Close Idealizations of the Galilean Kind

Kabir S. Bakshi
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It is, I think, expedient to set forth to all mankind the reasons by which I was convinced that the fabrication of the Galileans is a fiction of men composed by wickedness. Though it has in it nothing divine, by making full use of that part of the soul which loves fable and is childish and foolish, it has induced men to believe that the monstrous tale is truth.
Against the Galileans by Emperor Flavius Claudius Julianus circa 362.

Farewell! You Galileans have sent truth into exile. See, now, how we bear the buffets of fate. See, we hold high our wreath-crowned heads. So we depart—shortening the night with song, and awaiting Helios.
The Philosopher from Ibsen's *Emperor and Galilean* 1873.

Julian "the military commander, the theosophist, the social reformer, and the man of letters" was the last non-Christian emperor of the Roman Empire. He was also the last (psst... "proper") emperor of the unified Roman Empire before its eventual division into the Western Roman and the Byzantine Empires. *Julian: A Novel* 2003 by Gore Vidal and *The Last Pagan: Julian the Apostate and the Death of the Ancient World* 2008 by Adrian Murdoch are nice books about the Julian's life and times.

Aim: Are idealizations are truth-conducive?

McMullin:"My aims rather are, first, the systematic one of discovering what the techniques were and, second, the epistemological one of deciding whether they need be inimical to the truth-likeness of science."

Preface

While much of what McMullin has to say might seem old-news to our modern eyes, I've been told that at the time of its publication this (along wit Cartwright's *How the Laws of Physics Lie*) was pioneering work.

According to McMullin idealizations involve a "deliberate simplifying of something complicated with a view to achieving at least at a partial understanding of that thing."

McMullin distinguishes two broad categories of idealizations: construct and causal idealization.

McMullin:"We have seen that idealization in this context takes on two main forms. In construct idealization, the models on which theoretical understanding is built are deliberately fashioned so as to leave aside part of the complexity of the concrete order. In causal idealization the physical world itself is consciously simplified; an artificial ('experimental') context is constructed within which questions about law-like correlations between physical variables can be unambiguously answered."

Mathematical Idealization

What it is: Using mathematics to describe phenomena of interest to scientists. Here is McMullin summarizing:

> Mathematical idealization is a matter of imposing a mathematical formalism on a physical situation, in the hope that the essentials of that situation (from the point of view of the science one is pursuing) will lend themselves to mathematical representation.

Why is it an idealization: "the Book of Nature is not written in the language of mathematics"

Coal: too much meddled throughout with Aristotle and Galileo. I don't care about what they thought (*in so far as* I want to understand idealizations in modern science.

Response: practical difficulty of realizing mathematics in Nature. Impediments can be account for – *de-idealization* doing the work here.

McMullin:

> It would be hazardous today to argue … that there are causal factors at work in the natural world that are inherently incapable of being grasped in mathematico-physical terms. The weight of the inductive argument is surely in the opposite direction. But it should be underlined once again that what has made this possible is not so much the reducibility of the physical as the almost unlimited plasticity of the mathematical.

Seems to me to beg the question against one who holds that book of Nature is *not* amenable to mathematics.

How are mathematical idealizations truth conducive? McMullin has this to say:

> The theme of 'idealization', as it has been developed here, presupposes a world to which the scientist is attempting to fit his conceptual schemas, a world which is in some sense independent of these schemas and to which they only approximately conform. This is (it would seem) equivalent to presupposing some version or other of scientific realism.

This is not scientific realism!

Construct Idealization

What it is: Solve a more tractable version of the original problem by idealizing the source.

Why it it an idealization: Departing from truth.

Either imperceptibly small deviations or deviations can be allowed for.

Relevant features may be simplified or omitted and irrelevant features may be left unspecified. Notice this requires a lot of background theoretical knowledge and know-how.

Construct idealization can be distinguished into *formal* and *material* idealization depending on how one de-idealizes.

McMulllin: Formal and material idealization are two different aspects of a single technique utilized by scientists: construct idealization. They are worth distinguishing because the 'adding back' that follows the initial idealization and shapes the further progress of inquiry can take two quite different directions...

Formal Idealizations

De-idealizing by making models more specific, incorporating empirical results, and fitting the model to the data (but only in a non-ad-hoc way). Recall McMullin's ideal gas law example.

The idealization serves as basis for a continuing research program.

Why truth conducive? McMullin:

> This technique will work only if the original model idealizes the real structure of the object. To the extent that it does, one would expect the technique to work.

Seems to me to be a cheap way out.

Material Idealizations

Models are materials scientists work with.

The model is not fully specified for the time being. McMullin gives the Rutherford atom as an example.

Gem: Amazing examples for each type of idealization.

This again spawns a research program.

Why truth conducive? McMullin:

> What makes it heuristically sensible to proceed in this way is the belief that,the original model does give a relatively good fit to the real structure of the explanandum object. Without such a fit, there would be no reason for the model to exhibit this sort of fertility. This gives perhaps the strongest grounds for the thesis of scientific realism.

McMullin concludes his discussion of construct idealizations by underscoring their truth-conduciveness:

The implications of construct idealization, both formal and material, are thus truth-bearing in a very strong sense. Theoretical laws derived from the model give an approximate fit with empirical laws reporting on observation.

Causal Idealizations

What it is: Solve a more tractable version of the original problem by idealizing the "problem-situation."

McMullin: "[Galileo's] insight was that complex causal situations can only be understood by first taking the causal lines separately and then combining them."

Why is it an idealization: Decompose causes, treat them seperately, and combine them.

Can be done both experimentally and in thought ('subjunctive' idealizations). Different ways: the asymptotic experimental case or the pure power of thought.

How are they truth-conducive: By composition of cause and asymptotic experimentation. McMullin:

> The warrant for Galileo's law of fall was in the first instance an 'asymptotic' experimental one, as we have seen. The same would be true of a great many other laws in fields like chemistry or genetics.

Coal: A decidedly realist stance to the truth-conduciveness of idealizations. But maybe that's alright?

Approximations & Idealizations

A helpful distinction between idealizations and approximations comes from Norton (2012: 209) according to whom:

Norton (2012) "Approximation and Idealization: Why the Difference Matters." *Philosophy of Science* 79 (2):207-232.

> An *approximation* is an inexact description of a target system. It is propositional [and]
>
> An *idealization* is a real or fictitious system, distinct from the target system, some of whose properties provide an inexact description of some aspects of the target system.

Consider for example, Norton's example of the free fall of a body (of unit mass) in a medium with a small coefficient of friction μ. The equation for its speed (v) at time t is

$$\frac{dv}{dt} = g - \mu v$$

where g is the acceleration due to gravity. If the mass falls from rest at $t = 0$ the solution to the equation is:

$$v(t) = \frac{g}{\mu}\left(1 - e^{-\mu t}\right)$$

Using the power series expansion of e^x, we get:

$$v(t) = \frac{g}{\mu}\left(1 - (1 + \frac{(-\mu t)}{1!} + \frac{(-\mu t)^2}{2!} + \frac{(-\mu t)^3}{3!} + \ldots)\right)$$

$$v(t) = gt - \frac{g\mu t^2}{2!} + \frac{g\mu^2 t^3}{3!} - \ldots$$

If μ is suitably small, the speed of the body can be *approximated* to

$$v(t) \approx gt$$

This is an approximation because it provides an "inexact description" of our target system *viz.* the body of unit mass. In approximating the speed as gt we neglect higher-order terms in μ. However, we can also introduce an *idealized* system of a body with unit mass falling in a vacuum. For that system, $\mu = 0$ and

$$v(t) = gt$$

This is an idealization because it is "distinct from the target system" and has property which is an "inexact description" of the target system.

Are all Galilean idealizations idealizations or are some Galilean idealizations approximations?

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