

or at best irrelevant to, that argument (or vice versa). Such evidence is lacking in *Image and Logic*. The disagreements that Galison does describe between image and logic physicists suggest the weaker claim that physicists working in the two traditions differed in terms of the kind of evidence that they preferred. That is not surprising given the great differences of technical know-how and analytic tools employed in the two traditions. The underlying assumptions and potential defeaters relevant to arguments made within the two traditions were indeed different. That difference, however, falls far short of the kind of linguistic divide that Galison needs to invoke. Indeed, the process of hybridization itself suggests that physicists within each tradition wanted to incorporate the strengths of the other precisely because they understood perfectly well how the other tradition could bring facts to bear in their arguments that were not available in their own experimental work.

Although he fails to make a case for using anthropological linguistics in the resolution of philosophical problems in the sciences, Galison's stimulating and well-crafted narrative deserves serious attention. He documents thoroughly and convincingly the changes that experimental activity has undergone within twentieth-century microphysics, the disagreements amongst physicists concerning those changes, and the relative independence of instrumental traditions from shifts in theory, while at the same time portraying the life of the experimenter in microphysics in a wider cultural context.

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Jerrold J. Katz, *Realistic Rationalism*. Cambridge, MA: A Bradford Book, The MIT Press (1998), xxxiv + 226 pp., \$35.00 (cloth), \$16.00 (paper).

Naturalism, whether as an ontological doctrine (that there are only natural objects), an epistemological thesis (that knowledge is only of natural objects), or a methodological claim (that knowledge can be attained only by investigating natural objects), was a "fundamental mistake," according to J. Katz, whose goal in this book is to formulate and justify "a new version of traditional realism and rationalist philosophy" (xvii). For Katz, philosophy is not just a second-order discipline of conceptual analysis with no role in the finding and systematizing of facts about the world, as naturalism and empiricism would have it, but also a first-order disci-

pline with its own questions about the world. In particular, “philosophical discoveries” can “substantiate the existence of abstract objects and exhibit their epistemological and ontological character” (xxiii). Abstract objects are objects that are in neither space nor time, and therefore are causally inert and cannot be known the way natural objects are known. Our knowledge of such objects is the subject of the formal sciences—namely, pure mathematics, pure logic, and pure linguistics—and it is a priori knowledge based on reason alone, and hence on a rationalist epistemology. The “false assumption” of antirealists, according to Katz, is that “causal interaction is a necessary feature . . . in any form of knowledge” (25), an assumption based on “the empiricist principle that *all* knowledge depends on experience” (27). The realist must avoid an epistemology that treats knowledge in the formal sciences as a posteriori knowledge, and in particular as knowledge based on acquaintance with an abstract reality.

With respect to pure mathematics, for example, Katz claims that just as there are steps in empiricism from basic knowledge of medium-sized natural objects to “transcendent knowledge” of general laws and theories in the natural sciences, so too there are “steps from knowledge of simple mathematical facts to knowledge of mathematical laws and theories” (41). That is, we have “basic ratiocinative knowledge of evident properties of abstract objects, e.g., the knowledge that four is composite,” and “a rationalistic epistemology correspondingly posits transcendent knowledge of formal laws and theories” (42). Our “basic ratiocinative knowledge” is sometimes referred to as “intuition,” which Katz describes as “an immediate, i.e., noninferential, purely rational apprehension of the structure of an abstract object, . . . an apprehension that involves absolutely no connection to anything concrete” (44) (and which in that regard differs from the Kantian notion of intuition). Such an intuition is not infallible and can be corrected once it is integrated into a systematic methodology. “Systematization compensates for the fallibility of the processes of acquiring basic and transcendent knowledge by bringing considerations from one part of the overall system to bear on issues in another” (46). Such systematization gives “a holistic character to justification in the formal and empirical sciences” (46), a holism that is “compatible with various forms and degrees of foundationalism” (47).

Although not all transcendent knowledge can be shown to be necessary, Katz claims that some principles, such as mathematical induction, can be known a priori, because “there is no possibility of achieving the best systematization of the science without them” (47). Nevertheless, all a priori principles of the formal sciences are “revisable in principle,” but only “in the light of pure ratiocination” and not on the basis of empirical discoveries (48). The formal truths of the formal sciences are abstract propositions that are “true of abstract objects in virtue of their form” (79), and,

according to Katz, the certainty of these formal truths is because of their necessity, which is explained “in terms of the abstractness of the objects they are about” (78).

That is, formal truths are necessary because “they describe unchangeable properties and relations of unchangeable objects” whose unchangeableness is an aspect of their abstractness (78).

The abstract objects of a formal science, according to Katz, are “the norms governing correctness” in that science (82). The norms for sentencehood in English, for example, are “the sentence types of English” (82). The senses of these sentence types and other expressions of English are not the determiners of reference, the way they are in Frege’s theory; rather, according to Katz, senses are “the determiners of sense properties and relations, such as having a sense, having more than one sense, having the same sense,” etc. (78). Senses are “the linguistic objects that speakers have knowledge of in virtue of their semantic competence” (95); they “supply the normative element missing in mentalistic approaches” (114), i.e., they determine the rules underlying our use of language.

In Katz’s realism, abstract and concrete objects are “homogeneous” in that they are abstract or concrete, respectively, “all the way down” (121). There are also heterogeneous objects that Katz calls “composite” objects. These contain both abstract and concrete objects as constituents. Impure sets containing both abstract and concrete objects are composite objects, where the containment relation covers both inclusion and membership (142). The universe taken as “everything there is as a whole” is a composite object, because it contains both abstract and concrete objects as components (147). The equator of the Earth is also a composite object, its abstract component being a mathematical circle and its concrete component being “a part of the surface of the earth,” with the type/token relations being the “creative” relation that unifies them into a whole (148). The notion of a composite object is put forward as a way to respond to objections to realism, and Katz illustrates how it can be used in other philosophical contexts as well.

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Naomi Oreskes, *The Rejection of Continental Drift Theory and Method in American Earth Science*. Oxford: Oxford University Press (1999), ix + 403 pp., \$55.00 (cloth), \$29.95 (paper).

In the mid-1960s, geologists rapidly, and with few holdouts, abandoned their traditional hostility to the very idea that the continents could move horizontally across the earth’s surface, and converted to the theory of plate tectonics. As one of the most dramatic changes of scientific allegiance of