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NORMATIVITY OF SCIENTIFIC LAWS (II): ASPECTS OF IMPLICIT NORMATIVITY*

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Abstract. *In* Normativity of Scientific Laws (I) (Mets 2018) *explicit and implicit normativities were discerned and it was shown, following Joseph Rouse, that scientific laws implicitly harbour what Alchourrón and Bulygin imply to be the core of normativity. Here I develop this claim by discerning six aspects of implicit normativity in scientific laws: (1a) general and (1b) special conceptual normativity, concerning analytical thinking and special scientific terminologies; (2a) theoretical and (2b) material epistemic normativity, concerning mathematical and experimental accountability of the world; (3a) narrow and (3b) broad practical normativity, concerning technologies in both narrower and broader senses.*

Keywords: *laws of nature, normativity, implicit normativity, techno-scientific world picture, technology*

The discussion in *Normativity of Scientific Laws (I)* (Mets 2018) uncovered routes by which science becomes normative to us: by infiltrating our world picture and contributing to the material configurations by which technologies demand certain ways of behaviour. Thereby it comes to prescribe orderliness and corresponding actions. Now, I present my categorization of the aspects of science's normativity that are exhibited upon portions of the life-world other than science, and the activities bearing those aspects. The article is divided into three sections accordingly. Section 1 expounds conceptual normativity as it concerns the norms of speech and thinking: (1a) general and (1b) particular (or discursive) conceptual normativities. Section 2 details epistemic normativity, concerning scientific practices, as the most authoritative epistemic source in contemporary society: (2a) theoretical and (2b) material epistemic normativities. Section 3 exposes practical normativity, or how scientific norms influence the material world outside science: (3a) narrow and (3b) broad practical normativities. These six aspects pretend neither to completeness, exclusiveness, nor doubtlessly clear distinction, but rather illustrate and further clarify what I mean by the implicit normativity of science. I will explicate and articulate these aspects in greater detail below.

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1. Conceptual Normativity

Conceptual normativity hints to a conceptual treatment of the world, or how something must be comprehended and expressed in language and how language is related to the conceptualization and ontology of the world. This means that it pertains to what is believed to exist, thus it is relevant to actions and practices of those holding the beliefs. Rouse (2002: Ch. 6) also takes language, or discursive practices, to be a substructure of practice, meaning that conceptual normativity is intertwined with practical normativity.

1a. The general analytic way of seeing the world, both superimposed and presumed by the scientific thinking, divides the world into well-defined elementary parts, which when combined, make up the world. Examples of such compositions of elementary building blocks include: conglomerates of atoms; mathematical formulae, coupling variables referring to measurable properties; phenomena, either defined by the scientific laws of nature or by common thought; systems, as consisting of well identifiable and (conceptually) separable elements, with well definable relations between them (e.g., ecosystems, social systems). This general meaning of conceptual normativity is what I understand to be the core of Martin Heidegger's (1959a) notion of *Gestell* or enframing – the essence of technology, namely coercive scientific-technological ontology, whose essential features include clarity, countability, functionality, and stability (see also Seubold 1986 and Mets 2013). Arie Rip (2009: 408, 416) links such a conceptual treatment with engineering thinking, where the atomic, elementary parts that are believed to constitute the world can, in a hypothetical and ideal case, be manipulated in a controlled way like building blocks.

The concepts of the Universe of Properties, Universe of Cases, and Universe of Actions as atomic, independent, exclusive, and comprehensive exemplify this general, fundamental scientific-analytical attitude in the form of a logical system or a model. They are atomic, independent, and exclusive in both their elements, as well as among themselves. Another example might be that of measurement theory, which treats the world as divisible into independent dimensions, even if, in practice, the separate dimensions or attributes cannot be measured as unaffected by other attributes, e.g., length by temperature (some materials change their dimensions with changing temperature). A phenomenon in focus is defined as a structured set of attributes and, depending on the requirements of context, other circumstances are added as errors and uncertainties (the term +/-ε) or broken down into further factors, or separate phenomena, and inserted in form of variables[1]. Both these instances exemplify the model-based reasoning in science which requires this kind of analytic and atomistic treatment of the world.

I would also classify Mario Bunge's (2003: 173) general technological theories, such as information theory, optimisation theory, etc., but also mathematics here (Bunge does not list mathematics) because they shape general thinking about processes, phenomena, truth, or more generally ontology and structure of the world. Those instances also exemplify the next type of normativity and will be represented partially

[1] See, e.g., Baird (1964), Portides (2006) about pendulum, Boumans (2005), Mets (2012) about measurement theory and measurement errors.

in the example from economics below (from Tinker et al. 1982), that succinctly provides evidence for the normativity of those general technologies.

1b. Particular conceptual normativity concerns the way of correct thinking or talking or writing about the world (concrete elements of Universes of Properties and Universes of Cases) or perceiving it (concrete elements of Universes of Discourses), which might more properly be called "discursive normativity"[2]. This proper discourse is strongly influenced by the sciences: which words or conceptual networks should legitimately be applied, or truthfully describe the (human-independent) world.

This may hold true even if the exact scientific concept behind a word is unknown to most people using it. There are different ways in which language can be normative. For example, a scientifically laden word may be in broad use due to general science education in schools or due to popular science, but thereby hardly understood in its full scientific conceptualisation, thus sometimes boiling down to mere verbalism. Such is the case with the word "gene" in common language. It is often used to refer to "personal traits" and is used to explain various personal phenomena, which may be cultural instead of inherent as in the biological usage of the term, etc. Another kind of verbal normativity occurs when science hijacks words that may have, or had, common usages before the scientific one. Such as "energy", which is an Ancient Greek word meaning "activity" or "action", and the widespread extra-scientific uses of which is nowadays strongly dispraised, so physics in a sense prescribes the correct usage of the word. Then there is also a real coerciveness of conceptual systems behind the linguistic denotations applied, related to what Vyacheslav Stepin calls the special scientific world view. Antony Tinker, Barbara Merino, and Marilyn Neimark (1982) provide examples of this from value theory which has shaped the ways how means of subsistence and thus human economic conditions are treated in practice, guided by such concepts as capital, rent, profit, wage, optimization, etc. (Tinker et al. 1982: 176; more on this below). Some more examples of the complex, functional scientific concepts that shape common sense understanding or parlance of phenomena include: "species", "climate", "greenhouse gases", and "gravitational force".

Ernest Lowe (1989: 35) explicitly claims natural laws to be normative in a way that I consider relevant both conceptually and discursively. Under natural laws he understands nomological generalisations about sorts referring to normal sorts (hence his understanding of law of nature differs from mine). He seems to hold two different senses of normativity. The first is similar to judicial and moral laws and I will not pursue it further. The second sense of normativity (my reinterpretation of the first), which classifies it as conceptual normativity, pertains to the restrictions to human conduct and attitude (the discursive practices) towards the objects that laws refer to. Namely people, (e.g., scientists) who apply the laws, are to consider as objects (elements of the Universe of Discourse) of those laws those sorts, and derivatively individuals, that accord with the specification of the law. For example, the law "ravens are black"

[2] "Discursive normativity is an ineliminable dimension of all practices, including those scientific practices that disclose natural facts" (Rouse 2002: 173).

is to be applied to normal or typical ravens, whereas, e.g., albino ravens are to be considered as non-typical with respect to this law, although they may be typical with respect to a law about the underlying causes of albinism (Lowe 1980; 1989: 198-199). This reinterpretation pertains to my aspect of normativity *1b*, as laws of nature, or scientific laws, are embedded in scientific conceptualizations of the world. Thereby, they engender a sense of order as standards, and determine how it is normal to apply terms and understand relations between both them and their referents.

John Lemons, Kristin Shrader-Frechette, and Carl Cranor (1997), and Tinker et al. (1982) provide specific examples of this particular conceptual and discursive normativity of environmental modelling and of economics respectively. Lemons et al. tell of several examples of environmental management where politics relied only on scientific models, particularly numerically-mathematically expressible and evaluable aspects of the objects under consideration, without consideration to culture or other issues. The case of Yucca Mountain is in point here: considerations of its suitability as a heavy nuclear waste repository included measurable and calculable engineering and natural scientific models, neglecting discourse about the sanctity of the mountain for indigenous people as well as ecological aspects. This neglect is, however, perpetuated by the authors of said article. Tinker et al. recount how accountancy theories as allegedly positivist or realist (in contrast to normative) shape how values and relations between economy (subsistence and labour), finance, and society are understood: marginalist value theory expunged all but pecuniary relations from the concept of value. It thus ignores the underlying phenomena and processes and perpetuates capitalist market economy as a self-evident structure of subsistence. Being coercive, this theory shapes the way how economic processes and their participants – members of society – are handled, thus also pertains to the practical normativity (*3b*) expounded below. With their case study of value theories, Tinker et al. (1982) argue for the covert normativity of allegedly objective positivist (or realist) theories.

2. Epistemic Normativity

Epistemic normativity relates to what we know and can know, including both theoretical and material aspects of knowledge. It is primarily related to exact sciences or the sciences that formulate mathematical laws based on laboratory experimentation. Their epistemic success has raised them up as the epitome of science, engendering ideals and standards, however vague, of scientificity and scientific truth[3]. Even though the material experimental base of those sciences is indispensable for their mathematical theories, it makes sense to separate the material from the theoretical aspect of scientific knowledge and its generation, because the two sides sometimes seem to be detached from each other by insufficiently critical comprehension of science.

2a. The norm of theoretical and mathematical accountability, which is closely related to the requirement of conceptual clarity, requires measurability, or mathematical clarity, wherever possible. This implies in

[3] Vihalemm's concept of φ-science expresses, in idealized form, the essential characteristics of the exact sciences that underlie its reputation as *the* Science in Western societies, that include mathematicity and certainty in prediction.

principle, if not in practice, determinism, for mathematics is usually considered a priori, unique, and universal, independent of particular material idiosyncrasies (Vihalemm 1979: 44-50, 171-186, 191-198).[4] This means: mathematics requires no empirical testing – its truth derives from its theoretical base (axioms, definitions); in contrast to material and, hence, inherently historical and idiosyncratic things and situations, mathematical entities and relations are always and everywhere identical to themselves, not merely similar to some extent (Euclidian space and addition are always and everywhere Euclidian space and addition, "three" is always and irrespectively of counted objects "three" etc.).[5]

The normativity of mathematics as the principal feature of scientificity is manifested variously. One way is the expansion of the requirement of mathematization of theories beyond exact sciences. Rein Taagepera (2008) reports on and criticises social sciences for imitating physical sciences by purportedly bringing mathematics into their theories, thereby mistaking numericalness for mathematicity. Thereby their numericalness is achieved through statistics alone and the displayed exactitude is deceptive and has no functional role. Taagepera himself regards mathematics as equally important in social sciences (he has formulated such laws in political science), namely *principled* mathematical models, like in physics, not mere numericalness and ungrounded exactitude.

In Lemons et al. (1997: 217, emphases added) we can observe this normativity in an implicit form extended to natural sciences:

> In fact, ecology has *failed* to develop predictive laws because ecological *systems* are so inherently complicated that all the small and assumed insignificant *variables* can easily overwhelm the *ecological systems* and confound the *mathematical models*, as well as because of the fact that we simply do not understand much about the structure and functioning of ecosystems.

This quotation indicates both conceptual normativity (nature must be expressible as systems, that is, divisible into clear-cut elements with well definable relations among them) as well as mathematical normativity: that ecology is expected to provide predictive mathematical laws or models. Another quote provides further evidence of their sympathy for the mathematicity of sciences: "Many of these assumptions are scientifically questionable because they are not derived from any general scientific laws about fracture flow in a heterogeneous environment" (Lemons et al. 1997: 221). This concedes that it is the fundamental laws, and thereby probably the mathematical ones, that provide the truth.

The expectation of mathematically firm predictions in natural sciences and engineering is broader still. Case studies by Lemons et al. (1997), which focus on science based policy making, thus evidence the epistemic standards of fundamental science, like the standard of proof called the "95 percent

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[4] Probabilistic laws can be understood as deterministic in the sense that a particular probability holds necessarily. However, these so called laws (in physics) are based on particular frequencies in statistical collectives, hence they are statistical not probabilistic, that is, based on empirical data, not on apodictically true mathematical theory. (Probabilistic models, like fair coin or fair dice, could be said to constitute idealised versions of empirical frequencies.)

[5] Even though mathematics historically grew out of material practices like land-surveying and merchandise and others, hence has a material base, it is nowadays considered as a purely abstract discipline.

rule" (which means that a scenario of causal links has a confidence level of, or is taken as true if its probability is, at least 0,95). That rule can be applied in laboratory science, but is also expected and relied upon in complex cases with high environmental and health risks, where it is in fact inadequate. Such is the case of the Yucca Mountain as a possible repository for heavy nuclear waste where scenarios of nuclear waste evolution were considered as possible based on the 95 percent rule, even though models were severely restricted due to economic pressure and computational complication (ibid.).[6]

The demand for mathematicity and determinism of approaches in sciences restricts what is included in the models of those sciences: Universes of Properties and of Cases ought only to include quantifiable properties, hence, pursuant to Vihalemm (e.g., 2016), they model only those aspects of the world (Universe of Discourse) that can be described mathematically. In practical applications like policy making, this may severely hamper one's foresight, causing one to ignore aspects of things that cannot be meaningfully quantified. For instance, criticism by Lemons et al. (1982) of the modelling of Yucca Mountain only targets the restrictiveness of geological-physical attributes, but not the restrictiveness of the model merely *on* the said attributes with no attention at all paid to the biological or cultural contexts of the mountain[7].

Also the notions of measurement errors and noise provide evidence for the normativity of mathematical models of science: a datum, a (numerical) measurement result can only be said to exhibit an error or noise if there is a (mathematical) norm that says what an error or noise free datum should look like.[8] Moreover, following Demetris Portides' (2006) argumentation, the deviations from the idealised model of a phenomenon – the "noise" or material idiosyncrasies denoted by the ε (error margin) in equations – would themselves eventually become terms in a more "realistic" phenomenological model of that same phenomenon when they are on their part mathematized and integrated into a theory. Portides exemplifies this through the harmonic oscillator, or pendulum, whose pure idealised equation neglects such factors as friction, air resistance, quadratic damping, masses of the parts of the pendulum, etc. Those can be reinserted into the equation either in mathematical or purely numerical form to achieve a more precise mathematical description of the material pendulum. This manifests the urge to minimize the unknown and uncontrollable in theories and to maximize mathematical accountability, predictability, and control. I would regard these as elements of the Universe of Actions for science – mathematization and control.

2b. Material laboratory experimentation is a means to reach theoretical and mathematical accounts of the world. Scientific material practice answers the question: What should be done with the world, or how should the world be arranged and

[6] Epistemic values of science, particularly the 95 percent rule, is also discussed by Laudan (2006) in legal context which resembles the policy decision context as both depending on finding out the ultimate truth about particular real world individuals (objects or "systems", persons, events).

[7] Yucca Mountain has been a sacred site for local indigenous people since times immemorial (see Fowler et al. 1991; Kendziuk 2004).

[8] Agassi (1956 Part II: 95) concedes analogously: A fact seems "magical" or miraculous only in the light of a theory; and Giora Hon (2003: 190): Error is an epistemic phenomenon that is relative to a chosen standard.

ordered in a laboratory, so that the laws formulated in the sciences are applicable to it? I call this aspect "epistemic" because the aim of laboratory experimentation is to ensure knowledge about how a mathematical model and the material situation relate to each other, namely that they display a required resemblance. The epitomic concept of this resemblance are represented by Nancy Cartwright's (1999) nomological machines, which are material arrangements[9] displaying the regularities expressed in mathematical laws by featuring only and exactly the components or factors foreseen by their guiding law, and sufficiently stabilised (including the shielding from interfering factors)[10]. Therefore, they most closely approximate epistemic certainty.

This aspect pertains to the method by which "laws of nature" are reached: they are not read out of nature but constructed mathematically and experimentally. Mathematical theory guides laboratory activities, the design of experiments, and the interpretation of results (Agassi 1956; Taagepera 2008). Man arranges nature in laboratories according to his preconceived plans, some of which are mathematically defined, and in this sense sets norms on how nature should be (Glazebrook 1998 on Heidegger). Martin Heidegger's view of science as working or manipulating and refining the real to secure it for pursued aims expresses the active role theory and observation play in securing knowledge (Rouse 2002: 22; Heidegger 1977: 166-168; 1959b: 55-56; see also Stepin 2005, particularly chs. 1, 2, and 4). This view contravenes, in principle, both the inductivist as well as the representational understandings of law formation in science (or the naïve versions of them). In laboratories, the enacted causal chains of events lead to material setups which enable the measurement of theoretically prescribed attributes of interest. The Universe of Discourse is determined in laboratories: if a part of the world can be treated as a composition of measurable and calculable properties, or of simpler cases (combinations of properties) which can be treated in this way, it belongs to the Universe of Discourse or the scope of the theory. For example, climate models that cannot be studied in laboratories, are composed of simpler models of phenomena which can, on their own, be studied in laboratories: convection or properties of atmospheric gases, relations between atmospheric humidity, temperature, and pressure, etc.

Scientific practice is collective and evolutionary – that's where its normativity stems from.[11] "Evolutionary" denotes that due to the historically long practice and in a sense accumulative process, some of the theoretical knowledge becomes basic knowledge, often implicit and tacit, in the (laboratory) practice (of physics), and is not questioned anymore

[9] Nomological machines can be conceived variously: an ideal nomological machine is the abstract model corresponding exactly to the (mathematical) law that describes it; a material nomological machine is the laboratory set-up for the material testing of the law and its materiality conditions its imperfect similarity with the abstract model (Boumans 2005; Mets 2012). In some cases, a nomological machine can be realized conceptually or statistically, if the isolation of the phenomenon in laboratory is not possible, e.g., in clinical studies (Cartwright 1999: 113-118).

[10] As Boumans (2005) argues, the real material situation is never as perfect as the concept of nomological machine would have it. Instead, one must forego *ceteris paribus* – that all other circumstances remain equal – and content with *ceteris neglectis* – that the remaining dissimilarities of other circumstances are sufficiently insignificant with respect to the studied phenomenon.

[11] Rouse (2002) proposes implicit normativity in laboratory practices. See also Laudan (1984) and Stepin (2005).

(tests for a putative mathematical law are designed and run only until the mathematical formulation and test results are made to coincide, or the final shape and limits of the law settled[12], or the "phenomenon is stabilised"). "Collective" denotes that the normativity of laboratory physics is implicit in the "paradigm"; one learns already at the university what a "correct" problem looks like, how to treat it, what a solution ought to look like (one talks about "well defined" problems, variables and solutions). The correct formulation namely corresponds to the conceptual clarity of a scientific theory. Experimental practice serves to render unclear material settings into networks of well-defined quantities with sufficiently well determinable scales and magnitudes (conceptual clarification; e.g., Taagepera 2008: ch. 14). In order to conceptually distinguish the various quantities essential in something accepted as a phenomenon in a given scientific discipline, one must first distinguish its various possible magnitudes as magnitudes of one and the same attribute. Mathematical-experimental clarity, accountability, and controllability of matter, reached in exact sciences, has been the ideal and norm for scientificity, the epistemic *Leitbild* to be followed by other sciences and by practical designing of the world, thus underlying the next kinds of normativity that will be discussed.

3. Practical Normativity

Practical normativity bears on the implementation of science and scientific laws outside of the narrowly scientific world of laboratory and of observation. It concerns both the life-world and everyday doings: how science, through its models and practices, shapes, and creates our surrounding world that directs our relation to it and our activities.

3a. The narrower mode of practical normativity comprehends most of what Bunge (2003: 173) lists under material engineering (physical, chemical, biochemical, etc.). It pertains to applying both exact and non-exact scientific knowledge to design technological artefacts used in everyday life or industrial production, like appliances, apparatuses, chemicals, plant and animal breeds, etc. – the common construal of technology. Such technology is somewhere between epistemic and practical normativity: it is usually developed and tested in laboratories, but applied outside the laboratory and often gets its tasks and role from outside influencers, driven by the need for new technologies like drugs, machines, algorithms, gadgets, etc. Due to this "outside" dimension it cannot be entirely evaluated on the basis of laboratory testing, where only some technical functionalities can be tested, but not societal and environmental ones. For example, a well-functioning info-technological solution can both foster social cohesion and a loss of privacy; a drug can cure human disease and cause environmental problems; a plant or animal breed can eliminate both famine as well as biological and agricultural diversities.

This last type of normativity (*3a*) is the one mentioned in the introduction, where the world is made to conform to engineering-scientific models to reach human aims superimposed upon nature (see also Glazebrook 2000; Rip 2009). The artefacts are designed to perform certain functions, e.g., receive radio waves and transform them into audible sounds; the constructed prototype proves the implementability and reliability

[12] Thanks to Jaak Kikas for clarifications about this in personal communication.

of the particular design. When the artefacts – in this example, radio apparatuses – are produced and distributed, the world will fill itself with things that work in more or less the same way, bringing information to many end recipients across great distances at once if handled properly. The technoscientific model, applying several models of fundamental science, has prescribed the shaping of certain matter in certain ways, and that shape or design prescribes certain behaviour to achieve certain ends.

3b. The broader mode of practical normativity refers to social and technical practices and policies, including science teaching – social engineering and some of material engineering in Bunge's (2003) sense. It answers the questions: how it is correct to treat the world, for example, technical requirements for buildings, conservation of species, climate regulation, social regulation (like law) and policy making, etc. The cases dealt with by Lemons et al. (1997) and Tinker et al. (1982) (discussed above) provide good examples of this. The narrower, scientific-institutional ordering habits are expanded similarly outside the laboratory settings, such as when science is applied to real world problems in policy making (e.g., Rouse 1987: ch. 1 and p. 101; this is illustrated by Bunge's (2003) various kinds of broadly understood technologies – psychological, sociological, economic). In order to be compatible with the engineering approach, the real world is divided into problems of different disciplinary bearing[13]. The problems are defined by interconnected, practically identifiable, and measurable attributes, relevant for the aim of the solution sought after. Some of those measurable attributes are considered humanly manipulable, whereas others are seen as dependent on those attributes. The ways how to scientifically treat the world depend on how the world is scientifically understood, and the other way around – understanding and hence conceptualising the world depend on how it is perceived, which depends on the techniques of discrimination and the manipulation of the world, that is – on technology. Technology, particularly due to its ubiquity, determines how the world can be understood and treated in the present and future (e.g., "technology as prospective ontology" by Rip 2009). Technology and science determine certain Universes of Actions, so all these aspects of normativity are related to each other.

A brief contemplation might suggest that there really are just two kinds of normativity: theoretical, consisting of the conceptual (*1a* and *1b*) and mathematical-epistemic (*2a*) normativities, and practical, consisting of laboratory practice (*2b*), engineering (*3a*), and policy making (*3b*). This surely is another way of looking at those suggested normativities, or a level of categorizing them. I point out epistemic normativity, keeping in mind its special role in the reputation of the exact sciences, and hence its influence upon other sciences, science policies, and science-based action. The ground of this reputation is philosophically modelled by Vihalemm's notion of φ-science (e.g., Vihalemm 2007; 2016). Its essential features, like mathematicity, analyticity, calculability, and predictability, hint to regularities, order, and simplicity of some kind in the sense that something lets itself be known in

[13] Heidegger (e.g., 1959b) too emphasises and expounds this. An example of this division into disciplinary competencies is the case of value and accountancy theory by Tinker et al. (1982), where all other aspects (like societal) but monetary are delegated to other scientific disciplines.

advance and reckoned with. They provide a certain peace of mind or repose that can be regarded as an epistemic and moral aim at the same time, as Oliver Wendell Holmes (1897: 998) expresses it: "The process of analogy, discrimination, and deduction are in which [lawyers] are most at home. […] And the logical method and form flatter that longing for certainty and for repose which is in every human mind."

Conclusions

In the present project I have shown how science and its laws are variously normative in the sense of prescriptivity. Firstly, on the basis of a logical account of explicitly normative systems, I detected the essential features that render a system normative (Mets 2018): actions, and prescriptions concerning them. Science, particularly scientific laws, are not explicitly normative – they do not explicitly prescribe actions. However, there are accounts of science as normative, such as Joseph Rouse's account, which acts as the basis by which I further clarified the normative nature of science. I found that science is inherently linked to technology in a broad sense of the term, which implies actions: technology is human action upon the world, transforming, and rearranging the world for human aims, including epistemic aims in science. Technological thinking implies activity: technological artefacts, including laboratory apparatuses, prescribe certain actions to be undertaken with them. What determines prescriptions, or the aims toward which actions are to be undertaken, is determined by our increasingly scientific and technological world picture.

For a clearer account of the implicit normativity exhibited by scientific laws, I suggest a classification of the aspects of normativity found in science. Those are:

- *Conceptual normativity* (*1a* and *1b*), concerning how the world is thought and talked about, hinting to the underlying scientific world picture and the quest for analyticity and systematicity;
- *Epistemic normativity* (*2a* and *2b*), concerning specifically exact scientific practice and its influence on other scientific fields in theory and practice;
- *Practical normativity* (*3a* and *3b*), concerning actions beyond science, including norms and prescriptions about narrowly construed technology, such as engineering sciences, and broadly construed practical techniques and policies.

These three aspects of normativity refer to the actions and activities that can be the elements of Universes of Actions for science. These include discursive practices – thinking, talking in certain ways; epistemic practices – constructing and formulating bodies of knowledge, defining their reliability, etc.; solving problems by scientific-technical means; treating nature and human relation with nature, etc.

From the everyday usage of scientific terms to extensive policies encompassing the living conditions of many beings, scientific thinking has become the standard in, at least, the contemporary West. The presumption of objectivity makes scientific thinking the authoritative basis for decisions and their underlying values, including its epistemic values like truth and objectivity[14]. The laws that sciences formulate seem to provide a

[14] Even if it is really economic values that drive decision making, and science merely serves those, then the importance of science and scientific indicators, in contrast to, e.g., spiritual considerations, in influencing economically driven policies, is indicative of its authority.

firm ground for thinking and handling material situations, as they have fixed the orderly ways of how the world is and behaves. Thereby, it is often forgotten that the scientific laws on which this thinking and handling rests are restricted to very specific and contrived conditions. Often there are other things that determine how the world opens itself to us besides what can be submitted to scientific, and especially mathematical, treatment. My aim in this article is not to decry scientific knowledge and methodologies in any way, but rather to raise attentiveness to its impact on our life-worlds.

REFERENCES

Agassi, J., 1956. *The Function of Interpretations in Physics* (Thesis). University of London.

Baird, D. C., 1964. *Experimentation: An Introduction to Measurement Theory and Experiment Design*. Englewood Cliffs, NJ: Prentice-Hall.

Boumans, M., 2005. Measurement outside the laboratory. *Philosophy of Science* 72: 850–863.

Bunge, M., 2003. Philosophical Inputs and Outputs of Technology. In: R. Scharff and V. Dusek (eds.), *Philosophy of Technology: The Technological Condition. An Anthology*, Oxford: Blackwell Publishing, pp. 172–181.

Cartwright, N. D., 1999. *The Dappled World: A Study of the Boundaries of Science*. Cambridge: Cambridge University Press.

Fowler, C. S., Hamby, M., Rusco, E., and Rusco, M., 1991. *Native Americans and Yucca Mountain. A revised and updated summary report on research undertaken between 1987 and 1991*. Volume I. Reno, Nevada: Cultural Resource Consultants, Ltd. Accessible online at http://www.state.nv.us/nuc

Glazebrook, T., 1998. Heidegger on the Experiment. *Philosophy Today: A Quarterly Survey of Trends and Research in Philosophy Directed to the Interests of Scholars and Teachers within the Christian Tradition* 42(3): 250–261.

Glazebrook, T., 2000. From φύσις to Nature, τέχνη to Technology: Heidegger on Aristotle, Galileo, and Newton. *The Southern Journal of Philosophy* 38(1): 95–118.

Heidegger, M., 1959a. Die Frage nach der Technik. In: *Vortäge und Aufsätze*, Verlag Günther Neske Pfullingen, pp. 13–44.

Heidegger, M., 1959b. Wissenschaft und Besinnung. In: *Vortäge und Aufsätze*, Verlag Günther Neske Pfullingen, 45–70.

Heidegger, M., 1977. Science and Reflection. In *The Question Concerning Technology and Other Essays* (Translated and with an Introduction by William Lovitt). New York and London: Harper & Row.

Holmes, O. W., 1897. The Path of the Law. *Harvard Law Review* 10 (457): 991–1009.

Hon, G., 2003. The Idols of Experiment: Transcending the "Etc. List". In: H. Radder (ed.), *The Philosophy of Scientific Experimentation*, Pittsburgh: University of Pittsburgh Press, pp. 174–197.

Kendziuk, J., 2004. Environmental Justice Case Study: The Yucca Mountain High-Level Nuclear Waste Repository and the Western Shoshone. *Environmental Justice Case Studies*, 17 June 2004. Accessible online at http://www.umich.edu/~snre492/kendziuk.html

Laudan, L., 1984. *Science and Values: The Aims of Science and their Role in Scientific Debate*. Berkeley and Los Angeles: University of California Press.

Laudan, Larry. 2006. *Truth, Error and Criminal Law: An Essay in Legal Epistemology*, Cambridge: Cambridge University Press.

Lemons, J., Shrader-Frechette, K., and Cranor, C., 1997. The Precautionary Principle: Scientific Uncertainty and Type I and Type II Errors. *Foundations of Science* 2(2): 207–236.

Lowe, E. J., 1980. Sortal Terms and Natural Laws. *American Philosophical Quarterly* 17(3): 253–260.

Lowe, E. J., 1989. *Kinds of Being. A Study of Individuation, Identity and the Logic of Sortal Terms*. London, New York: Basil Blackwell.

Mets, A., 2012. Measurement Theory, Nomological Machine and Measurement Uncertainties (in Classical Physics). *Studia Philosophica Estonica* 5(2): 167–186.

Mets, A., 2013. *Normativity of Scientific Laws* (Dissertation). University of Tartu Press.

Mets, A., 2018. Normativity of Scientific Laws (I): Two Kinds of Normativity. *Problemos* 93: 60–69.

Portides, D., 2006. Abstraction, Induction, and Abduction in Scientific Modelling. In: P. Flach, A. Kakas, L. Magnani and O. Ray (eds), *ECAI06 Workshop on Abduction and Induction in AI and Scientific Modelling*, pp. 12–16. Accessible online at http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.99.8993&rep=rep1&type=pdf.

Rip, A., 2009. Technology as Prospective Ontology. *Synthese* 168: 405–422.

Rouse, J., 1987. *Knowledge and Power. Toward a Political Philosophy of Science*. Ithaca and London: Cornell University Press.

Rouse, J., 2002. *How Scientific Practices Matter. Reclaiming Philosophical Naturalism*. Chicago: University of Chicago Press.

Seubold, G., 1986. *Heideggers Analyse der neuzeitlichen Technik*. Freiburg/München: Verlag Karl Alber.

Stepin, V., 2005. *Theoretical Knowledge*. Dordrecht: Springer.

Taagepera, R., 2008. *Making Social Sciences More Scientific. The Need for Predictive Models*. Oxford: Oxford University Press.

Tinker, A. M., Merino, B. D., and Neimark, M.D., 1982. The Normative Origins of Positive Theories: Ideology and Accounting Thought. *Accounting, Organizations and Society* 7(2): 167–200.

Vihalemm, R., (ed.), 1979. *Teaduse metodoloogia* (*Methodology of science*). Tallinn: Eesti Raamat (in Estonian).

Vihalemm, R., 2007. A. Whitehead's metaphysical ontology and I. Prigogine's scientific ontology: From a point of view of a theoretical conception of science. *Problemos* 71: 78–90.

Vihalemm, R., 2016. Science, φ-Science, and the Dual Character of Chemistry. In E. Scerri and G. Fisher (eds.), *Essays in the Philosophy of Chemistry*, Oxford University Press, pp. 352–280.

MOKSLO DĖSNIŲ NORMATYVUMAS (II): IMPLICITINIAI NORMATYVUMO ASPEKTAI

Ave Mets

Santrauka. Straipsnyje „Mokslo dėsnių normatyvumas (I)“ buvo atskirtas implicitinis ir eksplicitinis normatyvumas ir remiantis Josephu Rouse'u buvo parodyta, kad mokslo dėsniuose glūdi tai, ką Carlosas Alchourrónas ir Eugenijus Bulyginas laiko normatyvo branduoliu. Šiame straipsnyje šis teiginys plėtojamas išskiriant šešis mokslo dėsnių implicitinio normatyvumo aspektus: (1a) bendrąjį ir (1b) specialųjį konceptualinį normatyvumą, susijusį su analitiniu mąstymu ir specialiomis mokslinėmis terminologijomis; (2a) teorinį ir (2b) materialinį episteminį normatyvumą, susijusį su matematiniu ir eksperimentiniu pasaulio apskaitomumu; (3a) siaurąjį ir (3b) platųjį praktinį normatyvumą, susijusį su technologijomis siauresne ir platesne reikšme.

Pagrindiniai žodžiai: gamtos dėsniai, normatyvumas, implicitinis normatyvumas, techninis-mokslinis pasaulėvaizdis, technologijos

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