachean Ethics*, in Gorgias' *Helena*, in Andokides' *On his return*, and elsewhere.

[18] This spontaneous adherence to morality was expressed by Democritus with the following words: "Do not feel shame more before other people rather than oneself, and do not do bad deeds more if no one will know than if all people know. But feel shame most of all before yourself, and establish the law within your soul, to do nothing unfitting" (*Ethical sayings from the collection of Stobaeus*, 264).

Democritean determinism has been related with an alleged tendency to reduce reality to the atoms, by a simultaneous underrating of sensory experience as ineligible. If one reduces macroscopic or cognitive phenomena to underlying atomic motions, one assumes that nothing can supervene atomist microphysics. As a response, the atomic swerve was fostered as a model that tried to escape Democritean reductivist determinism. This way, however, Epicureans had to face other irresolvable contradictions with intrinsic ethical concepts such as responsibility, as Sharples (1993) observed.

Epicurus tried to improve the atomic theory of Democritus with the notion of the swerve, which is a slight diversification and discontinuity of the atomic motion. Unfortunately, Epicurus' conception of the swerve is not extant. Hence, Lucretius is the basic resource of argumentation in favour of the swerve, while Cicero being the main source of counter arguments. On regard of the Epicurean rejection of determinism, Hankinson (1999b: p. 525) observes that Epicurus rejected Democritean determinism, by *suggesting* that his argumentation is not only self-refuting, but it also nullifies ethics. Nonetheless, it is false that Democritus ignored ethics, as his account of deliberation shows. We should state it in a really clear manner, with this occasion of misunderstanding, that an attempt to reconcile Democritean and Epicurean causal theories cannot be fruitful; not because of the notion of the swerve, but because Epicurus, as a matter of fact, would prefer religion from universal determinism. Most likely, for the same reason, the Lucretian poem begins with a hymn to Venus. This way, the Epicurean deflation of determinism is reconciled with a religious worldview.

From Epicurus to Lucretius, however, the deflation of determinism becomes more moderated. Lucretius emphasizes the boundary mark that necessitates events albeit the unpredictable atomic swerve, while Epicurus builds an ethical theory that is irreducible to the atomic motion. Epicurus criticized Leucippus and Democritus with the following words: "the first men to give a satisfactory account of causes, men not only much greater than their predecessors but also, many times over, than their successors, turned a blind eye to themselves (although in many matters they had alleviated great ills) in order to hold necessity and the automatic as the cause of everything" (*On Nature* 25; Sedley, 1983: pp. 19–23). Lucretius yet, giving emphasis to sensation, thought that the spontaneous atomic swerve permits mind to behave without an internal necessity:

> *But that within the mind there's no necessity*
> *Controlling all its actions, all its movements,*
> *Enslaving it and forcing it to suffer -*
> *That is brought about by the tiny swerving of atoms*
> *In neither place nor time determinate*
> (*DRN*, 2.289-93)

Quite stimulating to Lucretius was Theophrastus'[19] opinion that by spontaneity (*τῷ αὐτομάτῳ*) and through the rotation of the whole we may retrieve plausible explanations of the acquisition of certain forms of plants and inanimate things, as Johnson (2013: pp. 102-3) points out. Theophrastus would also assume that spontaneity is a natural cause of this heaven and of all worlds.[20] The concept of spontaneity, naturally expressed by the processes of the occurrence of streams, rivers, springs and floods, wild plants, wildfires, horses, salt crystallization, and human voluntary action should not be taken as causeless and random. It is described by Lucretius with the following words:

> *If you know these things well, you'll see at once*
> *That nature is free, no slave to masters proud;*

[19] Sedley (1998) also emphasized how significant was Theophrastus' imprint on Lucretius' thought.

[20] It is not a coincidence that Theophrastus, Straton of Lampsakos, and other philosophers, supported the theory of the disseminate void: "pockets of void are scattered throughout all things, and are the explanation of transparency, compression, and mixing" (Irby-Massie & Keyser, 2002: p. 12).

That nature by herself all things performs
By her own will without the aid of gods
(*DRN*, 2.1090-2).

That is to say, the Epicurean principle of the non-intervention of gods in natural processes is implied by the universal spontaneity of action. Owing to its relationship to necessity, spontaneity is an indispensable dynamic in the natural philosophies of Democritus, Aristotle, Theophrastus, and Lucretius. In chapters 7-9 of the VII book of *Metaphysics*, Aristotle distinguishes three kinds of things: generated by nature, generated as an effect of art, and generated spontaneously. Some things are produced either by art or spontaneously, for instance, health. Plants and animals that are not generated from seed, they are generated spontaneously. In *Generation of Animals* (III, 11, 762a 9), Aristotle claims that spontaneous generation is the effect of concoction (Lennox, 2001). In reproductive generation, the principle of movement lies within the semen; the semen contains a movement by which the parts of the new animal are formed. On the contrary, in spontaneous generation, it is "that portion of the soul principle (*psychikes arches*) which gets enclosed or separated off within the pneuma [that] makes a fetation and implants movement (*kìnesin*) in it" (*GA* III, 11, 762b 16-18). It is evident for Lucretius that natural spontaneity gave birth to human agents:

No golden chain, I think, from heaven on high
Let down the breeds of mortals to the fields;
Nor sea nor waves that break upon the rocks
Created them. From the same earth they sprang…
By her own will first made for mortal men;
Herself gave forth sweet fruits and joyful pastures,
Which now our toil scarce brings to growth and increase
(*DRN*, 2.1153-60).

In human voluntary action, spontaneity is expressed with the form of deliberation, as Democritus proposed: "It is better to deliberate (*προβουλεύεσθαι*) before action than to regret it afterwards" (*Δημοκράτους Γνῶμαι*, 31). Xenocrates also urged his students "to do of their own accord [*sponte sua*] what they are compelled to do by the law" (Cicero, *Rep*. 1.2.3). Human responsibility, autonomy, and freedom stem from the interplay between spontaneity and necessity rather than the vicissitudes of chance, destiny, or the whim of gods, as Johnson (2009) stresses.

The rebuttal of teleological action in favour of spontaneous generation is implicit in the Lucretian concept of the atomic swerve, since without this declination "no collisions between primary elements would occur, and no blows would be effected, with the result that nature would never have created anything" (*DRN*, 2.223-24). The natural creative potentiality, therefore, originates from the swerve of the atoms. Since everything in the void moves with equal speed, since void can never resist to anything (op. cit. 2.235-36), the atomic swerve emerges as an auxiliary explanation of the observed declinations of motion. The swerve is, furthermore, a spontaneous movement of self-defence, by bending aside, turning away, for instance, when "horses would shy and swerve to avoid the tusks' fierce onset" (op. cit. 5.1329-30). The swerving phenomenon causes atoms to lean, bend, incline, turn, divert, drive out, drive away, remove, expel, put out, put off, turn aside, according to the various translations of the Lucretian terms "clinamen," "declinare," "depellere," "inclinare."

6. Can the swerve preserve moral responsibility?

There are some principal features of the Lucretian atomic theory that become essential for an understanding of the debatable relationship between responsibility and the atomic swerve. On the one hand, atoms are indestructible, therefore, they are considered as having very stable properties and capable to relate to other atoms with a regularity that produces lawful necessitation. On the other hand, there exist exceptions to necessitation, in the cases of atomic inclination and volition. Lucretius did not try to reduce volition directly to the swerve, nor the opposite, although he has been interpreted in solely reductionist ways by Augustine and others. Nevertheless, he does not avoid a generalized reduction of the mind and the soul to physicalist explanations, based on the atoms. The swerve is the result of the wavering of the atoms of infinite matter in a boundless infinite universe that has no centre. Lucretius states exactly that the atoms can never find rest in the unfathomably abyssal universe (*DRN*, 1.921-1051). His cosmological argumentation can imply the ethical one, only through the mediation of the physical concepts of the body, the soul, the mind, the external objects, the idols that the objects emit, their impacts (*simulacra*) on the soul, and their results, feelings and volition.

Against this line of reasoning, the opponents can either question the epistemological theory of the emitted *simulacra* and their stipulated impact on the soul, or doubt about the role of the swerve in the generation of volition. The counter arguments would point out that ethical philosophy made significant progress with Democritus, Socrates, Pythagoras, Aristotle, especially with the definition of the concepts of deliberation and voluntary action, and the clarification of the role of knowledge in responsibility. After such advancements, the allegation of the emergence of volition from the atomic swerve would seem as a retreat and an oversimplified reduction. To these critiques that tend to underscore the independent and irreducible status of ethical values, the Epicureans would answer by referring to the Aristotelian argument that the soul cannot be self-moved, but the body moves from its striving for something else. Aristotle renounced the philosophical views that attributed movement to the soul, on the grounds that the origin of movement needs not be itself moved. The most sensitive part of the dispute can become ostensible, if we analyze the relationship between the mind and the atomic swerve. Since the external objects of the world emit idols that strike the human senses with unsurpassable aptitude, then the mind[21] would have either to be subjected to the impacted idols or react with a spontaneous reflex, which is identified with the atomic swerve. This intensive lack of resistance, which is an outcome of the swerve on the soul, makes possible the process of communication between bodies, namely, the traversing and perusing of the objects of sensation, for the purposes of cognition.

Nonetheless, a strenuous disagreement with the Epicurean natural explanations was developed by questioning the trifling role that the atomic swerve should play to the generation of concepts such as justice and responsibility. The slightest deviation of the atoms could not be responsible for the perdurance of stars and living creatures in randomness, nor for the validity of the principle of free will, as Plutarch ("The cleverness of animals," *Moralia*, 964C) judged. The gift of reason distinguishes humans from other animals, on the basis of their ability to establish justice in their social relations. By contrast, the atomic swerve doctrine leads to a treacherous and precipitous way of living, which permits wrangling and devastating evident veracities, rather than obeying and learning the Platonic rules and arguing according to obvious truths, as Plutarch wished.

This is a powerful argument, which the Epicureans would have difficulties to oppose. The same topic is mentioned in the essay *On the generation of the soul in the Timaeus* (*Moralia,* 1012B ff.), where Plutarch states that the Stoics rejected the Epicurean concept of the swerve

[21] "Leucippus, Democritus and Epicurus say that perception and thought arise when images enter from outside; neither occurs to anybody without an image impinging" (Aetius, IV, 8, 10; Kirk & Raven, 1957).

on the grounds that it pertains to an uncaused motion that originates from nothing (op. cit. 1015C). More importantly, in the *Stoic self-contradictions,* Plutarch introduces the expression "adventitious motion" (*ἐπελευστικὴν κίνησιν*), which is contrived into the reasoning faculty, by some philosophers, who suppose that external influences impact the impulses (*Moralia,* 1045 ff.). This corresponds to a swerve that motivates the soul to choose between two indistinguishable stimuli, which Chrysippus called it "random choice" and "chance inclination of the mind." For this reason, Plutarch describes the swerve as an artifice that devises the liberation of volition from the everlasting motion (*Moralia,* 1050B-C).

Moreover, in the face of the Chrysippean argument that nothing happens without a cause, the examination of the role of the atomic swerve for the preservation of responsibility can also have great significance. If the atomic swerve were responsible for the motion of the passions of the soul, it should be impossible to conceive any kind of ratio in passions. There would be a purposeless irritation, alienated from reasoning. The soul would be reasonless. On the contrary, if reason plays a role in the generation of the passions of the soul, why do some people hold wicked passions? How can passions take place without judgement, although they actually pertain to judgements? Which is the cause of this reasonless motion of the passions? The result, hereby, is a vicious circle that Chrysippus could not avoid, as it was pointed out by Galen (*De Plac.* IV, 389).

Last but not least, when voluntas is actually comprised of passions, its compatibility with reason and responsibility directs us to an outstanding moral problematic. Given that Epicurus had a significant contribution to moral philosophy, one could yet wonder how the atomic swerve could be connected to all this. Although it is interesting to hypothesize that soul and mind consist of fine particles, such as the ones conjectured by the Epicureans, this hypothesis, however, does not seem very helpful to answer the question: "How passions and voluntas can depend to reason and responsibility?" On the contrary, the atomic turmoil has often provided an "excuse" for the rejection of responsibility.

Theoretical inventiveness cannot be steadily infallible. Atomism proposed that the primary and simplest natural elements were atoms. The concept of the atom was yet criticized by Galen and Hippocrates on the basis of its restricted diversification and its inapplicability to the elementary composition of flesh (*σάρξ*). The atoms do not obtain naturally any corporeal quality, such as whiteness, blackness, coldness, hotness, but only shape, repercussion and weight (*σχῆμα… ἀντιτυπία καὶ βάρος*). "I say that, if man were one, he could never feel pain," argued Hippocrates.[22] Pain could never occur if the primary element were only one, as the atom, because the one is not mutable to otherness, while the immutable being impassive and painless. If the primary element of flesh were one, there would never be pain. Yet there is pain. Therefore, the primary element of flesh is not one.

7. Critique and conclusions

> *From our own aspect spontaneous, from the aspect of the cause non-spontaneous* (Hippocrates, cited by Galen, *De plac.* IV, 393, 14).

Many interpreters point out that the Aristotelian distinction between voluntary and compulsory action had influence on the Epicurean theory of free-will. In his *Letter to Menoeceus,* 132-3, Epicurus insisted on the significance of prudence, as the ability of a better man to laugh at destiny and attain the power to determine events. He also wrote: "That which is in our power is subject to no master, and blame and praise are applicable to this." The same point, on the attachment of praise and blame to voluntary, but not involuntary actions, was made by Aristotle

[22] Galen, *De constitutione artis medicae*, 7, Vol. I, p. 245 K (Arnim, 1964: pp. 137-8)

in *Nicomachean Ethics* (Γ 1, 1109 b 30-34). Therefore, one should interpret the Epicurean free-will as autonomous, spontaneous fondness rather than chaotic randomness.

The allegedly Epicurean conception of indeterminist freedom of choice or decision was revoked by Bobzien (2000), in favour of agent autonomy, as an appropriate interpretation of Epicurean ethics. Bobzien gave emphasis to the fact that Epicurus did never use the expression "freedom of will," but only the term *παρ' ἡμᾶς* in the *Letter to Menoeceus* 133-4 (to distinguish between necessity, chance, and responsibility) and *On Nature* 25. That is to say, Epicurus did not support an indeterministic two-sided freedom of will or freedom of decision. On the contrary, either the agent should be responsible for an action or something else. The expression *παρ' ἡμᾶς* means "because of us," "due to us." After all, Epicurus maintained a conception of freedom established in necessitation: "The greatest fruit of autarky is freedom" (Epicurus, *Gnomologium Vaticanum*, 77).

Comparing the Epicurean conception of freedom in autarky and the Lucretian argumentation on the swerve, we find out that Lucretius tended to justify volition under the influence of a rather reductionist physicalism. Lucretian argumentation implies that free-action originates from the atomic swerve, which identifies as a natural effect of the lack of any resistance to the motion of infinite matter in infinite void space. This failure to exercise resistance to motion is not only a possible precursor of the concept of inertia, but also the cause of the creative power of Nature, and the generation of volition in living beings. The argument is based on an analogy between motion, creation, and volition: The universal motion of infinite matter finds no resistance from the infinitely abyssal universe, generating, hence, unsurpassable creative resources, which become so competent that they can crisscross and discern between different and opposite directions in empty space, giving thus birth to variety and volition.

Motion in a void space is transition in a totally unresisting medium that permits atoms to obtain unassailable velocity, faster than light, either in gravitational descent or in collisions. The atoms do not only move without any resistance, but they obtain also a momentum through their collisions that is never absorbable, due to their great solidity. The effect is that universal motion is incorporated into every indestructible solid atom. The resulting swerve is a latent deviation from their path, to the minimum possible amount, a minimal spatial quantum, before they revert to their normal direction. However, the swerve itself is definitely non-observable (*ἄδηλον*), it is only inferred from an observable delay in animal reactions that betrays their attempt to grasp their object of desire, before they act.

Apart from the swerve, there exist also the regular effects of the weight of the bodies and the impact of the *simulacra* as an external force. Whereas weight and *simulacra* being responsible for determinate effects, the atomic swerve should be considered as a spontaneous cause that permits living beings to act in an autonomous way, argue the Epicureans. It is clear that "chance also and spontaneity are reckoned among causes: many things are said both to be and to come to be because of chance and spontaneity," as Aristotle (*Phys*. II 4) contended.

However, the alleged spontaneity of the atomic swerve could be nothing more than an epiphenomenon. Spontaneity, in fact, can only be considered as posterior to nature and mind, as the latter are prior causes to the universe and of many things in it besides. A logical argument, therefore, is that the heavenly sphere could not have arisen spontaneously from an atomic swerve, but efficiently, such as an olive tree comes from a seed and a man from another. Thus, Aristotle distinguishes between the determinate causes of a thing and the indeterminate causes that are incidental. That which is *per se* cause of the effect is determinate, but the incidental cause is indeterminable, "for the possible attributes of an individual are innumerable" (*ἄπειρα γάρ ἐν τῷ ἐνὶ συμβαίνει*, *Phys*. II 5). Chance is an incidental cause in intentional action. Strictly speaking chance is not the cause of anything. Chance is something contrary to the rule. Chance

occurs in indefinite many ways. Thought and nature retain a priority over chance, because they operate in a teleological manner (*Phys.* II 6).[23]

Aside from this, scrutinized critique might uncloak the atomic swerve as the outcome of determinate causes, such as collisions, rebounds, and the *simulacra*. What evidence could oblige us to recognize the action of an indeterminate atomic swerve? It could be only a reaction triggered by passions, as angst. However, conscious behaviour is much more complicated than passions, including sophisticated processes, such as decision-making, that cannot be established in declination alone. There would be, hence, impossible to behave responsibly, if everything would be the effect of arbitrary atomic swerving of passions, out of rational control. An infinitesimal spontaneity could never preserve responsible action. From the aspect of philosophical ethics, an allegedly spontaneous swerve could be dismissed as a non-justified hypothesis. The rational decision-making required in ethics, could be successfully implemented, only by argumentation based on justified non-spontaneous causes, based on clear evidence and unswerving reason.

The swerve was proposed as a getaway from fate. There would be no place for responsibility in a deterministic universe, as many scholars suggested. Even if this were true, the attempted resolution of the problem of freedom and responsibility with the proposal of an atomic swerve still misses out responsible agency. The swerve of the atoms of body, soul, and mind could probably explain indeterminant and defiant behaviour, but not original free-will and responsibility. Only in a universe where passions predominate can the atomic swerve be a suitable cause of the observed behaviour. In that case, should we really believe that passions constitute an unsurpassable limit for human reasoning? Is this probably an irony, with tragic repercussions sometimes? But Epicurus and Lucretius really believed that free-will can be sustained as a natural product of passions, namely, pleasures.

Lucretius wanted to emphasize the prevalent role of pleasure and inclination in natural science, ethics and philosophy; for this reason, he paralleled free-will with the uncertain atomic swerve, while stressing that the nature of the mind and the soul is bodily, as mind and soul suffer and share their feelings together with the body (*DRN*, 3.167-9). Lucretius claimed that the mind consists of very fine in texture, smooth, round and very tiny particles (*DRN*, 3.179-180) that move with incomparable swiftness, when smitten by a little impulse. The mind bestirs itself more nimbly than anything in the world, so fast as the water moves but not as honey. The smaller and smoother of the mind-particles consist of shapes so tiny that can transmit sensation among the limbs, with the gradual mediation of heat, wind and air. The failure of this Lucretian explanation comes from the hidden premise that only airy and fluid particles could boost the function of the mind, while nowadays neurology proposes some different models.

In conclusion, the origin of the model of the infinitesimal swerve of particles was the outcome of Lucretius' struggle to discover the necessary and sufficient reasons of alteration and coming-to-be, in Aristotle's words; of generation and corruption in physics and psychology. Pondering the philosophical schools of his times, Aristotle admitted that only Democritus had penetrated with careful manner and competent method to the problem of alteration and coming-to-be. Democritus explained coming-to-be in terms of association and dissociation of shapes. He also explained alteration in terms of order and position of shapes, as Aristotle (*GC* 1, 2) delivered. From this perspective, the doctrine of the atomic swerve must have its origin in the application of the method of exhaustion to the Democritean analysis of

[23] The distinction between chance and spontaneity, is based on the greater extension of the concept spontaneity, whereas chance is related specifically with the deliberate action that results to something that happens in vain. Spontaneity is the wider term, while "chance and what results from chance are appropriate to agents that are capable of good fortune and of moral action generally. Therefore, necessarily chance is in the sphere of moral actions… The spontaneous on the other hand is found both in the lower animals and in many inanimate objects" (*Phys.* II 6).

the shapes of matter as causes of coming-to-be and alteration. The minimal modifications of shape can represent instantiations of the slope in variations of motion, collisions, compounds-formation, just as in the generation of volition. Clearly, responsibility is impossible to be successfully preserved by such an embryonic physical-mathematical approach. If one would still insist on some kind of mystical tight linkage between the atomic swerve and free-action, he should have to explain what sorts of free-action could be expected, without an adequate justification of responsibility.

One might suppose that the atomic swerve model could stimulate varied pursuits that would deflect philosophical research either to ethics or to natural philosophy, as attempts to try and learn new approaches to understand nature and human behavior. However, the archaic echoing of *De Rerum Natura* that praises "Mother Earth and Father Sky" (*DRN*, 1.250 ff.), while seeking for Epicurean joy, the "sweet sense of pleasure" and "things that take pain away" (*DRN*, 2.1 ff.), can still not explain how the atomic swerve could effectively preserve at least pleasure, happiness or any comparable aim.

It becomes evident, therefore, that Lucretius rejects the pursuit of any other goal, aside from pleasure, relegating thus his argument to a wishful preservation of pleasure by the atomic swerve. The Lucretian argument can be reformulated in the following way: "The striving for pleasure implies the unobservable existence of the atomic swerve." Although this imaginary conception of an atomic swerve would tempt to appear as a shelter against emergent deterministic threats, it is yet from a rational, pragmatist, utilitarian point of view completely unjustifiable.

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