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	Suffix	
	Division	Philosophy Seminar
	Organization	University of Cologne
	Address	Albertus Magnus Platz, Cologne, 50923, Germany
	Email	ahuettem@uni-koeln.de
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10 **Andreas Hüttemann**

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13  
14 Metaphysics of science is currently a flourishing field of philosophical research  
15 touching issues both in metaphysics and in philosophy of science.<sup>1</sup> From the  
16 perspective of early twentieth-century philosophy of science, this is a rather  
17 surprising development. For as is well known, logical empiricists tended to banish  
18 metaphysical questions. Thus, the issue of realism versus anti-realism (or idealism)  
19 was classified as a pseudo-problem by Rudolf Carnap in the late 1920s and Ernest  
20 Nagel some 30 years later called it a “conflict over preferred modes of speech.” A  
21 major step towards the rehabilitation of metaphysical questions within philosophy  
22 of science and analytical philosophy in general was the development that led to the  
23 debate about scientific realism in the 1970s. It seemed to Putnam and others that,  
24 without taking into account that scientific terms refer to real entities, philosophy of  
25 science is unable to explain how theories can be compared trans-theoretically. At  
26 the same time, metaphysical or ontological questions became respectable again in  
27 areas such as philosophy of language, which ultimately led to what is now called  
28 analytical metaphysics (see Loux and Zimmerman 2003). During this period,  
29 philosophical problems that were formerly treated as pertaining exclusively the  
30 *language* of science were transformed into problems about metaphysical issues.  
31 Thus, for instance, theories of laws of nature in the 1950s aimed to define the  
32 characteristics of laws of nature entirely in terms of the syntactic structure of law  
33 statements. From the late 1970s on the question was what it is in the world that

IFL01 <sup>1</sup> In the sequel, I will refer to Anna Marmodoro’s volume by (P) (for Powers) and to Helen Beebe and  
IFL02 Nigel Sabbarton-Leary’s volume by (K) (for Kinds). (P) and (K) are the first two volumes in the new  
IFL03 series “Routledge Studies in Metaphysics.”

A1 A. Hüttemann (✉)  
A2 Philosophical Seminar, University of Cologne, Albertus Magnus Platz, 50923 Cologne, Germany  
A3 e-mail: ahuettetm@uni-koeln.de

34 corresponds to law statements and whether it is reasonable to assume *sui generis*  
35 nomic facts.

36 Currently, the expression “metaphysics of science” is used both in a wide and in  
37 a narrow sense. In the wide sense, metaphysics of science concerns any vaguely  
38 metaphysical theme that is connected with the sciences, including for instance the  
39 interpretation of theories of space–time or quantum mechanics. It covers much of  
40 the same ground as what has once been called “philosophy of nature” (*Naturphi-*  
41 *losophie*). In a more narrow sense, metaphysics of science is focussed on questions  
42 concerning laws of nature, natural kinds, causation, etc. (cf. Wilson, 192). The  
43 topics of the two volumes under review fall squarely within the scope of the narrow  
44 conception of metaphysics of science. Before I turn to the contributions themselves,  
45 let me mention two controversial issues in metaphysics of science as well as the  
46 resulting dividing lines that shape the argumentative landscape in this field.

47 The most important dividing line concerns the issue of Humeanism versus non-  
48 Humeanism. Humeans accept the claim that there are no necessary connections in  
49 nature between entities that are wholly distinct. Non-Humeans deny this. Humeans  
50 like David Lewis believe, for instance, that the apparent modal connection between  
51 dispositions and their manifestations can be reduced to categorical properties and  
52 laws. Furthermore, laws are conceived of as regularities that can be ultimately  
53 reduced to the Humean mosaic. By contrast, non-Humeans typically accept  
54 dispositions as real (i.e., irreducible to the Humean mosaic) properties and embrace  
55 the relevant modal implications.

56 A second dividing line concerns a methodological issue. What is the role the  
57 results of science or the scientific practice are going to play as possible evidence for  
58 metaphysical claims? While there are some who argue that the only evidential  
59 source for metaphysical claims is science (Ladyman and Ross 2007) others, like  
60 Lewis, almost never appeal to scientific findings in order to establish their claims.

61 It seems there are no clear correlations between the four options due to the two  
62 dividing lines. Some non-Humeans appeal to scientific practice and argue for the  
63 existence of dispositions or capacities on this basis (cf. Cartwright 1989), while  
64 others appeal to intuitions concerning so-called quidditism (Bird 2007, 70–80). On  
65 the other side, Humeans may tend to appeal less to science and its findings but even  
66 David Lewis would have—it seems—accepted a consistent successor of quantum  
67 mechanics as potential evidence for or against metaphysical claims (Lewis 1986,  
68 xi).

69 Volume (P), edited by Anna Marmodoro, focuses on debates relating to the  
70 notion of power. Powers (or dispositions—I will use these terms synonymously) are  
71 a central topic in debates in the metaphysics of science. Famously, Hume searched  
72 in vain for evidence for powers, which in turn motivated his denial of necessary  
73 connections. A further explanation for the centrality of issues concerning powers  
74 may start by pointing to the fact that while non-Humeans accept necessary  
75 connections in nature, the claim that there are *metaphysically* necessary connections  
76 in nature faces its own problems. For instance, causes may be thought to somehow  
77 necessitate their effects but this relation cannot be one of metaphysical necessity  
78 because there are potential interfering factors. Perhaps powers provide solace in this  
79 case. The relation that obtains between a power and its manifestation is exactly what

80 the non-Humean should be studying in order to understand the nature of the  
81 necessary connections in nature.

82 Volume (P) contains a number of contributions that are concerned with the very  
83 nature of dispositions. Even though most contributors agree on a realist reading of  
84 dispositions (i.e., they reject the idea that dispositional predicates can be fully  
85 explicated by virtue of conditional analyses), many aspects of dispositions remain  
86 controversial. One of the issues raised in some of the papers is the nature of the  
87 manifestations of powers or dispositions.

88 Jennifer McKittrick (P, 74) probably captures the standard view when she  
89 characterises the concept of a manifestation (i) as “minimally, that of an event—  
90 either an event-type or a particular event which occurs at a particular place and  
91 time” and (ii) often considered as being caused, triggered or brought about and thus  
92 conceived as an effect. This standard view can be challenged. Brian Ellis, for  
93 instance, assumes that causal powers “are properties that are displayed in causal  
94 processes” (P, 133). Conceiving manifestations as processes rather than events is,  
95 perhaps, not a major deviation depending on one’s conceptions of event and  
96 process. However, there are more significant disagreements.

97 Stephen Mumford follows Molnar in identifying manifestations with contribu-  
98 tions. These manifestations as contributions are not the effects or events considered  
99 by the standard view, but rather something in between the disposition and its  
100 manifestation in the traditional sense. The rationale behind this terminological shift  
101 is the following: Dispositions are identified by their manifestations. But the effects  
102 that the dispositions contribute to are varied, since often many dispositions  
103 contribute to one effect. As a consequence, the dispositions cannot be identified by  
104 their effects, but should rather be identified by their contributions (which are  
105 modelled on component forces; see also Mumford and Anjum 2011, chapter 2). As  
106 McKittrick points out, these contributions are not intermediate *events* between, say  
107 the triggering of a disposition and the ultimate effect, but rather an additionally  
108 postulated entity of its own kind—in order to deal with the problem of effects being  
109 due to more than one disposition.

110 Still another notion of manifestation is discussed by Toby Handfield. According  
111 to Handfield (P, 106), a manifestation of a disposition does not involve only the  
112 effect (end state), but also a causal process that leads to this effect. It is important to  
113 take these causal processes into consideration because what is constitutive of a  
114 particular disposition, Handfield argues, is not only the end state or effect but also  
115 the process of bringing it about. If the same effect is brought about by a different  
116 process, it seems plausible to speak of a different disposition. Handfield’s processes,  
117 which *bring about* the manifestation (conceived in the traditional sense), need to be  
118 distinguished from Ellis’s processes, which *are identical* with the manifestation in  
119 the traditional sense. Furthermore, Handfield’s causal processes should not be  
120 conflated with Molnar’s or Mumford’s contributions. Even though both are  
121 intermediaries between the triggering and the effect, Handfield’s processes are  
122 intermediate *effects*, whereas contributions are theoretical entities postulated to  
123 account for the fact that typically more than one disposition is involved in bringing  
124 about an effect (whether or not it is an end state or an intermediate effect).



125 A second issue discussed in (P) is whether the manifestation, in the sense of the  
 126 effect or end state, is brought about by necessity. It is important to note that this  
 127 claim is not entailed by dispositional essentialism. Dispositional essentialism points  
 128 out that it is part of the essence of certain kinds of objects or properties to have  
 129 certain dispositions. As Markus Schrenk (P, 173) explains, it is a *further* issue  
 130 whether these dispositions will display their manifestations (effects) by necessity  
 131 provided they have been triggered. Some dispositional essentialists, like Ellis and  
 132 Alexander Bird, have also embraced the necessity claim. Schrenk argues that the  
 133 very same arguments that point to the shortcomings of reductive analyses of  
 134 dispositions can be used against the claim that dispositions—if triggered—bring  
 135 about their manifestations or effects by necessity. Antidotes interfere with the  
 136 bringing about of the manifestation, *even though* the disposition has been triggered.  
 137 They are therefore counterexamples to the claim that a property is dispositional iff  
 138 had the stimulus been present, the manifestation would have occurred. At the same  
 139 time, Schrenk (P, 174) notes, these are counterexamples to the logically stronger  
 140 claim that it is metaphysically necessary that if the disposition is triggered the  
 141 manifestation occurs. While I think this is not an argument against dispositional  
 142 essentialism, it is convincing against the claim that manifestations are brought about  
 143 with metaphysical necessity—a claim that has been made by some essentialists.  
 144 Mumford and Anjum (P, 147ff) too claim that dispositions do not necessitate their  
 145 manifestations and defend it against some objections.

146 If the relation between the disposition and the trigger on the one hand and the  
 147 manifestation on the other hand is not one of metaphysical necessity, what is it?  
 148 This is a crucial question for non-Humeans to answer. It concerns the very core of  
 149 the disagreement with the Humeans, and thus non-Humeans need to spell out what  
 150 they have in mind here.

151 One option is to postulate a *sui generis* relation. This is the approach taken both  
 152 by Bird and by Mumford and Anjum. The latter identify causes with dispositions  
 153 and go on to claim: “Causes do not necessitate their effects: they produce them but  
 154 in an irreducibly dispositional way.” While this sounds like a description of a  
 155 problem rather than a solution, Mumford and Anjum go a long way in specifying the  
 156 characteristics of this “irreducibly dispositional way” of bringing about effects in  
 157 terms of a vector model.

158 A third topic discussed in (P) is the relation between dispositions and causation.

159 It is sometimes held that “disposition” is an inherently causal notion.  
 160 Nevertheless, the exact relation between dispositions and causes remains a  
 161 contested issue. There are many options how to spell out the relation. First,  
 162 *dispositions* might be considered to be the cause of the manifestations (cf. Mumford  
 163 and Anjum). Second, the trigger might be taken to be the cause (cf. Bird). Third, the  
 164 causes might be identified with interfering factors into those processes that systems  
 165 are disposed to display (cf. Hüttemann 2013). There are further options. Thus, it  
 166 might be argued that causation needs to be spelled out in terms of regularities or in  
 167 terms of counterfactual dependence, but that it is dispositions that ground either the  
 168 regularities or the counterfactual dependencies.

169 In (P), two of the foregoing options are defended. Mumford and Anjum hold the  
 170 view that causes are dispositions. Dispositions “bring about” their effects. So how

171 does that work? Mumford and Anjum represent causes as vectors that can add up.  
 172 An effect occurs when the different causes/dispositions accumulate to a certain  
 173 threshold value. They illustrate how this account can deal with negative causation  
 174 and how it accommodates the fact that causes do not necessitate their effects.  
 175 Nevertheless, certain questions remain open. What exactly is the status of the  
 176 threshold? Mumford and Anjum hold that “it is not a real thing at all” (P, 146). But  
 177 if it is not a real thing, what is it that determines whether the effect occurs or not?  
 178 Another question concerns the assumption that all powers can be represented as  
 179 vectors (made explicit in Mumford and Anjum 2011, 46). Physics describes only  
 180 some quantities that play a role in causation as vectors (e.g. forces), but other  
 181 entities in terms of scalars, two-dimensional tensors, etc. It seems that the account  
 182 needs some adjustment here. Bird starts with a view he calls the simple dispositional  
 183 analysis of causation: “A causes B when A is the stimulus of some disposition and  
 184 B is the corresponding manifestation.” This account allows drawing a distinction  
 185 between cause and condition: not all of the conditions necessary for the occurrence  
 186 of an effect count as a cause, only the stimulus of a disposition. Bird discusses one  
 187 problem that arises from cases of trumping pre-emption. In these cases, there are  
 188 two dispositions with the same kind of manifestation. Both stimuli occur, so does  
 189 the manifestation. The problem is to determine which stimulus was the cause. In the  
 190 end, Bird (P, 164) embraces the claim that the relation between the disposition and  
 191 the stimulus on the one hand and the manifestation on the other hand is  
 192 ontologically basic and cannot be spelt out, for example, in terms of counterfactuals.  
 193 At this point, some readers might feel that something more needs to be said about  
 194 this relation and about its modal character in particular.

195 Finally, there is the much-discussed topic of pan-dispositionalism. The  
 196 Introduction by Marmodoro and the paper by Kristina Engelhard give nice surveys  
 197 of the issues involved. With respect to categorical and dispositional properties, there  
 198 are monists and their rivals. Monists either claim that there are only categorical  
 199 properties (categoricalism) or that there are only dispositional properties (pan-  
 200 dispositionalism). The papers in (P) are mainly concerned with the question whether  
 201 pan-dispositionalism is a tenable view. Several regress arguments have been  
 202 mounted to show that this is not the case.

203 The pan-dispositionalist may hold that the manifestation event consists in  
 204 acquiring a dispositional property. According to a well-known objection “partic-  
 205 ulars would seem to be always re-packing their bags as they change their properties,  
 206 yet never taking a journey from potency to act” (Armstrong quoted by McKittrick in  
 207 P, 75). However, it is not clear how the objection works. If the claim is that nothing  
 208 ever becomes actual on a pan-dispositionalist account, then the claim seems to be  
 209 false. Having a disposition is something actual. According to McKittrick, the regress  
 210 should be reconstructed as implying that if no disposition ever becomes manifest,  
 211 dispositions will not be (neither directly nor indirectly) observable. This, she notes  
 212 (P, 79), might pose a serious objection to pan-dispositionalism. According to  
 213 another version of the regress argument due to E J Lowe, the identity of a power is  
 214 (partly) fixed by its manifestation type. If manifestation types turn out to be powers,  
 215 we are led into an infinite regress. It thus seems that the identity of a power cannot  
 216 be fixed. Against this argument, it might be maintained that in the actual world each



217 power is related in a unique way to other powers, such that the identity of each  
 218 power can be defined in terms of its unique place in the relational structure  
 219 constituted by all the powers in this world (cf. Lowe P, 15). Lowe, however, rejects  
 220 this move, because criteria of identity need to be applicable in every possible world,  
 221 and there is no a priori reason that the power structure in every possible world  
 222 contains the required asymmetries (P, 18).

223 That seems to leave us with the option to accept that there are both categorical  
 224 and dispositional properties. Why should that be a problematic view? From the  
 225 Humean/Empiricist perspective, the original problem with dispositions was that  
 226 they could not be directly observed. Only the manifestations were considered to be  
 227 observable. The problem of how to understand dispositional properties was then  
 228 considered as a special case of the interpretation of theoretical terms. More recently,  
 229 the observability issue is no longer considered to be an obstacle for a realist reading  
 230 of theoretical terms in general, and there is no reason why it should provide a  
 231 problem for dispositional properties. Today's opposition to the acceptance of  
 232 dispositional properties as real has to do with the modal relation that seems to obtain  
 233 between the disposition and the stimulus on the one hand and the manifestation on  
 234 the other hand. Even if the relation is not one of metaphysical necessity, the reality  
 235 of dispositions seems to imply that some kind of necessary relation seems to obtain.  
 236 It is this modal issue that drives Humeans towards categorical monism.

237 Non-Humeans are often driven into dispositional monism. They argue that the  
 238 very notion of a categorical property is problematic. According to their reasoning,  
 239 the identity of a property is constituted by its causal profile. If there were properties  
 240 that could not be individuated in terms of their causal profile, we could not know  
 241 about them. Two such properties could be swapped without us being able to realise  
 242 this (this is the so-called problem of quidditism). However, two questions may be  
 243 raised at this point. First, how do we know that this is not actually the case? Second,  
 244 could not there be other reasons for assuming the existence of properties over and  
 245 above their causal profile. Ellis, for instance, argues (P, 137) that powers need to act  
 246 from somewhere and thus presuppose locations. Locations are not themselves  
 247 located anywhere and are thus no powers. While this particular argument might be  
 248 objectionable, there is no reason why similar arguments to the effect that particular  
 249 dispositions or dispositions in general presuppose the existence of particular  
 250 categorical properties should not work. Monism of whatever kind is not inevitable.

251 The volume (K), edited by Helen Beebe and Nigel Sabbarton-Leary, raises  
 252 another important issue for non-Humeans: the question of how we can come to  
 253 know that necessary connections obtain. In pre-Kripkean times, it was generally  
 254 accepted that necessary connections if at all can only be known a priori. The  
 255 importance of Kripke's work on proper names and natural kind terms in particular  
 256 consists in opening up the prospect that there might be a posteriori knowledge of  
 257 necessary connections. Paradigm cases are "Water is H<sub>2</sub>O" and "Gold is the  
 258 element with the atomic number 79." In these cases, we have a rigid designator on  
 259 the left-hand side of the identity statement because the natural kind terms function  
 260 like proper names. Likewise, we have a rigid designator on the right-hand side  
 261 because the terms in question pick out the essence of water or gold. Because we  
 262 have rigid designators on each side of the identity statement the identity claim, if

263 true, is true with metaphysical necessity. It is, however, an a posteriori matter to  
 264 figure out the essence of water or gold. The notion of an essence, it seems, can thus  
 265 be made plausible within a metaphysics of science. Furthermore, if laws of nature  
 266 are conceived as statements that describe the dispositional essences of properties or  
 267 objects as a consequence, it seems plausible that laws are both metaphysically  
 268 necessary and a posteriori. However, while Kripke certainly provides a useful  
 269 analogy for dispositional essentialists, there are a number of obstacles that make it  
 270 doubtful whether this analogy is of great help.

271 One issue is raised in a paper by Joseph LaPorte. LaPorte does not put into doubt  
 272 that theoretical identity statements are true. He does, however, question whether  
 273 they are in general a posteriori. Rather than describing discoveries, LaPorte holds,  
 274 they may state stipulations. It was a stipulative decision to no longer use the word  
 275 “fish” as applying to whales. Similarly, “Water is H<sub>2</sub>O” may be regarded as a  
 276 stipulation rather than as describing a discovery. LaPorte points to the fact that  
 277 natural kind terms were often used vaguely before being *precisified* by science.  
 278 Which precisification is chosen is ultimately a matter of a decision. It might well  
 279 have happened that deuterium oxide was counted as non-water (K, 107). Both Bird  
 280 (K, 125) and Robin Hendry (K, 149–50) have challenged this claim. Both argue that  
 281 there is less room for conceptual choice than LaPorte suggests. This discussion is  
 282 largely about referential stability across theory change and about the interpretation  
 283 of historical episodes.

284 Beebe and Sabbarton-Leary try to establish the general point that theoretical  
 285 identities can only be analysed as metaphysically necessary statements a posteriori  
 286 if certain conditions are met. For a statement like “Water is H<sub>2</sub>O” to be  
 287 metaphysically necessary and a posteriori, at least the following has to be the case:  
 288

- 289 (1) Even if water has an essence, it has to be established that “water” works like a  
 290 proper name, rather than as a description such as “drinkable liquid typically  
 291 found in rivers.” In the latter case, “water” would refer to XYZ on twin earth.  
 292 So the metaphysical necessity of a theoretical identity statement can only be  
 293 established if it is shown that the left-hand term works like a proper name.  
 294 (2) It has to be established that the natural kind term on the left is not introduced  
 295 as a stipulative definition (this is the same point as the one discussed by  
 296 LaPorte and others) (K, 151).

297  
 298 Beebe and Sabbarton-Leary argue that if dispositional essentialists like Ellis do  
 299 not explicitly show that these conditions are met, they are not entitled to rely on the  
 300 Kripkean analysis of theoretical identities. The upshot is that while Kripke’s  
 301 analysis is useful in pointing to the conceptual possibility of statements that are  
 302 metaphysically necessary and a posteriori, much work needs to be done to provide  
 303 actual examples of such statements and to establish that laws of nature are among  
 304 them.

305 Jessica Wilson presents an abductive argument for the existence of necessary  
 306 connections. She starts from the observation that many (Humeans and non-Humeans  
 307 alike) accept constitutional necessities like “Water is H<sub>2</sub>O” or “Anything that is an

308 electron is electrically charged” (K, 197). She then argues that the non-Humean can  
 309 provide a better explanation for why we should accept that such statements are  
 310 necessarily true. The non-Humean in contrast to the Humean can appeal to the  
 311 modal stability of causal profiles, that is, to the claim that, for instance, water and  
 312 H<sub>2</sub>O share their causal profile across possible worlds. The Humean does not accept  
 313 that (some or all) properties are individuated in terms of their causal profile because  
 314 that would presuppose necessary connections between the property and its causal  
 315 profile. The claim then is that the non-Humean can give a better explanation of a  
 316 fact accepted by both the Humean and the non-Humean (K, 206–7).

317 That leaves us with the general question what options there are for arguing for the  
 318 claim that necessary connections obtain in nature—besides a priori reasoning and  
 319 Kripke-style analyses of theoretical identities. Abductive arguments, as we have just  
 320 seen, might be such an option. More particularly, there might be also abductive  
 321 arguments from scientific practice. Some authors like Armstrong (1983, 104) have  
 322 argued that the success of certain explanatory or inductive scientific practices can  
 323 best be explained in terms of necessary connections that obtain in nature. This line  
 324 of argument might be promising (For a recent critique of such arguments, see  
 325 Beebe 2011.).

326 To conclude, the two volumes under review contain very stimulating papers by  
 327 some of the main contributors to the flourishing field of metaphysics of science.  
 328 While the shortcomings of Humean metaphysics have already been widely  
 329 discussed, these volumes show how much work there is to be done by non-  
 330 Humeans in order to provide convincing alternatives to Humeanism.  
 331

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