NoMoS Conference
Laws and Powers in the Metaphysics of Science
12- 14 June 2023
National and Kapodistrian University of Athens
Dept. of History and Philosophy of Science

About NoMoS

NoMoS aims to break new ground by advancing a novel theoretical model of the status and necessity of the laws of nature. It will attempt a major reconceptualisation and synthesis of some of the most basic concepts within metaphysics of science by overcoming extant conceptions and by bringing the metaphysics of science in better contact with the current scientific image of the world. The core of this new theoretical model will be a unified approach, according to which both laws and causal powers play discrete and indispensable roles in specifying the nomological structure of the world.

* Principal Investigator: Professor Stathis Psillos, Department of History and Philosophy of Science, University of Athens
* Team Members: Konstantina Antiochou, Antionis Antoniou, Stavros Ioannidis, Maria Panagiotatou, Vanessa Seifert
* Collaborators: Vasilios Livanios, Carl Hoefer, Markus Schrenk, Robert DiSalle
* The project is supported by the Hellenic Foundation for Research & Innovation (H.F.R.I.).

For more information, visit: https://metaphysicsofscience.wixsite.com/nomosproject
Follow us on twitter: @NoMoS_P

Book of Abstracts

Antonis Antoniou (University of Athens)
Making sense of laws in Cosmology

The conceptual understanding of laws in cosmology faces important difficulties due to two closely related characteristic features of cosmology: (i) the uniqueness of the Universe, and (ii) the questionable distinction between initial conditions and laws of nature. Regarding the former, Munitz (1962) and Ellis (2006) have argued that the uniqueness of the Universe makes the concept of 'Laws of Physics' that apply to only one object questionable, and thus, as opposed to other branches of physics, cosmology does not undertake to establish laws about the Universe. With respect to the latter, Ellis (2014) has argued that in cosmology, it is not clear how to separate laws (generic relations that must always be true) from initial and boundary conditions (contingent conditions that need not be true). As a result, certain lawlike constraints on the initial conditions of the Universe (such as the Past Hypothesis (Callender 2004) and spacetimes with no closed timelike curves (Sklar 1984)) can be regarded as fundamental laws of nature. The aim of this talk is to

examine these two philosophical issues and provide (the seeds of) a Carnapian theory of laws in which (a) the concept of laws that apply only to one object makes sense and (b) the distinction between the initial conditions of the Universe and the laws of the Universe is elucidated.

Francesca Bellazzi (University of Bristol)
Biochemical powers

Biochemical molecules are interesting case studies for those interested in inter-science relations as they can be approached either from the perspective of chemistry, focusing on their microstructure, or from the perspective of biology, focusing on the function they play. They are molecules at the borders: on the one hand chemical on the other biological. I this paper, I will consider how biochemical functions can be considered a bridge between the two components, instead of a sort of disunity. Throughout the paper, I will support my argument by referring to vitamin B12.

The structure of the talk is the following. First, I will present the debate concerning biochemical kinds and why functions are often taken to be a source of disunity. Then, I will present a way to interpret biochemical functions. I will argue that biochemical functions can be analysed in terms of a specific set of chemical powers that contribute to the biological process under consideration. These powers can be considered weakly emergent, and thus "biochemical" together with chemical. In this way they can be seen as a bridge between the chemical and the biological, without losing their proper identity. I will conclude by considering whether this form of emergence is compatible with forms of reductionism, such as functional reductionism.

Robert DiSalle (University of Western Ontario)
Natural laws and metaphysical necessities: On the ineffective reasonableness of mathematics

Newton's *Principia* advanced the idea of a world governed by strict mathematical law. Hume's admiration for Newton's laws did not prevent him from advancing his well-known skeptical argument against the idea of necessary connections in nature. But Newton himself anticipated some of Hume's skeptical concerns. I will show how, in facing those concerns, Newton took a far-sighted view of the power and the limitations of mathematical laws, and the subtle relations between natural powers and our mathematical pictures of them. Along the way, Newton's approach suggested what it might mean to take a realist perspective on laws that are possibly, if not probably, wrong. This approach is illuminating for contemporary debates on the application of mathematics to physics, and on the role of mathematics in physical explanations. In particular, it places the connection between mathematical necessity and metaphysical necessity in a problematic light.

Toby Friend (University of Bristol)
Nature's Just Laws

I defend the thesis that all of nature's foundations are metaphysically explained by elementary laws—in a phrase: *nature's just laws*. Why defend such a view? I will make the following case. 1. It's the best metaphysics of laws for making justifying foundationalism in physics (i.e. the view

that there are some foundational laws which are comprehensive and exceptionless). 2. It's the best metaphysics of laws for doing justice to the idea that laws explain their instances. 3. It's the best metaphysics of laws for making sense of the availability of alternative formulations of laws within foundations of physics. The thesis can sound a bit like Ontic Structural Realism. I'll end by saying why I prefer not to think of it that way.

Michel Ghins (UC Louvain)
Powers without essences: a necessitarian account of laws of nature

An empiricist metaphysics must be as close as possible to perceptual experience and also strive to avoid superfluous ontological baggage. In this paper, I defend a propositional or sentential view of laws according to which laws are propositions; they are not realities in the world. Scientific laws are identified as universal propositions belonging to well established scientific theories. Moreover, laws are propositions for which we have good reasons to believe that they are approximately true. But science alone is unable to ground the distinctive mark of laws, namely their necessity. I argue that such necessity is grounded on causal powers the belief in which is justified on the basis of indirect empirical evidence. Yet, powers are metaphysical entities since they are not immediately observable. Thus, scientific laws deserve to be called "laws of nature" because the ground of their necessity is metaphysical.

Are laws necessary in a strong – absolute - sense, that is, true in all logically possible words? I think not. The necessity of laws is not a *de dicto* necessity depending on the meanings of words, but a *de re* necessity depending on the instantiation of causal powers, which is relative to some worlds, but not all, and is thus contingent. The necessity of laws is then conditional upon the instantiation of their corresponding powers.

Some authors, such as Brian Ellis, attempt to defend that the laws of nature are necessary by adding substantial natural kinds in their ontology. I argue that such a ploy is impotent to justify attributing strong necessity to laws. Moreover, I submit that there is no empirical evidence in favour of the reality of substantial natural kinds. The natural kind terms refer to associations of properties. Some of these associations are necessary in some worlds, but not all.

Giacomo Giannini (LSE)
Unmasking the Big Bad Bug for Dispositionalism: Necessary Perfect Masks, Degrees, and Locality.

Dispositionalism is the theory that grounds metaphysical modality in the potentialities of actual entities. It is widely recognised that its most formidable challenge is the possibility of Necessary Perfect Masks: necessary entities that infallibly prevent some potentiality to bring about its manifestation. The existence of necessary perfect masked potentialities is inconsistent with Dispositionalism. There are three solutions: i) modify Dispositionalism, ii) show that NPMs remove the masked potentiality, or iii) show that there are no NPM. Vetter argues against i) and ii) on grounds that it would undermine the localised character of Dispospositionalism. I will argue that the 'big bad bug' of Dispositionalism goes beyond than Necessary Perfect Masks — the possibility of NPM only highlights a deeper issue within Vetter (2015)'s theory, concerning the role

of degrees in the theory. Only potentialities with a non-zero degree ground possibilities — but degrees are not a localised affair. This allows for a simple solution to the problem of necessary masks — at the price of locality. Thus, dispositionalists need to choose between abandoning locality, or modifying their theory as to preserve and offer an independent solution to the problem of NPM. I suggest that the former is preferable, and argue that the value of locality is vastly overstated.

Carl Hoefer (University of Barcelona)
Kripke-Putnam essentialism about water and the laws/powers debate

Stavros Ioannidis (University of Athens)
Laws and Powers in Descartes

According to a traditional view, in the seventeenth century the concept of laws of nature replaced the aristotelian notion of powers in natural philosophy. However, a closer look at the work of central figures of the period reveals a more complex conceptual landscape, where the notion of power is not abandoned but transformed and reconceptualised. Thus, a dualist model, where both laws and powers are needed to understand the nomological structure of the world, seems to better account for the views of various early modern thinkers. The aim of this paper is to examine the relationship between laws and powers in the thought of René Descartes, and defend a realist solution to what is known as the 'problem of force' in Cartesian physics, i.e. the problem of how to understand the ontological status of forces in Descartes's *Principia*. Contrary to common non-realist views, I will defend a realist account of forces, according to which forces are modes of bodies grounded in motion that ground body-body causation. The main claim of the paper is that Descartes has a concept of force that is structurally similar to the aristotelian notion of power. Thus, a dualist model of the metaphysics of Cartesian physics looks very promising.

Philip Kitcher (Columbia University)
The theory of scientific explanation: an obituary

Vassilis Livanios (University of Cyprus)
Powerful Qualities and the Dualist Model

Ioannidis, Livanios and Psillos (ILP) have recently proposed a Dualist Model (DM) for the source of natural modality found in the actual world. According to DM, relata-specific nomic relations and properties with thin powers are individually necessary but only jointly sufficient in order to have an adequate metaphysical explanation of the actual behaviour and dispositions of objects. DM, as ILP themselves acknowledge, needs further elaboration because it leaves some crucial questions unanswered. One of these questions concerns the grade of modal strength of nomically governed properties. In this talk, after presenting some reasons for embracing the view that the most plausible version of DM accords to properties the ultra-light power of nomic governability in general, I will focus on the question regarding the nature of properties possessing the ultra-light power. I will first argue that the only existing metaphysical view about the nature of properties which is compatible with the ultra-light-power version of DM is the Powerful Qualities View (PQV); that is, the view according to which properties are both dispositional and qualitative. Then,

I will propose a novel version of PQV according to which properties are dispositional because they have the ultra-light power to be nomically governable, and qualitative because they need metaphysically robust, governing laws to determine their nomic role.

Wayne Myrvold (University of Western Ontario)
Varieties of Wave Function Realism
The phrase "Wave Function Realism" (WFR) has come to be used for a family of views according to which quantum theory motivates us to think that quantum wave functions are fields on a space of extremely high dimension, which is in some sense more fundamental that ordinary three-dimensional space or four-dimensional spacetime.

With an aim at gaining clarity about the nature of the project, in this talk I distinguish between varieties of Wave Function Realism that one might advocate. I focus on two axes of distinction. One has to do with the nature of the project. Is it an Interpretive project, one of accepting standard quantum theory pretty much as we have it, and exploring its implications for ontology? Or is it a Constructive project, which finds standard quantum theory wanting in crucial aspects, and seeks to construct a new theory that will satisfy some set of metaphysical constraints? The other has to do with how radical the claims are that are made about the nature of spacetime. Does the fundamental space on which the wave functions of WFR are defined have intrinsic structure corresponding to the low-dimensional spacetime structure? I call versions of WFR on which this is so, "Mild" versions, as on such a view any sense in which the low-dimensional spatial structure is non-fundamental would be at best a highly attenuated one. A more radical view, which I call "Spicy," has it that the fundamental space has no intrinsic structure corresponding to our low-dimensional spacetime, and that such structure is emergent from the structure and evolution of certain sort of wave functions.

Judging from what they say about the view, it seems that proponents of WFR intend it to be Interpretive and Spicy. I will argue that there can be no such position. Standard quantum mechanics makes such heavy use of low-dimensional spacetime structure that an Interpretive version of WFR must be Extremely Mild. A Spicy but Constructive version has yet to be formulated, as proponents of WFR have never been specific about the structure of the supposed fundamental space, or about the dynamics of the theory they envisage.

Maria Panagiotatou (University of Athens)
Wave function: law, power, both, or neither?

My aim is to analyse the status of the wave function in quantum mechanics and examine the prospects of a dualist model in the metaphysics of science with laws and powers equally fundamental. I will discuss views that attribute law-like status to the wave function and views that give power-based descriptions of it. In this light, I will examine whether there is room for unifying the law-like and the power-based views about the wave function in order to suggest a better understanding of its role in the context of nonrelativistic quantum mechanics.

Stathis Psillos (University of Athens), with commentary by Mauro Dorato (Università degli Studi Roma Tre)
Natural Necessity De-Ockhamised: a Leibnizian account

The main thesis of this paper is this: the sources of natural necessity are both laws and powers. This dualist account was first presented by Ioannidis, Livanios and Psillos (I.L.P) in a paper published in EJPS in 2021 and promises to overcome the problems faced by monistic accounts, that is accounts of natural necessity which posit either laws or powers. Monism has been the dominant approach and it comes in two broad forms: one is based on laws, claiming that natural necessity is nomological necessity, while the other is based on causal powers, claiming that natural necessity is a function of the powers particulars have to act and be acted upon. We can call the former view Lawful Powerlessness (LP) and the latter Powerful Lawlessness (PL). Among the advocates of LP the prominent two are nomic necessitarians a la Armstrong and primitivists, while the advocates of PL are dispositionalists.

The paper is structured as follows: There are four sections. In section 1, two of the key arguments against monistic views will be reviewed. Against PL it will be argued that an exclusively power-based ontology cannot account for laws of conservation. Against LP, it will be argued that it cannot solve the 'governing problem', viz. the problem of how properties in general are nomically relatable. It will be suggested that all of these problems are overcome if we adopt a dualist ontology, viz., laws and powers. In section 2, we will revisit the argument of, what I take him to be, a key precursor of dualism, viz., Leibniz. He had an account of the metaphysics of science in which laws (holding with natural and not metaphysical necessity) are required for the overall structure and the intelligibility of the world while powers are required for the laws to be 'executable' by worldly things. This argument was based on Leibniz's God-governed universe; and yet it can be dissociated from this, along the following lines: laws follow from basic (primitive) symmetries that obtain in the universe but some conception of powers is needed to explain why and how things 'obey' laws. In section 3, the Dual Model will be introduced. It will be explained how a relatively thin conception of powers is enough to ground the nomic relatability of worldly things but that laws are also necessary to account for the overall structure of the world as well as for the existence of specific relations among worldly things. Finally, in section 4, the key methodological problem of the apparent uneconomical (de-ockhamised) character of dualism will be addressed.

Vanessa Seifert (University of Athens)

The (many) laws in the periodic table

Unlike what is standardly called the 'periodic law', there are many- not just one- laws represented in the periodic table. These laws correspond to regularity relations connecting physical and chemical properties of various (sets of) elements. Chemists discover these relations through the analysis of the posited classifications of elements in the modern periodic table. I support this claim in three ways. First, I show that standard features associated with laws are exhibited by these regularity relations. Secondly, the regularity relations of the periodic table can be coherently spelled out in terms of the two standard views on laws: the regularity and necessitarian view. Thirdly, these relations can figure in discussions about the reality of laws, as plausible candidates of ceteris paribus laws. All this offers convincing grounds that these relations are at least as good candidates of non-accidental regularities as other paradigmatic examples in science. Finally, I

present two challenges which could undermine this claim and which concern the predictive and explanatory power of these regularities. I discuss how they can be overcome.