CASE STUDIES

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РОЛЬ ИДЕИ ИМПЕТУСА В РАЗВИТИИ ЕСТЕСТВЕННЫХ НАУК

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В дискуссиях вокруг теорий, объясняющих научный прогресс, натуральная философия позднесредневекового периода рассматривается как играющая роль апологетики. Для философов науки с их отказом от метафизики задача обеспечения рациональной реконструкции научного прогресса представляется почти невозможной. Даже объяснения, предложенные Поппером и Куном, испытывают большие трудности и дают лишь частично удовлетворительные результаты. В своей работе «Логика научного исследования» К. Поппер утверждает, что метафизика играет случайную роль в появлении новых научных идей. В свою очередь, в «Структуре научных революций», осуществляя теоретические интерпретации и классификацию эмпирических фактов без их метафизических предпосылок, Томас Кун приходит к выводу о том, что естествознание сформировалось под влиянием ошибочных интерпретаций аристотелевской натурфилософии средневековыми натурфилософами. Это является одной из причин того, что медиевистам до сих пор приходится защищать натурфилософию позднего Средневековья от поверхностных убеждений в том, что в средневековых университетах вообще не могло быть ничего, имеющее значение для современной науки и философии. Стремясь представить фрагмент последовательной реконструкции развития естественной философии, я рассматриваю одну из идей позднесредневековой философии – а именно, объяснение движения (импетус). Основной тезис данного исследования в том, что идеи позднесредневековой натурфилософии сыграли отнюдь не случайную либо отрицательную роль в развитии современного естествознания – напротив, они имеют здесь решающее значение. Следуя аристотелевскому философскому подходу, статья раскроет предпосылки теории импетуса Жана Буридана. Затем будут представлены дебаты по поводу объяснения движения снаряда, и, наконец, будет выявлено необходимое значение этой метафизической идеи о

модификациях натурфилософии.
Ключевые слова: философия науки, позднесредневековая натурфилософия, теория импетуса

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THE SIGNIFICANCE OF THE IDEA OF IMPETUS FOR THE DEVELOPMENT OF NATURAL SCIENCE

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In the discourse around theories explaining scientific progress, natural philosophy of the Late Medieval Period is seen as playing the role of apologetics. For philosophers of science, with their repudiation of metaphysics, the task of providing a rational reconstruction of how scientific progress has occurred is nigh on impossible. Even explanations such as the Popperian and the Kuhnian strain under great difficulty and provide only partly satisfactory results. In his "Logik der Forschung" (1934) Karl Raimund Popper argues that metaphysics plays an accidental part in the emergence of new scientific ideas. Correspondingly, in "Structure of Scientific Revolutions" (1962), by carrying out theoretical interpretations and classification of empirical facts without their metaphysical premises, Thomas Kuhn comes to the conclusion that natural science was formed under the influence of erroneous interpretations of Aristotelian natural philosophy presented by medieval natural philosophers. These are some of the reasons why medievalists are still made to defend late medieval natural philosophy from shallow convictions that at medieval universities nothing of any significance to contemporary science and philosophy took place at all. Seeking to render a fragment of a coherent reconstruction of the development of natural philosophy, I will investigate one idea of late medieval philosophy – the explanation of motion (impetus). The main statement of the paper holds that the ideas of late medieval natural philosophy have a decisive significance for the development of modern natural science instead of accidental or negative one. In the paper, following Aristotelian philosophical approach, premises of Jean Buridan's theory of impetus will be exposed. Then, debates over the explanation of projectile motion are going to be presented, and finally, the necessary significance of this metaphysical idea on the modifications of natural philosophy is going to be ascertained.
Keywords: philosophy of science, late medieval

natural philosophy, theory of impetus
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1. Introduction

In the discourse around theories explaining scientific progress, an important task is to provide a rational and coherent reconstruction of how scientific ideas develop. However, in the context of late medieval natural philosophy, this task is nigh on impossible. Even explanations such as the Popperian and the Kuhnian strain under great difficulty and provide only partly satisfactory results. In his "Logik der Forschung" (1934) Karl Raimund Popper argues that metaphysics plays an accidental part in the emergence of new scientific ideas. Correspondingly, in "Structure of Scientific Revolutions" (1962), by carrying out theoretical interpretations and classification of empirical facts without their metaphysical premises, Thomas Kuhn comes to the conclusion that natural science was formed under the influence of erroneous interpretations of Aristotelian natural philosophy given by medieval natural philosophers. Thus, natural philosophy of the Late Medieval Period is still seen as playing the role of apologetics and needs to be defended from shallow convictions that at medieval universities nothing of any significance to contemporary science and philosophy took place at all.

The research is based on a premise that two ancient Greek philosophical systems had a significant impact on forming the conception of natural philosophy in the Middle Ages. The systems are Platonic and Aristotelian. Without metaphysical premises, they also included theological ones [Crombie, 1953; McKeon, 1930; Wallance, 1972].

Briefly, Crombie states that the most striking changes in history of science are for the most part brought about by new conceptions of scientific procedure. Since the rational explanation contained in scientific texts confronted significantly with empiricism in practical arts in twelfth and early thirteenth centuries, questions concerning reality and truth were being posed as a special part of a single philosophical activity, "natural science". And it was metaphysics that played a big part in providing every science with necessary characteristics of reality [Crombie, 1953, p. 1–2]. Wallance documents the legacy of Greek science and treats how Platonic currents merged with Aristotle's thought as they were transmitted to the Latin West. 13thand 14thcenturies are regarded as centuries of shaping scientific explanation, causal terminology, developing consistent methodological tradition that continued all the way to the founders of modern science [Wallance, 1972, p. 10–11]. McKeon's statement is even more straightforward. The problem of knowledge has been investigated through the whole age of Western philosophy and the significant characteristics of philosophy have been determined in large part by the answer which has been given in each case to the problem of how we know: "if the Platonist turned to God and eternal ideas in answer to the question of how we know, the Aristotelian sought the an-

swer in terms and ideas, and in their combinations and separations, which are accomplished by the human intellect. ... It was the Aristotelian logic and the Platonist philosophy, not science, which first turned philosophers of the thirteenth and fourteenth centuries to the data of experience" [McKeon, 1930, p. xi–xii].

The main statement of the paper holds that the ideas of late medieval natural philosophy have a decisive significance in the development of modern natural science instead of accidental or negative one. In order to prove the statement, I will firstly investigate Popperian and Kuhnian attitudes towards the importance of metaphysical systems to the development of scientific ideas. Secondly, following Aristotelian philosophical approach, I will analyse Jean Buridan's explanation of projectile motion and its premises. Lastly, I will establish their significance to a coherent reconstruction of scientific development.

2. Accidental and negative significance of metaphysical ideas to scientific change

In Kuhnian and Popperian theories around explaining scientific change, medieval natural philosophy is considered to be significant to the development of scientific ideas only for:

1) Accidental and psychological importance of metaphysical ideas for the advance of science throughout history [Popper, 2002, p. 16], which could be equated to any other non-scientific cause, for example, newly emerging universities [Grant, 1996, p. 32].
2) The negative effect that "the series of crises" caused by Aristotelian researchers had on Galileo's views [Kuhn, 1996, p. 123].

In the first instance, for Popper, the question of how a new idea occurs is irrelevant to the logical analysis of scientific knowledge, but may be of great interest to empirical psychology. The former is concerned with questions of justification or validity (*quid juris*) only, and may be logically examined. The latter is concerned with the process involved in the stimulation and release of an inspiration: metaphysical realism, according to Popper, can only give a methodologist "some intuitive encouragement, some hope, but no assurance of any kind. And although a rational treatment of methodology may be said to depend upon an assumed, or conjectured, aim of science, it certainly does not depend upon the metaphysical and most likely false assumptions that the true structural theory of the world (if any) can be stated in human language" [Popper, 2013, p. 146]. Thus, there is a sharp distinction between the process of conceiving a new idea and the methods and results of examining it logically. Therefore, the logic of knowledge and the psychology of knowledge stand in contradistinction to one another [Popper, 2002, p. 7–8].

As for the second instance, by carrying out theoretical interpretations and classification of empirical facts without their metaphysical premises, Thomas Kuhn comes to the statement that natural science was

formed under the influence of erroneous interpretations of Aristotelian natural philosophy presented by medieval natural philosophers. Comparing Nicole Oresme's and Galilei's explanations of the motion of a pendulum, Kuhn states that Aristotelians deployed different conceptual categories when they dealt with a falling body. Deploying different conceptual categories had created different experiences and had formed intellectual changes that produced Galilei's laws: "Normal research guided by them could not have produced the laws that Galileo discovered. It could only – and by another route it did – lead to the series of crises from which Galileo's view of the swinging stone emerged. As a result of those crises and of another intellectual changes besides, Galileo saw the swinging stone quite differently" [Kuhn, 1996, p. 123].

For Popper, metaphysics plays an accidental role in the emergence of new ideas and is not linked to a rational reconstruction of scientific ideas. To Kuhn's scope, metaphysical premises are disregarded, therefore the inquiry into nature is expressed in the need to systematise facts instead of the need to understand nature. Kuhn's aim to describe scientific development of research paradigms, erroneously, reinforces the preconception that at medieval universities nothing of any significance to contemporary science took place at all. Moreover, in both explanatory systems natural science is autonomous: it describes its own principles and itself determines its development.

3. The reconstruction of the idea of impetus

This paper uses Jean Buridan's theory of impetus and Nicole Oresme's notion of empty space as one of the best examples that show how metaphysical and theological premises play much more important role in defining and developing natural inquiry than Popper and Kuhn had indicated. Besides, the theory of impetus is a good solution to Aristotle's projectile motion problem. Therefore, I will briefly describe the main aspects of Aristotle's explanation of a motion of a falling body, then the main characteristics of the theory of impetus and how it conditions explanations of empty space and the philosophical inquiry into nature.

For Aristotle, scientific knowledge stems from a grasp of principles, causes and elements of a subject. It is the first step that needs to be taken to gain scientific knowledge of nature [Arist. *Phys*. I.1, 184a10-a16, trans. Waterfield]. Because of that, the explanation of projectile motion requires continuous efficient causation. In Aristotle's case, such efficient causation was the air "for air is both light and heavy, and thus *qua* light produces upward motion, being propelled and set in motion by the force, and *qua* heavy produces a downward motion. In either case the force transmits the movement to the body by first, as it were, tying it up in the air" [Arist. *DC*, III. 2, 301b23-27, trans. Stocks].

This explanation was actively interpreted by *via moderna* natural philosophers "as implying that a projectile, on leaving the hand or mechanism of projection, was kept in motion either by some extrinsic

cause such as the air, or by an intrinsic cause, a *fluxus formae* or a *forma fluens*, such as the *impetus impressus* postulated by the French physicist, Jean Buridan" [Crombie, 1953, p. 175–176].

Impetus was introduced as an effect that produces continuous efficient causation for the motion of a projectile. It also served the purpose of solving Aristotle's conceptual problems about the effect of the heaviness of a body for its natural and constrained movements. Buridan argues:

> "Thus, we can and ought to say that in the stone or other projectile there is impressed something which is the motive force *(virtus motiva)* of that projectile. And this is evidently better than falling back on the statement that the air continues to move that projectile. For the air appears rather to resist. Therefore, it seems to me that it ought to be said that the motor in moving a moving body impresses *(imprimit)* in it a certain impetus *(impetus)* or a certain motive force *(vis motiva)* of the moving body, [which impetus acts] in the direction toward which the mover was moving the moving body, either up or down, or laterally, or circularly. *And by the amount the motor moves that moving body more swiftly, by the same amount it will impress in it a stronger impetus.* It is by that impetus that the stone is moved after the projector ceases to move. But that impetus is continually decreased (remittitur) by the resisting air and by the gravity of the stone, which inclines it in a direction contrary to that in which the impetus was naturally predisposed to move it. Thus, the movement of the stone continually becomes slower, and finally that impetus is so diminished or corrupted that the gravity of the stone wins out over it and moves the stone down to its natural place" [Buridan, 1959, p. 534–535].

Not only was Buridan's concept proposed "as a further development of Aristotle's theory of motion, wherein the distinction between natural and violent (compulsory) still obtained" [Wallance, 1981, p. 42], but the concept also shows how the inquiry into the natural world is implemented into Aristotelian metaphysical system.

4. Conclusions

Comparing Popperian and Kuhnian attitudes towards the importance of metaphysics in natural inquiry for scientific change with Jean Buridan's theory of impetus, Aristotelian metaphysical system and the study of nature in Late Medieval Period, we are likely to come to the conclusion that neither Popperian nor Kuhnian explanations decently qualify for the aims of this paper. Unlike Popperian and Kuhnian explanations of scientific development, accepting Aristotelian system of philosophical inquiry into nature gives us access to further investigations of how scientific ideas had been developing over Late Medieval Period. The example above shows that (1) Aristotelian metaphysical system embodies the forming of methodological foundations of inquiry into nature in late medieval Western Europe [Plėšnys, 1999, p. 5]. (2) In the

14th century, before any significant revisions in Aristotelian natural philosophy, smaller incremental departures of exact sciences from natural philosophy were taking place. They were enough to fashion a spirit of inquiry, that may have provoked the *Scientific Revolution* [Grant, 2011, p. 106], but they were not as thoroughgoing as to have been considered independently from metaphysical contexts.

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