Questioning Maxwell's Continuum Attack on Anti-realism

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The realist debate as to the status of scientific theories is one of the more lively and pertinent exchanges to have occupied philosophers of science. Should we take scientific theories as potentially accurate accounts of the world, to which we can ascribe truth or falsity, or merely instruments with a degree of usefulness? Even then, what should we make of the objects scientific theories postulate that are beyond our direct observation?

Philosophical debates into scientific realism are largely centred around the status of these unobservable, or theoretical, entities that appear ubiquitously in scientific theories, from electrons, molecules and atoms, to black holes.[1] It will be useful, for clarity, to state at the outset a simple explication of each side's viewpoint. Thus, scientific realism is the view that 'objects of scientific knowledge exist independently of the minds or acts of scientists'.[2] The anti-realist view refutes this, claiming (broadly) that scientific postulates are linguistic constructs. This essay is concerned with arguments about whether a tangible line can be drawn between entities that are directly observable and those that are not.

Grover Maxwell, in his paper, 'The Ontological Status of Theoretical Entities,[3]' responds to anti-realist criticism of such a tangible line, and puts forward the idea of a continuum of observable and theoretical entities. In this essay, I will argue that Maxwell's observable-theoretical continuum misrepresents the idea of theoretical entities in scientific theories, and as such I will hope to undermine one of the major realist responses to anti-realist criticism. To do this, I will first examine Maxwell's argument that there is indeed a continuous line between so called theoretical entities and directly observable ones, and Bas van Frassen's reply to it. I will show that no

1 Throughout the course of this essay the terms directly unobservable scientific entities and theoretical scientific entities are used interchangeably.

2 Fine, Arthur: (1998) 'Scientific realism and antirealism,' 'In E. Craig (Ed.), Routledge Encyclopedia of Philosophy. London: Routledge. Retrieved January 31, 2007, from http://www.rep.routledge.com/article/Q094.

3 Maxwell, Grover: (1962) 'The Ontological Status ofTheoretical Entities,' Philosophy of Science, Curd and Cover (1998 Norton).

sharp distinction between theoretical and observable entities is needed to defeat the realist opposition to anti-realism's theoretical terms.

The Continuum of Direct Observability

I agree that there is no clear line delineating what is directly observable and what is not .There is, as Maxwell states, a continuum of sensory experience of scientific entities. By this, Maxwell means that due to different characteristics (often size-related) different scientific entities are more or less observable without using any kind of apparatus such as magnifying glasses or microscopes. Maxwell claims that if using microscopes is not direct observation- a common example cited in the literature 'What [is] seen by… the microscope [is] just a shadow' [4]- then neither is looking through a window. His reasoning is that the principle of direct observation is violated in both cases- both require the laws of optics to hold for the observation to be correct.

Van Frassen counters this view by explaining that, although looking through a window is indeed not direct observation, it is absurd to say that things observed through a window are not directly observable. The object being viewed through the window is not a theoretical entity, because it can in principle be directly observed- for example by being on the other side of the window. Similarly Jupiter is directly observable in principle- 'a look through a telescope at… Jupiter seems to me a clear case of observation'[5] - because from a more advantageous position Jupiter is large enough to be seen in detail with the naked eye. Van Frassen would argue that the impossibility, thus far, of getting a human to one of Jupiter's moons to view it is irrelevant, as various data have verified its existence and detailed various features that would make this feat possible.

I strongly reject this argument, however, because once direct observation is being conducted in principle it is no longer direct by any reasonable definition. From the realist point of view particularly, science is empirically based, so observation must be direct in the true sense for theory to be based on it. Maxwell would agree in rejecting van Frassen's point, emphasising that the 'man-is-the-measure' test is important to science. What is observable has to bear some relevance to human characteristics (for example, being medium sized). That we could see viruses if we were the size of bacteria is not a useful concept, and one that, more importantly, may be inaccurate. We cannot know for sure what we would see if we were the size of bacteria without relying on unobserved data mined from indirect observations. We

4 Ibid.

5 Van Frassen, Bas C (1980) The Scientific Image, (Oxford: Clarendon Press).

know that viruses and bacteria are as they are by using microscopes etc. so we are justifying their direct observability using indirect observation. This is circular.

Man is not the measure

Maxwell would respond by claiming that the line on the Spectrum of Observability being badly defined only goes to show that the definition is of negligible ontological significance. If it is not certain where the line should be, and particularly if it depends on the point of view of the observer, then direct observability is of no consequence to the realism of science. The argument that measurement by man is an intrinsic part of science is a notion of practical, rather than theoretical, importance. As early science was based almost exclusively on direct observation and exploration, science has progressed in a radial way from medium sized objects (directly observable without instruments) to take in, in its modern form, some of the smallest objects thought to exist to super-giant stars. It is true that we would know a lot more about bacteria (probably) if our height was measured in nanometres, but since we are not, we have to accept our limitations- but these are not the limitations of science. Furthermore, it is these limitations that make scientific entities such as forces seem directly unobservable. The typical arrow from a box on a page depicting the frictional force between the tyres of a car and the tarmac does not seem to be a true depiction of what we mean by a force, but this is simply because schematic diagrams are precisely that- heuristics that help students of the natural sciences to grasp the idea of a force. No serious experimental physicist conceptualises forces as arrows or vectors, but doing so may make computational work easier, or describing her work to a layman friend easier.

Anti-realists would not argue with the point that science has necessarily progressed radically, but would take aim at the idea that measurement by man is not important. To an anti-realist science is precisely a way of understanding the world around us semantically, rather than a way of describing reality. It must, therefore, be of fundamental importance to a realist that man be central to our scientific concepts, otherwise observation reduces to nothing more than a semantic notion-precisely the opposite view to that realists would purport to hold. The argument that it is human limitation that prevents us from directly observing scientific phenomena is a circular argument that does not help support the realist argument at all. If, as humans we are unable to observe phenomena, then these phenomena are, clearly, unobservable.

Noting that, if humans developed a natural mechanism for detecting the existence of forces, then forces would be directly observable, as Maxwell does - 'I can clearly experience a force in my bottom after having sat through a boring lecture in a hard chair'[6]- is not a valid argument. For it to be valid, a premise along the lines of: 'electrons exist and are as mature scientific investigation has shown them to be' would have to be added. It is this premise that anti-realists would take issue with, because they consider electrons to be theoretical entities. Moreover, it is this premise that is not supported by the claim that the limitations of science and of scientific practise falsely construe certain scientific entities as unobservable.

Entities Theoretical by Definition

The sharp distinction between what is directly observable and what isn't is not important. What is important for the anti-realist view of science is that some scientific theories postulate entities which are defined as being unobservable. There are clear examples of these in secondary school physics - forces are defined as being directly unobservable. A force is defined as a "push or a pull experienced by a mass when it is accelerated"[7] - therefore, unless the mass on which the force is acting is a person, force cannot be directly observed by definition. What is taken to be evidence of a force by scientists is the acceleration of a body, but this is not the direct observation of a force - acceleration of a body and force experience are not logically equivalent without also including Newton's first law as a premise.

In reply to this, it can be argued that viewing a mass accelerating is direct observation of a force acting on that mass. Although Newton's law has to be included as a premise, as this is a mature scientific theory (or an approximation of one by the Einsteinian account), the working scientist should have no problem with doing this. Although it is not possible to directly observe the idea of a force, this is more to do with the problem of defining the set forces than an admission of the theoretical nature of forces. The force of friction between a car tyre and the road can be seen by the gripping of the tyre as the car moves forward. A different observation describes the force of a player kicking a football, but this is not because either force is not wholly described by the observation, but because the forces in each situation are quite different entities. The word force describes a whole cadre of entities, pulled to-

6 Maxwell, Grover The Ontological Status ofTheoretical Entities Philosophy of Science Curd and Cover (1998 Norton).

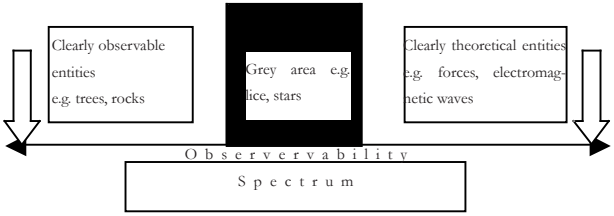
7 'Eric Weisstein's World of Physics' Retrieved January 31st, 2007 from http://scienceworld.wolfram.com/physics/Force.html

gether by Newtonian mechanics. Forces are the major scientific entities that are used as examples of 'theoretical by definition' entities. With these examples explained to be directly observable, from the realist point of view, it is questionable whether any entities that are theoretical by definition truly exist.

Using the result of a force as an example of its observability is, in my view, begging the question 'how can the force of friction be observed in the acceleration of a car?' The acceleration of a car being caused by the friction between tyre and road cannot be caused by a force defined in terms of the acceleration of the car. Similarly, the 'working scientist' referred to above as being happy to use Newtonian mechanics in the premises of her theories should not be happy with using, as verification of a special case of a force acting on a body, a premise entailing the acceleration of that body, the precise phenomena being observed. These two examples can be generalised as the causes of forces being defined by their effects. In this form the circularity is obvious, and therefore, the existence of entities theoretical by definition stands, at least in the special case of forces.

Realism and the Observability Spectrum

Now that it has been established that there are theoretical entities in science, it is possible to see how the realist argument may be refuted. Maxwell claims that there are no theoretical entities in science because there is no sharply defined line between what is and is not directly observable. As has been shown this is not the case as, although there is no sharply defined line, a line does exist in the continuum, with things that are definitely observable and definitely theoretical at either end, and entities with more debatable ontological status in between (see below).



That there is no precise line regarding what is in the set of theoretical entities is

not important , as long as some members are universally accepted (and I believe I have shown that this is the case). As is shown in the diagram above, Maxwell's Spectrum of Observability does exist, on which sit all scientific phenomena. It is not well defined (and I would argue that it is impossible to define) where the line rests delineating all phenomena that are directly observable. The focus of the debate between realists and anti-realists on where this line rests, however, is missing the point. Scientific realism necessitates all scientific entities being actual, not theoretical, and therefore, the existence of a line (broad or narrow, wherever it lies on the spectrum) is enough to undermine the realist position.

Conclusion

Throughout this essay, I have shown how the realist challenge to anti-realism fails. The argument that there is no distinct line beyond which all entities can be shown to be theoretical, put forward by Maxwell, was explained and shown to be true. This is challenged by the realist position, which claims that the Spectrum of Observability draws attention to the observability being unrelated to ontological status. This is refuted by the central role that human empiricism plays in scientific enquiry. The realist challenge was further undermined by the observation that being unable to draw a sharp line delineating precisely the subset of all scientific phenomena that are not directly observable does not mean that there are no theoretical entities in science. Some entities, it has been claimed are generally agreed to be directly unobservable by definition. The only inarguably theoretical entities are those whose existence is defined by their unobservability. It was argued that forces were, in general, cases in point because they necessitate Newtonian mechanics (approximately) for their existence. It was argued that as a mature science, Newtonian mechanics can be used as a premise in a scientific theory. This was refuted on the grounds that forces are defined circularly if they (as causes) are defined by their effects. As such, the claim that theoretical entities in science exist stands. With this claim established, it is clear that the realist challenge of the Spectrum of Observability to the theoretical entities of anti-realism, falls.

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