

Realism and substantialism in atom conceptions*

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§1. Realism and substantialism as epistemological obstacles in the history of atomism

THE PRESENCE OF THE REALISM AND SUBSTANTIALISM notions is striking in the course of the history of atomism and, according to Bachelard's reflections, are epistemological obstacles that hindered the development of a scientific perspective of the structure of matter. In *La formation de l'esprit scientifique. Contribution à une psychanalyse de la connaissance objective*, Gaston Bachelard reveals that scientific knowledge is constructed in a fight against epistemological obstacles of recurrent and general character. An epistemological obstacle is any element or extra-scientific process that, influencing the scientific theory and practice, provokes «stagnation and even regression»¹ in the production of scientific knowledge. Epistemological obstacles are sedimented in scientist's mind by the daily life. And, according to Bachelard, it's only possible to attain the scientific spirit if one psychoanalyzes the scientific knowledge, uncovering the spontaneous and unconscious psychological projections that the scientist has allowed to be introduced in the field of knowledge, creating intellectual resistances, and that have to be eliminated. Thence Bachelard considers absolutely pertinent to ask to scientists questions like these:

How do you think, what are your attempts, your trials, your mistakes? What are the motivations that lead you to change your mind? Why do you express yourselves so succinctly when you speak of the psychological conditions of a *new* investigation? Let us know especially your vague ideas, your contradictions, your fixed ideas, your unconfirmed

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¹ *Vide* the definition of epistemological obstacle in Bachelard 1938, p. 13.

convictions. [...] Tell us what do you think, not when *leaving* the laboratory, but in the hours when you leave the everyday life to *enter* the scientific life (Bachelard 1940, p. 13).

A man arrives into science full of desires and unconscious beliefs. It should be noted that a scientist is also, and above all, a man of common sense. Thus, «facing the mystery of the real, the soul can not, by decree, become naive. It is so impossible to make *tabula rasa*, at one blow, of the usual knowledges. [...] When the spirit is presented to scientific culture, it is never young. It is even very old» (Bachelard 1938, p. 14). It is so scarcely surprising that «it is therefore all the use of the brain that is under discussion. Henceforth the brain is absolutely no longer the adequate instrument of scientific thought, that is, the brain is *the obstacle* to scientific thought. [...] It is necessary to think *against* the brain» (Bachelard 1938, p. 251). And not only against the brain but also against the first experiences of knowledge of nature; as Bachelard claims, «the scientific spirit must be formed *against* nature, against what is, in us and outside of us, the impulse and the instruction of nature» (1938, p. 23). Thus, psychological factors and the realism of the sensibility must be controlled.

The objective knowledge will have to be questioned, to uncover the epistemological obstacles that are hidden and encrusted in it. Realism is one of those epistemological obstacles, typical of the pre-scientific spirit, which, associated with substantialism, has greatly influenced atom conceptions. As an introductory presentation, one can say that, in the course of the history of atomism, realism is «an instinct» (Bachelard 1938, p. 131) and substantialism a narrow realist philosophy, being «the monotonous explanation of the properties by the substance» (*Ibidem*, p. 21). As all the epistemological obstacles, realism and substantialism present themselves in various ways, and that's why we are going to expose two types of realist atomism and an illustration of several substantialist intuitions.

§2. The realist atomism

Deeply analyzing the history of atomism, Gaston Bachelard has shown the *realist atomism* as being «the simplest, the most naive»² ([1933] 1975, p. 13) of

² Considering atomistic doctrines from Antiquity to the early twentieth century, Bachelard recognizes —in *Les intuitions atomistiques (Essai de classification)*— four types of atomism and the *realist* is one of them. The first integral translation of that book: Gaston Bachelard, *As intuições atomísticas (Ensaio de classificação)*. Tradução e prefácio por Lídia Queiroz, 2015, Cadernos de Filosofia da Ciência 13, Lisboa, CFCUL.

atomistic conceptions and, according to him, this kind of atomism began not with the first Greek atomists but with Epicurus. As he points out: «fatefully, sensitive intuitions should gradually spread their influence throughout the philosophy of matter. [...] An invader realism succeeded then the logical ontology of Leucippus. [...] Epicurus establishes, so to speak, a naive atomism starting from an erudite atomism» ([1933] 1975, p. 44). The primitive atomism of Leucippus and Democritus had the merit of daring to attach to the elementary corpuscles properties resulting not from the observation of phenomena but from a rational perspective (like eternity and immutability, among others).³ Giving great relevance to sensitive experience, what Epicurus did was to bring more elements from experience to the logical conception of atomism; according to Bachelard's perspective, Democritus's thought was more of an idealist character.⁴ Epicurus adopted and further elaborated the Leucippian-Democritean theory, making also several modifications to the doctrine: for example, he gave weight and liberty to atoms. The assignment of liberty to atom made a big difference in the atomistic doctrine: more than a *substantial unity*, Epicurus's atomism enriches the atom making also of it the *causal unity*.

Differently from the physical determinism of Leucippus and Democritus, Epicurus states that there are occasions when the atoms «swerve» a little from their regular course (the «clinamen»), by chance, at unpredictable times and places, rather than just falling in the void like raindrops, with equal speeds, due to their own weight. It's only because the atomic swerve occurs that a change of motion is possible, breaking the causal chain of determinism. The swerve is only possible if one admits that the atom is not only subject to laws of nature but has also an inner and immanent power. The unpredictable swerve of the atom explains how it was possible the generated combinations in nature, the emergence of the extraordinary phenomenic diversity. The declination of

³ We see Leucippus and Democritus giving to the concept of *atom* the same characteristics of the concept of *being* of the Eleatics. C. Lüthy *et al.* (2001), p. 6: «one might say that the atoms of Leucippus and Democritus were “Parmenidean” in two ways: because they were of one sort of material eschewing any qualitative variety and because each of them was a “Parmenidean” one». For the metaphysical necessity of the identity of atoms, *vide* G. Bachelard [1933] 1975, pp. 43-44.

⁴ *Vide* G. Bachelard (1933) 1975, p. 9. Let us consider as an example determinism in the natural world admitted by Democritean doctrine: «It is interesting to note that determinism presents itself there as a hypothesis; no experience proves it, and even no experience indicates it» (*Ibidem*, p. 8). On the *necessity* and *liberty* (including the assumption of spontaneous deviation of atoms or *clinamen*), confront the deterministic current of Democritus with the atomistic conceptions of Epicurus and Lucretius in, *v. g.*, P.-M. Morel (2000), pp. 16-52.

atoms causes collisions, atoms initiate new causal chains. Without swerves, nothing would ever have been formed, because atoms would have been describing determined paths in straight lines forever. In the Epicurean system, we can perceive this idea of atom-cause (which is more than just to be atom-substance); the substance passes to be regarded as a *cause* of its attributes (a *causa sui*). With Epicurus, realism starts to percolate through atomistic conceptions and gradually the enrichment of the atom will be seen as well in later authors. Lucretius's atomism is already a sign of this tendency—regarding the atom as a germ, as an atom of life (remember the *genitalia corpora* (generative bodies) and the *semina rerum* (seeds of things) in the poem *De Rerum Natura*)— that will continue in the course of the history of atomism.

§3. Subdivisions: *internal realist atomism* and *external realist atomism*

Bachelard subdivides the category of realist atomism into two types, namely: the *internal realist atomism* and the *external realist atomism*. The first (more naive) presents the atom as a rich substance in attributes; the second adopts a minimalist position.

The common task to every realist atomism is to discern which visible qualities on a phenomenon can be taken to belong to the substance itself, distinguishing «what is real and what is illusory in the phenomenon» (Bachelard [1933] 1975, p. 46); and so realism does not constitute «a claim of the reality of the phenomenon» but rather «a claim of the reality of the substance» (*Ibidem*, p. 47). In short, it consists in finding the link that strongly connects the exterior to the interior,⁵ the manifestations of matter (the phenomenon) to the internal constitution of a substantial entity. The pre-scientific mentality reveals this need of calling for a substance for qualities perceived in data of sensory experience, this tendency for the immediate realism. Thinkers easily tend to have substantialist intuitions: the particularities of the multiple experiences are explained by the particular nature of substances.

So, as mentioned above, the substantialist atomism can be seen in doctrines whose atoms are thought as being rich or poor in attributes. If poor, their essence is restricted to a *fundamental* attribute. These doctrines, which

⁵ In Bachelard 1938, chapter on the substantialist obstacle, p. 101, the author speaks of the «*inner myth*», presenting it as «one of the fundamental processes of the unconscious thought most difficult to exorcise».

Bachelard designates as «erudite realist atomisms» ([1933] 1975, p. 59), can be illustrated by the philosophical theories of Ralph Cudworth and Géraud de Cordemoy (both atomisms of Cartesian influence). In both theories we see the focus on the idea of substance: the form/figure is inherent to matter. In Cudworth, the material nature of atoms is of a striking qualitative poverty: an atom is not more than a fragment of extension. It is not even by themselves that they move, but for divine action. The movement they get then from outside will be transmitted between them. Cordemoy's perspective is even more radical: God transmits the motion to atoms at *all* occasions of their shocks, that is, they do not even communicate movement with one another by themselves. Atoms are only geometrical forms.

The substantialist atomism can also be seen in doctrines whose atoms are thought as being rich in attributes. Over the course of time and the evolution of systems, philosophers and scientists started to pass qualities observed in phenomena into the essence of atoms, assuming to be their inner qualities. For example, as the physical beings manifest cohesion, it is necessary to explain how it is achieved through the union of atoms. So it is speculated that atoms would have hooks, which would allow them to fit into each other.

The realist atomism is the most substantialist —holds Bachelard— and the deepening of the realist position takes it, for that, to become increasingly «thing-ist». And so it is no wonder that in atomistic philosophy one passes to consider the existence of atoms of tastes, smells, sounds, colors, etc. Chemical properties —such as sweetness, acidity and others— were taken as inherent attributes to the substance, attributes directly related to sensory experiences — as it is the case of taste sensations. To explain our tactile and gustatory experiences of the quality «cold», for example, the pre-scientific spirit speaks of atoms with a pointed shape. We are then faced with a type of explanations that, although naive, become increasingly sophisticated in their details. The Dutch physicist Nicolas Hartsoeker, for instance, has proposed several forms for atoms, depending on the substance under consideration. Here, for example, we see the representation of an atom of mercuric chloride:



He imagined a sphere with spikes arising from its surface. One reads in *Conjectures physiques*:

As the Mercury becomes a very violent poison, called corrosive sublimate, [...] one can think [...] that each ball of Mercury has many small holes where the parcels of these acid salts get stuck, as it seems by this figure. Thus all Mercury balls —being spiky as many very pointed and trenchant needles— must, in this state, cut and tear apart all through which they pass (Hartsoecker 1706, pp. 130-131).

The idea is that «the parcels» of the acid salts fix themselves, introduce themselves in mercury holes and thus the mercury gets bristling with spikes that justify the name of the compound —called corrosive sublimate, currently known as mercury (II) chloride, which is in fact very toxic and corrosive.

§4. The substance's interior and the substantialization

Analyzing atomistic doctrines with a strong realist tendency, Gaston Bachelard notes that «for pre-scientific spirit, *the substance has an interior*, or better, the substance *is* an interior» —as he says (1938, p. 99). To that *interior* are sent not only manifested qualities but also hidden qualities, that is, the substance receives a jumble of qualities and the attribution is made without worrying with a determination of the relations or hierarchy that those might have between them. They are all just condensed in an object in which they play a role, even properties that we don't know actually. As Bachelard says, «one of the clearer symptoms of the substantialist seduction is the accumulation of adjectives for the same substantive: qualities are linked to the substance by a so direct link that they can be juxtaposed without much concern about their mutual relations» (1938, p. 111).

Moreover, the superficial quality and the deep quality of a substance can be contradictory. For instance, as one can read in a *philosophical letter*: «Gold seems to be and is externally fixed, but internally it is volatile» (Sendivogius 1723, p. 53).⁶ As we can perceive, not only the substance can receive the projection of observed qualities but also some which are invented by human imagination and dreaminess. The latter are therefore absolutely subjective. Like in that example, since that *internal* volatility, its dynamism, can only be seen as a fantasy about matter, since we don't see to which quality it corresponds.

In sum, one is facing an immediate substantialism when we see thinkers following their strong conviction that they just have to find the specific substance that is the root of all its qualities. For the *internal realist atomism*, the substantialization provides a match of qualities to substances, linking descriptive elements of a phenomenon to the respective substance, satisfying itself with this kind of previous solution for the problem of the phenomonic composition.

The temptation is to assign directly to the substance the immediate data of sensorial experience, to make of the substances a mirror of our subjective impressions —and so they can be diverse and even contradictory—, as we can see illustrated in this example: for Jules-Henri Pott, *hardness* (and not sweetness) is a water quality. And he proves it with this reasoning: «It is necessary that the water particles are very hard, as it dig the stones and rocks exposed to its continual movement. We also know that we feel pain if we strongly hit the water surface with the palm of the hand» (1782, p. 11).⁷

The history of electricity, for instance, also shows well the substantialization of an immediate quality perceived in a direct intuition. As Bachelard writes:

That the light bodies *are attached* to an electrified body, this is an immediate image — indeed very incomplete— of some attractions. Of this single image, which is only a moment of the total phenomenon [...], the pre-scientific spirit will make an absolute explanation and therefore immediate. In other words, the immediate phenomenon will be taken as a sign of a *substantial property*: right away any scientific investigation will be stopped; the substantialist response suppress all questions. And it is attributed to the electric fluid the quality «glutinous, unctuous, tenacious» (Priestley 1771, p. 13).⁸

⁶ Cited by Bachelard 1938, p. 100.

⁷ Cited by Bachelard 1938, p. 110.

⁸ Cited by Bachelard 1938, p. 102.

The realist tendency also goes through the nineteenth century science, as we can appreciate in this quote on light and substance, about energetic conservation: «George Stephenson had a favorite idea [...]; he believed that light that we get at night of coal, or another fuel, was a reproduction of the light from the sun, that beings of organic or vegetable structure have absorbed in the past» (Grove 1867, p. 147).⁹ This idea also manifests the pre-scientific character: the substance seems to have a power of absorption, the coal was impregnated by the light of the sun. Light is explained by matter, it is the attribute of a matter: the light is there, *latent*. Facing the substantialist intuition, we perceive this temptation to make matter *retaining* something: light's properties pass into substances, which absorb it.¹⁰ And so science of the nineteenth century doesn't destroy that fundamental idea of qualities, but instead keep them.

In short, we keep seeing the reproduction of the realistic bias of atomism during the evolution of scientific thought: actually, it occurs from time to time, just differing the manifestations of this realism in the many and varied substantialist conclusions of atomistic investigations.

§5. Conclusion

The realist atomism appears then as a tendency to enrich in qualities the object under study, with characteristics observed in phenomena, assigning directly to the atom what comes from sensation, from what the immediate experience gives. What is manifested in phenomena is explained then by the properties of substances. Substance seems to be such a simple idea that it gets an abusive intrinsic clarity.

Having read numerous works of the seventeenth and eighteenth centuries with atomistic reflections (works of alchemists, physicists and philosophers), specially, Bachelard perceived so many substantialist convictions and so naive that he came to the conclusion that realism must be an instinct and, besides that discovery, he felt the need of proposing a special psychoanalysis about it. According to him, «for better characterize the fascination of the substance idea, it will be necessary to look for the principle in the unconsciousness, in which the indestructible preferences are formed» (Bachelard 1938, p. 131). And, as he

⁹ Cited by Bachelard [1934] 1970, pp. 58-59.

¹⁰ For more about this correlation between light and matter, *vide, v. g.*, G. Bachelard [1934] 1970, «Lumière et substance», pp. 45-75.

appreciates, a realist thinks to be «*immediately* at an advantage over the opponent because he *has* —he believes— the real on his side, *the richness* of the real, while his opponent [...] chase vain dreams. [...] (So) The psychoanalysis to be instituted for substantialism therapy should be the psychoanalysis of the *feeling of having*» (Bachelard 1938, pp. 131-132). A realist thinker suffers, so to speak, of a syndrome of *possession* and this creates difficulties for objective knowledge, resulting in obstruction. The realist has an affective relationship with the object of study, which is taken as personal belongings, spiritually known by the interior of a substance that shall be found out. The scheme of substantializing every phenomenon results in a quick answer to mysteries: sensations are not criticized and explanations are brief, comparing with the methodical and theoretical path typical of the scientific spirit.

With the emergence of the scientific spirit, the idea of substance will be placed in a new level, as a result of not only the advances in contemporary Chemistry (with the new realities of substances rationally created by organic chemistry) but also of the ones in Physics (with the investigations on the energetic variation of the atom). Substantialism was on the basis of classical science: then, every object of study was seen to have an immanent substantiality. If chemistry was being developed as a science of *realist materialism*, contemporaneously it should be said that it is *rational materialism*.¹¹ The contemporary atomic science deals with other kind of realism: a mathematical realism, which means that *the real is produced*, by realizing theorems, what was predicted by mathematics. Thus realism is not anymore to contemplate phenomena and to assume the task of describing them with accuracy and precision but instead to create them. The approach to contemporary scientific knowledge is therefore mathematical. As Bachelard declares, «with the electron, the scientific explanation has, so to speak, *surpassed realism*» ([1932] 1973, p. 168).

Atom of contemporary science is a de-substantialized object. The deepening of the study of matter led to a progressive *dematerialization*, being the elementary particles energy, movement. Now, we must explain the substance by vibration, radiation,¹² light. And how to say now that energy is a *substance*? Matter is not anymore understood as something material. When contemporary physics speaks

¹¹ Vide G. Bachelard 1953 and 1940, pp. 52-93.

¹² On this subject, vide G. Bachelard [1934] 1966, pp. 59-82.

of a corpuscle, it is not speaking of a fragment of substance.¹³ It exists as a pure mathematical form. Etymologically *substantia* is what «stand under» (*substare*) but for contemporary atomic science substance is relation (it exists above and not below). Alone this subject of the deep change in the idea of substance well deserves a detailed and posterior article.

¹³ On the notion of corpuscle in contemporary science, *vide* G. Bachelard 1951, pp. 105-125.

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