Эпистемология и философия науки
2021. Т. 58. № 3. С. 57–68
УДК 167.7

Epistemology & Philosophy of Science
2021, vol. 58, no. 3, pp. 57–68
DOI: https://doi.org/10.5840/eps202158343

BACON'S INDUCTIVE METHOD AND MATERIAL FORM*

Ori Belkind – PhD,
Senior Lecturer.
The Cohn Institute For History And Philosophy of Science and Ideas, Tel Aviv University.
Tel Aviv, 6997801, Israel;
e-mail: obelkind@tauex.tau.ac.il

This paper contends that Bacon's inductive method depends crucially on his general account of matter. I argue that Bacon develops a dynamic form of corpuscularianism, according to which aggregates of corpuscles undergo patterns of change that derive from active inclinations and appetites. The paper claims that Bacon's corpuscularianism provides him with a theory of material form that enables him to theorize bodily change and possible material transformations. The point of natural histories and experiments is then to find the processes of corpuscular change that correlate with making present or making absent simple natures.

Keywords: Francis Bacon, Induction, Material Form, Corpuscularianism, Early Modern Science

ИНДУКТИВНЫЙ МЕТОД БЭКОНА И МАТЕРИАЛЬНЫЕ ФОРМЫ

Ори Белкинд – доктор философии, старший преподаватель.
Тель-Авивский университет.
Тель-Авив, 6997801, Израиль;
e-mail: obelkind@tauex.tau.ac.il

В данной статье защищается положение, что индуктивный метод Бэкона в значительной степени зависит от его общего представления о материи. Я утверждаю, что Бэкон развивает динамическую форму корпускуляризма, согласно которой соединения корпускул претерпевают изменения, вытекающие из их активных склонностей и аппетитов. В статье утверждается, что из корпускуляризма Бэкона вытекает теория материальной формы, которая позволяет ему теоретизировать изменения в телах и возможные материальные трансформации. Смысл естественной истории и экспериментов заключается в том, чтобы выявить процессы корпускулярных изменений, которые соотносятся с появлением или отсутствием простых природ.

Ключевые слова: Фрэнсис Бэкон, индукция, материальная форма, корпускуляризм, наука раннего Нового времени

Introduction

A traditional interpretation of Bacon's method holds that he introduces an inductive method devoid of any material presuppositions. Presumably, induction should work the same way in all contexts of inquiry and ought to reflect a universal canon for inferring conclusions from observational statements. Thus, induction is likened to a formal theory of deductive reasoning[1].

* This paper was written as part of work funded by the Israel Science Foundation, grant 992/19.

The formal notion of validity is very compelling and often appears to be the basis for rational discourse. Philosophers often say that induction, contrary to deduction, has a strength that depends on the inclusion of more or fewer premises, in case they are relevant to the conclusion. But this suggests the nonformal character of inductive inference. Our evaluation of the argument's strength depends on a prior decision to include or exclude relevant premises from the argument. We might try to make the argument appear to be independent of these prior decisions, if we use the following schema:

All observed F's were G's.

All F's are G's.

This schema disposes of the worry that certain relevant premises were excluded from the argument.

However, this is not a formal schema, given that the notion of observation is not a formal notion[2].

One of the most important works on induction in the history of philosophy is Francis Bacon's *Novum Organum*. Standard presentations of this work understand it as the search for what Bacon called "interpretations of nature" – representations of natural objects that are devoid of any presuppositions or biases. To avoid any type of preconception or "anticipation of nature", one has to begin with observed facts and results of experiments, and construct "natural histories" of scientific objects – that is, systematic collections of empirically established facts. The scientist must then use the method of induction to slowly generalize from these well-established facts.

But is the Baconian method devoid of *any* presuppositions? Dan Garber has shown textual evidence for the claim that it is not. Bacon describes his method as that of finding the Form of a body that is correlated with one of its simple natures. The notions of "form" and "nature" have particular meanings:

[1] [MacFarlane, 2000] identifies logic with its formal nature but argues that one should distinguish various meanings of the notion of *formal:* normative rules constitutive of discourse, independence of subject matter, independence of semantic content. I shall not define the precise nature of logical form but claim that Baconian induction cannot be taken to be formal in any of those senses.

[2] We can consider much of the history of logical positivism as a series of attempts to devise a formal theory of observation and failures to do so. For example, Wittgenstein's logical atomism, Carnap's formal analysis of sense content in the *Aufbau*, the debate between Schlick, Carnap, and Neurath about protocol statements, and Carnap's distinction between observation and theoretical predicates. See [Hempel, 1935] for an account of early developments.

> The idea here is, first of all that there are a certain number of privileged properties in bodies, the "simple natures". All bodies can be thought of as an aggregate of such simple natures, unified in a single thing which can be said to have all the properties conjointly. And secondly each of those properties has a single form which is present in each instantiation of the simple nature [Garber, 2021, p. 4].

Bacon's method is based on the presumption that each natural substance can be considered the aggregate of simple natures. This assumption can be taken as Bacon's guide to turn observational statements into empirical inquiry. If a substance can be taken to be the aggregate of simple natures and there is a basic alphabet of simple natures, then Bacon provides a general guide for analyzing observational statements.

Following the analysis of bodies into simple natures, Bacon imagines the inquiry to be that of finding out the particular Form that is necessary and sufficient for rendering present a simple nature. He takes this to provide humans with control over natural bodies. If one knows which Form one can produce in a body to make a simple nature present, then one can, in principle, produce any body by independently producing every single one of its simple natures. Bacon assumes that the production of one simple nature is independent of the production of another simple nature.

Bacon's Matter Theory

The initial sense in which Bacon's method does not follow a formal schema is that he provides us with a guide for analyzing phenomena into simple natures. The purpose of constructing natural histories presupposes that bodies are thusly analyzable. Each natural history aims to investigate a simple nature, as Bacon's example of heat demonstrates. One also learns, after the method of induction is carried out, how to induce a simple nature onto a body.

But a further, even more substantial assumption concerns Bacon's notion of Form. Even though Bacon often refers to Forms as natures, they are not the same as the simple natures that are the elementary ingredients of phenomena. Rather, the notion of Form helps inquirers transcend the veil of perception. While Bacon is often characterized as a strict empiricist – taking the content of observations and results of experiments to be the basis for all scientific knowledge[3] – Bacon explains that sense-perception is limited and misleading:

> But by far the greatest hindrance and distortion of the human intellect stems from the dullness, inadequacy and unreliability of the senses, so that things which strike the senses outweigh those which, even if they are

[3] See [Popper, 1994, 84] for such a reading.

> more important, do not strike them immediately. Reflection therefore almost stops where sight does, and so things invisible attract little or no attention. Thus every operation of the spirits enclosed in tangible bodies lies hidden and escapes men's notice. In the same way too every more subtle metaschematism in the parts of grosser bodies (which they commonly call alteration, though it is really local motion *per minima*) evades detection; yet unless the two things just mentioned are sought out and brought to light nothing great can be done in nature as far as works are concerned… For the sense is by nature a weak and wandering thing; and instruments to amplify and sharpen the senses do not count for much; but all truer interpretation of nature is accomplished by means of instances, and apt and appropriate experiments, where the sense judges only the experiment while the experiment judges nature and the thing itself [NO, I, 50][4].

Bacon conceives two aspects of matter that are hidden from the senses, and so to make knowledge of nature possible, one must find a way to disclose those aspects. The two elements are the operations of spirits enclosed in tangible bodies and the structural changes in the parts of dense bodies.

The concluding remark of Aphorism I, L, illuminates what can be take as a theoretical scaffolding for Bacon's method. For Bacon, sense gives only a judgment on the experiment, while the experiment gives a judgment on the nature of the thing itself. Thus, it seems that Bacon is speaking of some indirect inference from sense-impressions to the conclusions of the inductive inference. The senses do not provide the *content* of the inductive inference; they provide opportunities to reveal, through experiments, some hidden structures that give rise to simple natures.

Guiding Bacon's thinking about the subsensory level of description is a form of corpuscular thesis, in which change is conceptualized as a change in the configuration of the corpuscular parts. In Bacon's work, there are favourable remarks regarding ancient atomism [ibid., 57], but also critical remarks[5]. To understand Bacon's commitments regarding atomism, one can consult a text entitled *Cogitatione de Natura Rerum* (CNR), probably written in about 1604[6]. In this text, Bacon articulates a corpuscular program for studying nature. This program deviates from ancient atomism in that it takes configurations of corpuscles to change as

[4] NO refers to [Bacon, 2004].

[5] Commentators debate whether and to what extent ancient atomist theories of matter inspire Bacon. [Kargon, 1966] argues that Bacon's conception of matter is based on atomism, while [Rees, 1980] emphasizes Bacon's alchemy. One can also find variations in Bacon's attitude toward the vacuum (see [Manzo, 2003]). In the rest of the paper, I hold that Bacon revises ancient atomism to produce a dynamic form of corpuscularianism. According to Bacon's theory, natural processes are reduced to changes in corpuscular configurations that stem from active inclinations that are present in corpuscles and composite bodies. Thus, both the qualified remarks favorable to atomism and alchemical, active principles can be accommodated in Bacon's matter theory.

[6] CNR quotations are translations from [Bacon, 2011].

a result of the inclinations and appetites present in those corpuscles[7]. Bacon argues that standard accounts of change and motion, many of which are derived from the Aristotelian tradition, ought to be replaced with another account:

> With these things dismissed, or related and damned to vulgar expositions, those inclinations and affections of things finally ought to be investigated, from which flow and emerge, as we see, such a great variety of effects and changes in the operations of both nature and craft. And this is to be done so as to bind nature, like Proteus in chains. Proteus's true chains are the rightly discovered and discerned kinds of motions. For the conversion and transformation of matter itself follows the stimuli and constraints of motion (that is, of excitation and restraining) applied [CNR, 20–21].

Corpuscular inclinations or appetites provide a reductive program, given that "a great variety of effects and changes" may follow from them. Knowledge of inclinations or appetites is also crucial for studying human crafts that transform substances. The purpose of seeking such knowledge is both theoretical and practical: The aim is to "put Proteus into chains", to harness natural processes for human ends and technological power.

In Bacon's program, patterns of corpuscular changes and transformations are studied for their own sake:

> The principles, origins and forms of motion, that is, the strives and affections of matter of every kind, are lacking in philosophy. And subsequently also: impressions and impulses of motions, restrictions and obstinancies, paths and impasses, alternations and mixtures, periods and sequences and, finally, the universal progression of motions [ibid., 21–22].

What Bacon seeks is not to reduce observable properties to the properties of the corpuscular parts and their configuration. Rather, he claims that the *inclinations* for change ought to be the aim of study. He imagines these inclinations as "principles" or "forms" of motion. Moreover, he holds that the properties that appear to be motionless states of bodies are the result of inclinations for change present in the corpuscular parts. For example, although heat is often attributed to bodies as if it were a certain state or a property of bodies, one can reduce heat to inclinations for change and patterns of motion that underlie this property – in particular, the motions of corpuscular parts, but also the hot body's tendency to expand. Or, for example, the solidity or fluidity attributed to substances may be the product of equilibrium of tendencies for change and motion.

Once the basic inclinations for change are known and categorized, one may demonstrate how bodies exhibit a combination of those inclinations, to form the specific bodies we encounter in nature.

---

[7] For an extensive discussion of material appetites in the *Sylva Sylvarum* see [Giglioni, 2010].

> And certainly, just as the words and terms of all languages, in all their immense variety, are made up of few simple letters, by the same reason the universal forces and actions of material things consist of a few natures of simple motions and origins. For it ought to be shameful for man to explore so thoroughly the ringing of their own voice and yet be so illiterate in understanding the voice of nature, and in the manner of primitive times, prior to the invention of letters, to discern only composite sounds and vocalizations and discern not elements and single letters [CNR, 22].

Bacon provides an analogy of letters and words in a language to make his idea about forms of motion clear. There is a finite number of letters in a language, but an infinite number of words (or expressions) that can be constructed from these letters. Similarly, there is a finite number of universal forces and actions – a few simple motions – and an infinite number of combinations of these forms of motion. The task is therefore to find and categorize the basic "forms of motion" and construct a complete understanding of how specific bodies are formed and transformed. Bacon's analogy suggests that before the invention of writing, one was able to discern only composite sounds and vocalizations in language, without knowledge of how to construct words from their basic elements. Similarly, in our study of nature, we recognize some composite changes and motions but are not able to identify the "simple motions and origins" from which such changes arise.

In the NO, Bacon explains that the inductive method is to find, for each simple nature, the Form that is necessary and sufficient for making present the simple nature. However, he does not articulate very precisely what he means by Form, and he does not explain how the notion of Form is related to his matter theory. But there is much textual evidence that, in the NO, he takes the Forms to be those very forms of motion he described in the CNR. That is, he takes Forms to be a list of basic inclinations that bodies have to change their corpuscular configurations. For example, regarding what natural philosophy *needs* to do versus how traditional philosophy pursues knowledge, he describes it as follows:

> But there is no more to these notions than their popular appeal, and they do not penetrate into nature in any way; and they are just the measures and periods of motion, and not its species. For they suggest *how far* and not *by what means*, or *from what source*. Nor do they signify anything to do with the appetites of bodies or the process of their parts; but only when the motion presents the thing to our sense in the crudest way as something different from what it was do they begin to establish a division…
> But leaving these matters aside, if someone sees (for example) that bodies have an appetite for mutual contact, so that they do not let the unity of nature be completely broken up or torn apart to create a vacuum; or if someone says that bodies have an appetite for recovering their natural size or tension so that if squeezed within or stretched beyond it, they at

> once try to recover and take up their old sphere or bulk again; or if someone says that bodies have an appetite for getting together with the masses of their connaturals – i.e. dense bodies towards the Earth's globe, and thinner or rarer ones towards the confines of the heavens then these and others like them are truly physical kinds of motions; whereas those others are simply logical and scholastic, as is obvious if you compare them [NO, I, 66].

Bacon explains what kinds of explanation one should find for change, replacing explanations that are prevalent in existing philosophies of nature. His explanations include the various appetites that are present in bodies. He provides examples to make his aim clear: the appetite for mutual contact (some force of attraction between bodies), the appetite for withdrawing to the body's natural size (elasticity), and the appetite to assemble with masses of the same kind (the mutual attraction of bodies of the same kind).

There is more textual evidence for taking the notion for Forms to be the "forms of motion" of the CNR. In Book II, Bacon articulates a list of what he calls "practice instances"; these instances will guide those who are interested in the practical arts of transforming bodies.

> For the most part operation lets you down (especially after careful investigation of natures) by inaccurate determination and measurement of the powers and actions of bodies. Now the powers and actions of bodies are circumscribed and measured either by point in space, moment of time, concentration of quantity, or ascendancy of virtue, and unless these four have been well and carefully weighed up, the sciences will perhaps be pretty as speculation, but fall flat in practice. The four instances which are useful in this connection I call by the single name of *Mathematical Instances* and *Instances of Measure* [NO, II, 44].

Thus he suggests that to identify the appetites of bodies, one has to determine and measure their powers and actions. He claims that one should measure carefully the parameters that determine the nature of the appetite – its strength in relation to distance, time, and mass, or its strength relative to the strength of other appetites. Thus, Bacon holds that the study of these appetites requires quantitative measurement and analysis.

In summary, Bacon's notion of Form provides a theoretical scaffolding for the analysis of natural bodies. He imagines all natural phenomena can be explained with the help of appetites of various strengths – dependent on parameters such as distance, duration, mass, and relative strength. The program then relies on inductive inference to correlate such fundamental appetites with the simple natures observed in bodies. This is a reductive program, aiming to fill out the details, in terms of both discovering the basic forms of motion and correlating these forms with simple natures.

The Relation Between the Inductive Method and Matter Theory

What is the relation between the inductive method, as Bacon conceived of it, and his dynamic form of corpuscularianism? Contrary to standard interpretations of Bacon, he does not think one should approach nature without any presuppositions about it. Rather, Bacon presupposes the contours of a general matter theory as a theoretical background necessary for carrying out the inductive inference. For Bacon, his dynamic form of corpuscularianism is necessary for several reasons.

First, much of what is true of natural bodies lies beneath the level of observations. Thus, we need to conceive of the contours of some matter theory to make inferences from observable natures to their underlying causes. The theoretical scaffolding enables the inference toward the unobservable realm, the processes that are too minute and subtle to be observed by the naked eye.

Second, while Bacon attempts to reveal the unobservable processes of nature, he does not infer from some observable effect, a sense-impression, the causal basis that produces the impression in human perception. Rather, the dynamic form of corpuscularianism enables Bacon to infer from observable change – mediated by his matter theory – the nature of material change. Bacon conceptualizes all change as a result of bodies' tendencies to change their corpuscular configurations. These tendencies underwrite the processes that *make present* and *make absent* the sensible natures in bodies. Thus, Bacon's inductive method attempts to track how simple natures *become* present and how they *become* absent. It follows that the inductive method studies transformations, not merely the presence of certain observable qualities. Bacon's inductive method does not try to find correlations between two observable qualities, but to find correlations between two levels of description of bodily changes. One level is the hidden process of change: change in the configuration of corpuscles. The second level is the overt process: an observable quality becoming present and becoming absent.

Third, there is a sense in which matter theory *grounds* our reasoning in things rather than words. Words have a logical form, which enables us to understand the logical relations between propositions. The logical form can be used to form a judgment about the validity of arguments – that is, whether one proposition can be derived from other propositions or whether a set of propositions is consistent. But matter theory in its most general articulation provides us with *material form*, the possible states of bodies. More importantly, a generalized matter theory offers paths by which bodies can transform – not how one proposition can be derived from other propositions, but how one state of matter can be physically derived from another. According to this analysis, particular inclinations are

distinct paths of transformation narrowed down from an infinite set of possible transformations. Thus, a given generalized theory of matter does not predetermine the results of the inductive inference. It does provide the inductive inference with a clear contour for analyzing change, but it does not reveal which particular inclinations are parts of nature.

Thus, we might summarize the above by claiming that Bacon's dynamic form of corpuscularianism is a theory of material form. With the help of this theory, the scientist can theorize material change and the making present and absent of observable qualities. This theory also informs the practice of experimentation because it guides the experimenter in making the kinds of interventions that are supposed to make present the observable quality. It tells the experimenter what is happening, theoretically, during experimental transformations.

The Epistemic Status of Material Form

What is the epistemic status of Bacon's generalized matter theory, his dynamic form of corpuscularianism? The theory presupposes primary qualities attributed to the corpuscular parts, qualities such as size, shape, and local motion. It also presupposes geometry as the background structure which helps to describe a certain inclination. An inclination is derived from observations, but since it amounts to typical changes in the configuration of corpuscles, to describe the inclination one must presuppose geometric knowledge of distance relations. Bacon's matter theory also presupposes a temporal metric with which one can determine the rate of change for corpuscular configurations. If Bacon's inductive method presupposes a geometry, a temporal metric, and a generalized matter theory, can we treat the contents of such a theory as synthetic *a priori* judgments? Does it have the status of relativized *a priori* in the neo-Kantian sense? If the generalized matter theory is not valid *a priori*, are there unique inductive procedures that aim to gain knowledge of the general framework of matter theories?

Needless to say, Bacon does not address these questions; he treats his matter theory as a general backdrop for defining the inductive method. Given the flexibility of dynamic corpuscularianism and given that the specific types of natural inclinations are not defined prior to empirical inquiry, the theory does not prejudge the results of empirical investigations. That is, the theory does not predetermine which inclinations will be revealed by experiments. We can therefore retain the analogy between logical form and material form: The logical form of a proposition does not predetermine the type of content it can articulate. Similarly, material form does not predetermine the types of inclinations that would form the bedrock of Bacon's fully articulated matter theory.

Still, in hindsight we can identify several scientific revolutions, and Bacon's dynamic corpuscularianism does not resemble current theories of matter. For example, Cartesian and Newtonian theories incorporate the concepts of *conatus* and inertia, formulated for the most part after Bacon's work. Inclinations, in later matter theories, must take into account the basic inclination of matter to remain at rest or to move uniformly in a straight line. Moreover, Bacon does not analyze forces or bodily actions as the exchange of quantities of motion. Although he does recommend measuring the strength of the inclination, he does not recognize the fundamental role of quantities of motion in measuring the strength of those inclinations. Furthermore, Bacon does not explain whether types of inclination belong to particular *kinds* of matter or whether these inclinations exist in all material parts. Clearly Bacon's theory of matter is very rudimentary and, in hindsight, inadequate.

Bacon's theory of induction cannot be relied upon to explain how empirical evidence can increase our understanding of the general contours of matter theory. Nevertheless, some of the inductive strategies relevant for assessing matter theory were developed later. In his *Principia*, Newton articulated such an account in his Third Rule for the Study of Natural Philosophy. In this rule, Newton describes a unique inductive method for revealing the primary qualities of corpuscles[8]. Newton's argument in the *Principia* is that gravity is a universal property existing in the ultimate material corpuscles from which bodies are made. The argument is based on an invariance that gravity exhibits: Gravity remains invariant under transformations of bodies because it depends only on the body's mass and no other property. Thus, Newton's argument broadens the evidential basis for the dynamic corpuscularianism presupposed by Bacon, showing why gravity should be included as another inclination existing in corpuscles. This inclination is described with mathematical precision by Newton's Universal Law of Gravitation.

In one of the queries to the Opticks, Newton describes a program of finding additional central forces that explain bodily properties such as electricity, magnetism, and cohesion. This program appears to correspond, while presupposing Newton's three laws of motion and his mathematical definition of central forces, to those inclinations described very roughly by Bacon. This Newtonian program was later superseded by field theories and later revisions in fundamental assumptions about geometry and matter. So perhaps we should think of Bacon as envisioning the initial step toward an inductive method based on a rudimentary notion of material form. His method does not describe the empirical strategies used to revise our understanding of fundamental features of our matter theories, only the role of a general matter theory in explaining the appearance and disappearance of observable qualities. Bacon's dynamic form of

[8] See [Belkind, 2017; Belkind, 2019] for an account of Newtonian induction.

corpuscularianism is *a priori* in one sense: It consists of assumptions presupposed in analyzing transformations and change. But it is empirical in another sense – based on empirical evidence in ways that Bacon does not have the resources to explain.

Garber grapples with the role of matter theory in Bacon's inductive method. He is rightly perplexed by how Bacon might have relied on matter theory when he attempted to do away with anticipations of nature. Garber suggests that we might take Bacon's presuppositions as a distinct kind of *a priori* – not a set of *a priori* judgments about the world, but a set of *a priori* methodological assumptions:

> I propose that they are what we might call *methodological anticipations* or a *methodological a priori*. They can be thought of as "preparative" to the method insofar as assumptions of some sort are necessary to get the method off the ground [Garber, 2021, p. XX].

The notion of material form helps to explain how substantive assumptions about nature might have the role of being *methodological a priori*. They are *a priori* in the sense that they are crucial in designing experiments and learning from experiments about natural processes. We need to suppose how bodies transform when we design interventions into natural processes. But we try to articulate these assumptions so as not to prejudge the *outcome* of these experiments. I would also argue that Bacon's account of the inductive method is an incomplete account of the strategies for deriving knowledge from empirical evidence and that his theory is the initial step in a program that unfolds over a long period of time.

Acknowledgments

I would like to thank Aviram Rosochotsky, who translated the *Cogitationes de Natura Rerum* and provided many useful comments on this and similar work.

I would also like to thank Dana Jalobeanu and Dan Garber for organizing a joint symposium on Bacon's *Novum Organum* as part of the Princeton-Bucharest Virtual Seminar in Early Modern Philosophy – the exchange in this paper with Dan Garber is an outcome of the symposium. I benefited and learned much from discussions with Dana and Dan, and with Elodie Cassan who also participated in the symposium.

References

Bacon, 2011 – Bacon, F. *The Works of Francis Bacon*, vol. 3. Cambridge University Press, 2011.

Bacon, 2004 – Bacon, F.; G. Rees and M. Wakely (eds.) *The Oxford Francis Bacon, Vol 11*: *The Instauratio magna part II: Novum organum and Associated Texts*. Oxford University Press, 2004.

Belkind, 2017 – Belkind, O. "On Newtonian Induction", *Philosophy of Science,* 2017, vol. 84, no. 4, pp. 677–697.

Belkind, 2019 – Belkind, O. "In Defense of Newtonian Induction: Hume's Problem of Induction and the Universalization of Primary Qualities", *European Journal for Philosophy of Science*, 2019, vol. 9, no. 14. DOI: 10.1007/s13194-018-0241-5.

Garber, 2021 – Garber, D. "Bacon's Metaphysical Method", *Epistemology & Philosophy of Science,* 2021, vol. 58, no. 3, pp. 22–37.

Giglioni, 2010 – Giglioni, G. "Mastering the Appetites of Matter. Francis Bacon's *Sylva Sylvarum*", in: C.T. Wolfe and O. Gal (eds.) *The Body as Object and Instrument of Knowledge*. Springer, 2010, pp. 149–168.

Hempel, 1935 – Hempel, C.G. "On the Logical Positivist Theory of Truth", *Analysis*, 1935, vol. 2, pp. 49–59.

Kargon, 1966 – Kargon, R.H. *Atomism in England from Hariot to Newton*. Clarendon Press, 1966, 178 pp.

MacFarlane, 2000 – MacFarlane, J.G. "What Does It Mean to Say That Logic Is Formal?" Doctoral Dissertation, Pittsburgh.

Manzo, 2003 – Manzo, S. "The Arguments on Void in the Seventeenth Century: The Case of Francis Bacon", *British Journal for the History of Science,* 2003, vol. 36 (1), pp. 43–61.

Popper, 1994 – Popper, K.R. *The Myth of the Framework: In Defence of Science and Rationality*. Routledge, 1994, ix+158 pp.

Rees, 1980 – Rees, G. "Atomism and "Subtlety" in Francis Bacon's Philosophy", *Annals of Science,* 1980, vol. 37 (5), pp. 549–571.