Maxwell on Metaphysics, Epistemology, Methodology

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Readings

1. Maxwell (1870), “Address to the Mathematical and Physical Sections of the British Association”
3. Maxwell (1879), “Thomson and Tait’s Natural Philosophy (A Review)”
Contemporary Orthodoxies in Philosophy of Science

1. Math represents the world.

2. Theories are clearly delineated, precisely individuated entities, which are independent of each other.

3. Every theory has a canonical form that “shows us what the world would be like if the theory were true”.

4. Scientific knowledge is of a single kind, always clearly articulable in propositional form.

5. Theory and experiment are radically different from each other.

6. The scientist is a solitary creature, whose knowledge, beliefs and activities can be characterized in isolation from those of others.

7. Falsifiability is the most important virtue of a theory from an epistemic point of view.

8. Scientific epistemology ultimately rests on perceptual observation.
Maxwell, with divine obliviousness, is ignorant of them all.

I will focus only on Maxwell’s views contrary to the first orthodoxy, that math represents the world, and that mostly in “Address to the Mathematical and Physical Sections of the British Association”.
To appreciate most fully Maxwell’s views on the relations between math and the world in science—and for a more complete defense of my claims about those views—one must look at how he uses math in his own research and in his pedagogy, and in a few explicit remarks in methodological papers. I especially recommend:

6. Maxwell (1877), *Matter and Motion* (see also Curiel 2021)
7. Maxwell (1891), *Theory of Heat*
The central problem: to explore and describe (p. 216)
that still more hidden and dimmer region where Thought
weds Fact, where the mental operation of the mathemati-
cian and the physical action of the molecules are seen in
their true relation?

(“more hidden and dimmer” than the serene heights of pure
mathematics, as expounded by Sylvester)

In other words: how does mathematical thought make substantive
and intimate connection with the physical world? What is that
connection?
attend to the words Maxwell uses (he is a sedulously precise writer, even—especially?—when he is being wicked, as with the Tennyson quote)

1. “Thought weds Fact”: this is an active relation; Thought brings Fact into its life, shares its entire life with it, with at least one goal being procreation—the creation of new and vital knowledge

2. the active aspect of the relation(ship) is emphasized by Maxwell’s assertion that it is the mental operation of the mathematician and the physical action of the molecules that stand in relation to each other

3. this is not the “mathematics itself”, the formalism, a lifeless and static thing, and not “the world” conceived of as an entity in abstraction from its motion, behavior, evolution

4. this is not the passivity of contemporary philosophy’s “representation” (“the formalism represents the world”)

5. however, scientific knowledge comes about, however scientific meaning is achieved—whatever those two things may be—they involve, essentially and inextricably, the cognition of the scientists (compare the remarks of Stein (1995) on Plato’s Seventh Letter)
p. 227:

*Physical research is continually revealing to us new features of natural processes, and we are thus compelled to search for new forms of thought appropriate to these features. Hence the importance of a careful study of those relations between Mathematics and Physics which determine the conditions under which the ideas derived from one department of physics may be safely used in forming ideas to be employed in a new department.*
1. we must look for new forms of *thought*, not new forms of mathematics, when investigating new features of natural processes

2. the mathematics helps us (when possible) translate our knowledge from an existing field into a new one

3. math regiments, encodes the structural relations among our ideas, and so allows us to see when our ideas about two *prima facie* different things have the same form

4. math does not regiment or encode “the structural relations among things in the world”; it regiments and clarifies our ideas about the structural relations among things in the world

5. it *certainly* does not “show us what the world would be like if the theory were true”

6. the method of physical analogy (pp. 218–219) could never work if that is what math were to do, nor could we understand the success of radically different successful accounts of the same phenomena (pp. 227–228)

7. thus, math mediates the connection between our ideas and the world, but does not itself represent the world: the way our concepts represent (latch on to, make substantive contact with, have intercourse with) the world, the way they acquire empirical content, is informed by math
Maxwell (1871, p. 246):

Consider the relation in which we stand to those mathematical studies which have so long flourished among us, which deal with our own subjects, and which differ from our experimental studies only in the mode in which they are presented to the mind.

Mathematical thought is a “mode of presentation” of a subject, the same as experimental practice, not a representation.
Maxwell (1879), on the idea that “matter” must be defined in order to discuss the idea of mass in abstract dynamics (p. 214):

*Why should we find it more difficult to endow moving figures [as depicted in geometrical diagrams] with mass than to endow stationary figures with motion? The bodies we deal with in abstract dynamics are just as completely known to us as the figures in Euclid. They have no properties whatever except those which we explicitly assign to them.*

The mathematics represents nothing; we put it to use to help us bring our concepts and ideas into contact with the world. Math does to represent the world; it mediates the way our concepts grasp the world (when they do), and it does so by the way that we put the math to use.
representation, and concomitantly our knowledge of the “inner, hidden metaphysics” of the world, is limited by the concepts we have available to apply to the mathematics we use in modeling physical systems (pp. 214–215):

The phenomena of real bodies are found to correspond so exactly with the necessary laws of dynamical systems, that we cannot help applying the language of dynamics to real bodies, and speaking of the masses in dynamics as if they were real bodies or portions of matter.

We must be careful, however, to remember that what we sometimes, even in abstract dynamics, call matter, is not that unknown substratum of real bodies, against which Berkeley directed his arguments, but something as perfectly intelligible as a straight line or a sphere.

Real bodies may or may not have such a substratum, just as they may or may not have sensations, or be capable of happiness or misery, knowledge or ignorance, and the dynamical transactions between them may or may not be accompanied with the conscious effort which the word force suggests to us when we imagine one of the bodies to be our own, but so long as their motions are related to each other according to the conditions laid down in dynamics, we call them, in a perfectly intelligible sense, dynamical or material systems.

Whatever may be our opinion about the relation of mass, as defined in dynamics, to the matter which constitutes real bodies, the practical interest of the science arises from the fact that real bodies do behave in a manner strikingly analogous to that in which we have proved that the mass-systems of abstract dynamics must behave.