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Mokslo filosofija ir logika

NORMATIVITY OF SCIENTIFIC LAWS (I): TWO KINDS OF NORMATIVITY*

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Abstract. *This article presents the results of a broader research project which aims to argue for the normativity of scientific laws. Usually scientific laws are regarded as descriptive, which contrasts them to prescriptive norms. To show their normativity, I utilize the logical account of explicitly normative systems by Carlos Alchourrón and Eugenio Bulygin (1971). I identify the characteristic elements of normativity and analyse accounts of implicit normativity in science using those terms to show the affinities of explicit and implicit normativities. The research project continues with the substantiation of the normativity of scientific laws in detail and the results will be presented in* Normativity of Scientific Laws (II) *(Mets 2018).*

Keywords: *laws of nature, normativity, explicit normativity, implicit normativity, technology*

The laws formulated in sciences, either mathematical like the Newtonian laws, or qualitative like the law of evolution, are often taken to be descriptive. I agree that these laws describe models of nature rather than nature directly, as held in the constructive realist philosophy of science, advocated by Ronald Giere, Rein Vihalemm, Vyacheslav Stepin, and others. I subscribe to many of the implications of the model based approach to science. However, I argue that the laws and models of science are not merely descriptive but also normative in certain senses. This article extends and further develops the results presented in my doctoral dissertation (Mets 2013), which examined the normative attributes of scientific laws.

The implications of a model based approach to science are essential to my argumentation. Models are abstract entities that have similarities in certain aspects and

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to certain degrees with studied portions of reality. Constructed in scientific practice and described by scientific laws, they represent their target system, enabling "surrogate reasoning" – theoretically figuring out solutions to questions concerning the empirical world, without having to empirically try the solutions out at the start (Suárez 2004). It is then up to humans to assign the model to represent a certain portion of reality for a certain purpose (Giere 2004, 2010). As Giere (2010: 274, referring to Suárez 2003) emphasizes: representation rests on similarity on the one hand and on human agency on the other: as similarity is a symmetric relation (if a model (M) resembles reality (R), then R resembles M), then it is the (scientific) agent who brings the asymmetry into the relation, intending to use one thing as representing the other and not the other way around (hence M is intended to represent R, but not R to represent M).

Introducing a reversal of this relation, I claim that not only do models represent reality, but reality, in some senses, also represents models. Namely the reality *is made* to represent models, that is, it is rendered into as close conformity with them as possible. This is most clearly seen in engineering – building apparatus on the basis of drawings and schemata, but also occurs in several implicit and covert ways both mentally and materially (we *believe* to fall due to gravitational force, and airplanes are *built* to defy it). Joseph Rouse expresses the implication of such models succinctly: models are simulacra – they do not merely represent (a representation would be an abstract object), but they are more things in the world, they "transform the available possibilities for human action […] by materially enabling some activities and obstructing others" (2002: 176-177).

Therefore, scientific models and their corresponding laws are particular kinds of norms that form the basis by which portions of the world are shaped. I find it important to notice this kind of normativity for broad political reasons: just as our actions are not normatively neutral to the world – that is, they contribute to the perception of how it is normal to act. In this way, our theories, especially scientific theories, are not neutral. They have become taken-for-granted in our thinking and behaviour. This often happens to the exclusion of other ways of thought and cognition, thus scientific laws are potentially oppressive and authoritative due to their socio-political imperativeness. Therefore, I regard part of this "enabling of some activities and obstruction of others" as coercive, like social norms, or implicitly prescriptive.

The normativity of explicitly normative systems lies in prescribing the actions or the end states (of those actions) in defined cases (Alchourrón and Bulygin 1971; see also Mets 2013 for a comparison of legal and scientific systems from this point of view). Scientific laws in themselves seem to prescribe no actions, hence they are said to be normatively neutral (Beebee 2000; Haack 2007; Rundle 2004; Mumford 2000, 2004; von Wright 1951, 1963; Dalla Chiara and Giuntini 2002).[1] However, not only did historical forerunners or analogues of contemporary sciences entail explicit

[1] Value-neutrality or value-ladenness of scientific laws is closely related to their prescriptivity: as much as values guide choices and decisions, they influence actions to be taken. Here I can touch upon the value-ladenness of scientific laws only briefly.

prescriptions, but also some contemporary philosophical accounts of scientific laws and theories, more or less explicitly state their normativity – primarily implicit prescription (or entailment) of actions. I will use Alchourrón's and Bulygin's (1971) "logic of normative systems" in order to provide a clearer shape to the aforementioned accounts. This corresponds well with the model based approach and is sufficiently intuitive. As a result, several kinds of normativity that are implicit in scientific laws will be exposed, which I will briefly enumerate and describe.

The output of the *Normativity of scientific laws* is divided into two parts. The aim of the current article is to discern the two kinds of normativity and to compare them in respect to their logical structure. In the second part of the research (Mets 2018), I suggest my own categorisation for the implicit kinds of normativity in science. In the first section of this article, I articulate the concept of explicit normativity by Alchourrón and Bulygin (1971) in order to establish a clear, analytic account of normativity – of what bestows normativity to a system, and consider a preliminary analogical application to science. Using the received concept of "normativity as prescription of actions", in the second section, I provide an approximation to implicit normativity on the basis of Joseph Rouse's (1987, 2002) philosophical account of science as normative practice. I then expose the most pertinent aspects of scientific practices that imply actions and prescriptions thereto and constitute an essential background for the kinds of normativity expounded in the second part of the project: technology and world picture.

1. Explicit Normativity

To be quite clear about what is meant by normativity, let us take an account of explicitly normative systems as the reference point. We utilize Carlos Alchourrón's and Eugenio Bulygin's (1971) logical reconstruction of normative systems. Their logic is that of legal acts and the system consists of the following elements: the Universe of Discourse, the Universe of Properties, the Universe of Cases, the Universe of Actions, and the Universe of Solutions. The Universe of Discourse addresses which real world events (misdeeds) the law is aimed at. The elements of the Universe of Discourse are actual, individual events happening in concrete space and time, for instance, on Sunday evening, John sells Jack a book owned by Mary. The Universe of Properties establishes which legally relevant properties constitute the treatment of a particular kind of misdeed in written law (e.g., a certain kind of harm – Mary was dispossessed of her book, or in good faith with a party in an event – Jack believed John to be entitled to sell the book). The Universe of Cases is defined by the presence or absence of aid properties; it is a set of generic cases, e.g., theft, which, together with the Universe of Properties (inflicted harm, bad faith), determine an appropriate Universe of Discourse or elements thereof. The Universe of Actions includes the possible actions to be taken in case of said type of misdeed (for example, the difference between theft and a larceny may include incarceration). These actions possess a logical atomism in which they are logically independent of each other and from other properties; they are equated with their effects, that is, with states of affairs to be reached through the actions. Lastly, the Universe of Solutions provides the Universes of Actions with deontic operators ("permitted", "obligatory", "prohibited", and "facultative"). Any normative system correlates Universes of Cases with Universes of Solutions (Alchourrón and Bulygin 1971, Ch. 1).

From this basis, I suggest a way scientific laws can be mapped onto the given logic of laws and normativity, using the Newtonian law of gravitation as an example. The Universe of Discourse for a scientific law is comprised of the cases which it can be applied to (e.g., massive bodies – for that is what the gravitational law is applied to). The Universe of Properties are the quantities defined in a physical theory and used to define laws of nature, e.g., mass *m*, gravitational force *g*, time *t*, etc. The Universe of Cases is the set of laws where the relations and, thereby, intensities of said properties are defined, here $F=gmm'/r^2$, where proportionality, inverse proportionality, and multiplication are the relations, and whenever four of the variables have determinate magnitudes, the fifth is determined too. In model-theoretic terms, the properties are the aspects of a real-world system that the model or case represents (i.e., their mass or bulkiness, distance of their centers of mass). This terminology can analogically be transferred to law, where cases are models of the (social) world in legal theory or act, and properties are the aspects of the world that matter in terms of, and for the purposes of, that theory or act. At first sight, there seem to be no clear correspondence with the Universe of Actions and the Universe of Solutions in science like there is in law. Science is often viewed as normatively neutral, that is, it makes no prescriptions for treating concrete, real-world systems (e.g., laws of nature describe, whereas legal norms prescribe). Due to this, whereas legal norms can be obeyed or disobeyed, laws of nature cannot be said to be disobeyed and in this sense they also cannot be said to be consciously obeyed or followed; necessary *A* implies *A*, obligatory *A* does not imply *A* (von Wright 1951, 1963; Dalla Chiara and Giuntini 2002; Haack 2007, and others). Therefore, whereas a stone necessarily falls with the acceleration of ~9,8 meters per second square near the earth's surface, it is not by necessity that a larceny is followed by 10 years of incarceration if the law establishes it so.

Alchourrón and Bulygin (1971: 170) themselves draw a parallel between the logical functioning of scientific and normative systems that I here present in tabular form below (logical denotations in the rightmost column added by me):

	Explaining (science)	**Justifying (normative)**	**[logical denotation]**
Description of:	phenomenon	Solution	$[G]$
deduced from:	scientific system	normative system	$[\{(F\rightarrow G)_i\}_{i=1\ldots n}]$
– consisting of:	general laws	general norms	$[(F\rightarrow G)_i]$
and from:	antecedent conditions	a case	$[F]$
Uses	predicting future phenomena	guiding future actions	$[(x)(Fx\rightarrow Gx)]$
	explaining past facts	justifying past actions	$[(x)(Fx\rightarrow Gx)]$

Here one can then recognise that the Universes of Cases and of Solutions (introduced as *F* and *G* respectively for the column "Justifying (normative)") are united in the normative system and its constituent norms. The corresponding universes for science differ from my given interpretation by implying a temporal relation similar to that of law in which it is applied diachronically, that is, after the precedent case or conditions have taken place, not simultaneously with them. In my framework, the conditions can be considered as a result of the coupling of the properties (variables) in a scientific law (the "general laws") being assigned certain values, thus resulting in the description of a certain state of affairs or a possible real phenomenon; e.g., a stone of a certain mass falling from a certain height near the earth's surface. Although, also here an interpretation of the Universe of Actions is missing for science, something can be inferred about it based on the uses indicated in the table. Whereas there is justification and guidance for the uses of normative systems related to human will and action, there is prediction and explanation for scientific systems. Those rely on causal relations (explaining or predicting somethinghappening on the basis of its antecedent conditions), normally understood as independent of human agency.

Two important aspects of Alchourrón's and Bulygin's account should be noticed here. Firstly, what makes a system normative is actions. Normative systems prescribe actions to be taken (or to be refrained from), or more broadly, activity and actor or agent constitute an essential part of the system. And secondly, end states of actions are included in normative systems as elements of Universes of Actions. This means that certain states of affairs are considered normative or wishful and actions are prescribed to the effect that those states of affairs are reached. So, the prescribed actions ought to eliminate what is considered discrepancies and errors from the world, to bring the world into conformity with norms. This brings Alchourrón's and Bulygin's account of normativity closer to the understandings of implicit normativity introduced in the next section.

2. Implicit Normativity

The systems that Alchourrón and Bulygin (1971) call normative are so on logical grounds due to them containing explicit prescriptions for actions. As they advocate analyticity and clarity of concepts through strict definitions of technical terms, their concept of "normative" may also be regarded as technical. They are "explicitly prescriptive" in this logical sense of sentences telling what is to be done or which states of affairs are to be reached. However, there are also less technical concepts of normativity applied in the context of science. In this section I will link the elements of normativity established previously to Joseph Rouse's (1987, 2002) explicit conception of normativity in science. His account of science's normativity is rare and full-blown, in that it touches upon all aspects of science. I will also bring in the notions of technology and world picture to strengthen my claims and articulate the implications they hold for scientific laws and their prescriptivity.

Rouse (2002) argues for implicit normativity in scientific practices as an alternative to the regularities-account: that is, scientific practices cannot be identified on the basis of regular procedures and activities, as there are no objective regularities, e.g., in following rules, including following rules of doing science (traditions, common beliefs, etc., that identify a scientific community) (Rouse 2002: 168–183). Rouse's normativity-account of scientific practice has various "constituents" and "intra-actions" that he furnishes with the adjective "normative":

- The surrounding world;
- Understanding of the self in relation to this surrounding world;
- Other practices (including discursive practices);
- Inter- or intra-actions – particularly causal ones – with the world (people and things): ("Causal interactions with objects acquire normative authority over what people say and do" (*ibid*: 186));
- Interaction with scientific-experimental apparatus (*ibid*: 286-287);
- And also that which in other accounts might be called laws of nature, or phenomena: ("The repeatable pattern of a physical phenomenon is […] normative rather than simply regular" (*ibid*: 280)).

The last three – causal interactions, phenomena, and apparatus – will be brought out in my discussion as they are the most relevant for science. They touch upon several aspects of laws that Rouse regards as interdependent: their expression of some kind of order or regularity in the world, their relation to the world, the theories that encompass them, and the ones that formulate them. Rouse sees discourse as strongly dependent on practice and perception. Above all, his notion of normativity seems to mean the implicit guiding role of "what is at issue and at stake" in scientific practices, what is being aimed at, and that something is being aimed at. The issues and stakes, on their part, change constantly as the world and perception of it is changed through material activities (practices) (*ibid*: 25, 174-176).

To clarify Rouse's concept of normativity further, let me highlight that the practice or action makes up the world and therefore also makes up science.[2] Actions, and those actions being provided with deontic operators, are exactly the element of a logically normative system that underlies its normativity. In interpreting Rouse's account through Alchourrón's and Bulygin's terms, I then argue the fundamental constituent of life-world (the subjective world immediately experienced) and science is the Universes of Actions, and that "what is at issue and at stake" determines the Universes of Solutions (i.e., what state of affairs is to be reached and what is to be done). Those are the two defining features of explicitly normative systems. Scope or Universe of Discourse is, on the one hand, the perceived part of the world but, on the other hand, it must be regarded as the world acted upon, for we aim our actions towards what we perceive as existing and relevant. However, it is also clear that all the Universes are subsumed to constant reconceptualization and reestablishment, as issues and stakes change due to the constant explorative and conceptual reconfiguration of the world in scientific practices and other actions. This of course implies the historical changing of implicit norms, which complicates detecting concrete norms and demonstrates the normativity of practices like science.

Rouse (1987, 2002) locates the various normativities he detects in science in a

[2] Thanks to Associate Professor Endla Lõhkivi for pointing this out to me.

broad existential and cultural context inspired by Martin Heidegger:

> We always find ourselves in a world whose sense is already laid out toward concrete possibilities. We choose among specific possibilities, but we do not in the same way choose the field of possibilities from among which we choose. This field remains hidden from us […] as something so close to us and so obvious that we see right through it. We are unable to envisage concretely what an alternative to this field would be, and we are likewise unable to envisage the field itself as such (Rouse 1987: 62).

This hints at what Heidegger (1959b, 1977a) calls the "fundamental characteristics" of the "reality within which man of today moves and attempts to maintain himself", and those characteristics are "determined on an increasing scale by and in conjunction with that which we call Western European science" (Heidegger 1977a: 156). The ground for this interpretation is the concept of world picture[3], which I believe to encompasses (if not outright consists of) both the said fundamental characteristics of the reality and the hidden field of possibilities. Vihalemm describes world picture as an ontological projection of pre-theoretical and theoretical schemata, or what the world is believed to consist of. It thereby determines legitimate actions and activities because one acts upon and in accordance with what one believes to exist. Inspired by Heidegger, Vihalemm views world picture as strictly linked to science.[4] For Heidegger (1977b), this concept refers to the world, including human action (upon it), becoming a picture, an ordered, observable, and controllable system, in and through scientific theories.

Taken more broadly (as does Vycheslav Stepin, introduced below), world picture also encompasses other comprehensions of the world besides the scientific one. [5] It is normative as far as the ontology – what is believed to exist in the world, including which phenomena and (causal) relations (elements exerting normative power, in Rouse's account) – determines actions to be taken. For example, if it is believed that there are laws given by a higher, transcendental being that all must follow, then what appears as unusual might be seen as violating those laws and thus as subject to sanctions – hence motivating man to take action such as punishing the trespasser. For instance, there were cases in Medieval Europe where roosters were punished for laying eggs, for they violated God's laws that male birds should not lay eggs (example from Needham 1951: 225). If laws are seen as inherent (instead of universal and transcending), so that every individual thing is seen as following its own laws, like in Confucian China, then it is the law of that particular rooster to lay eggs and no action is taken against it for that (*ibid*). A contemporary, natural scientific world picture would motivate studies to find a universally holding natural cause for a bird with female reproductive organs to grow the feathers characteristic of males.

Vyacheslav Stepin (2005) additionally proposes narrower notions of the scientific world picture and more specified world pictures for specific disciplines. The world picture, besides its other functions, creates

[3] Vihalemm 1979: 40, 183-184; see also Stepin 2005: 93, and Agassi 1956: 1-4.

[4] From personal communication with Professor Vihalemm.

[5] Here I stick to the broader notion and save "world as picture" for the Heideggerian notion.

a system of values that determines the character of world cognition and an active relation of man to the world. It thereby prescribes legitimate hypotheses, problems, and solutions for scientific theorising and research. That is, they restrict the underlying assumptions of theories and hence the phenomena that make up the scope (Universe of Discourse) of the theory, but also its structure (Universes of Properties and of Cases), thereby determining what makes up phenomena and what deserves heed.

Thus the world picture can be said to determine what or which state of affairs are considered as normal or wishful. Consequently, it is a background determinant of Universes of Solutions as elements of Universes of Actions (actions and their end states), furnished with "deontic operators". Explaining this in Rouse's terms: the Universe of Solutions are the specific choices made among the field of possibilities (though I will not address the question as to whether the Universe of Actions constitutes the entire field of possibilities).

Apparatus, as one of the elements exerting normative power in Rouse's account, pertains to technology. Heidegger (1959a: 14) points out two notions comprising the essence of technology that he claims to be prevailing in common thought: technology as human activity (anthropological notion), and technology as a means to an end (instrumental notion). Taking these into account, we see that scientific practice, as accounted by Rouse, is technological in both senses: science as activity is human doing, and as an aspiration to create solutions to problems, determined by what is at issue and at stake, it is a means to an end. As everything that a human does is human doing, the instrumental definition necessarily complements the anthropological one, as not all human doing need be a means to an end. It might further be specified by Mario Bunge's (2003: 173) characterisation of technology, according to which technology is "that field of research and action that aims at the control and transformation of reality whether natural or social". Bunge concedes that science does the same as technology, in this respect, but to a lesser extent – only in laboratory settings. However, even if the explicit aim towards the control and transformation of reality is less visible and extensive than in technology, implicitly and historically it is inherent in science. Experimental science materially, and any science conceptually, transforms the world for epistemic aims. Material, conceptual, and mathematical control is essential for formulating the so called "laws of nature".

From a simple pendulum to a particle accelerator, material rearranging of the world is the manifest precondition for the possibility of mathematising the world. Even the mathematization of celestial phenomena presupposes arranging certain observational apparatuses and situations. There are many accounts that link the notion of the laws of nature or scientific laws to purposeful activity, such as Vihalemm's φ-science, Nancy Cartwright's nomological machine, and others[6]. In essence, they state that the laws of exact sciences do not tell us what the world itself is like, but rather what can be done with it and what cannot, and in this sense, guide the material ordering of the world with the aim to achieve accordance with the mathematical formulation

[6] See Vihalemm (2016), Cartwright (1999), Dretske (1977: 264), for instances. Heidegger (1977a), Rouse (2002), Glazebrook (1998, 2000) express the same idea.

of the law. These accounts construe laws of nature (scientific laws) as built upon human activities, based on the ways human practices order and arrange the material world. As Cartwright (1999) argues, there are not enough regularities in the world as it naturally occurs, so in order to get a scientific law hold, one needs a contrived reshaping of the world where only the features included in the law are effective, and interfering factors are eliminated or taken control of as well as possible. This means that the Universe of Discourse of scientific laws is artificially created.

Conclusion

Normativity, as found on the basis of explicitly normative systems as in the case of law, is essentially prescribing actions or certain states of affairs as achievable via actions. This kind of normativity can be detected implicitly in science, particularly in scientific practice, as argued here on the basis of several philosophical approaches to science. This refutes the commonly received view of scientific laws in which they are merely descriptive (even if descriptive about models as abstract entities). Substantiating the normativity of scientific laws, however, requires further study into the ways how science implicitly performs prescriptions. This will be addressed in the second part of the research (Mets 2018), by mapping illustrations and accounts of normativity in science found mainly in philosophical, but also detected in scientific, literature.

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MOKSLO DĖSNIŲ NORMATYVUMAS (I): DVI NORMATYVUMO RŪŠYS

Ave Mets

Santrauka. Straipsnyje pristatomi pirmieji platesnio tyrimo projekto, kurio tikslas – pagrįsti mokslo dėsnių normatyvinį pobūdį, rezultatai. Įprasta teigti, kad mokslo dėsniai yra deskriptyvūs, ir priešinti juos preskriptyvioms išraiškoms – normoms. Siekdama pademonstruoti mokslo dėsnių normatyvumą, remiuosi Carloso Alchourróno ir Eugenijaus Bulygino (1971) atlikta aiškiai normatyvinių sistemų logine analize. Straipsnyje nustatomi elementai, leidžiantys apibūdinti sistemą kaip normatyvinę, ir jais remiantis analizuojamas moksle implicitiškai glūdintis normatyvumas. Taip panaikinamas pagrindas priešinti eksplicitinį ir implicitinį normatyvumą, išryškinamas jų bendrumas. Antrojoje šio tyrimo projekto dalyje (Mets 2018) detaliau aptariami šeši aspektai, teikiantys pagrindą mokslo dėsnius traktuoti kaip normatyvines išraiškas.

Pagrindiniai žodžiai: gamtos dėsniai, normatyvumas, eksplicitinis normatyvumas, implicitinis normatyvumas, technomokslinis pasaulėvaizdis, technologija

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