# Philosophy of Science // Fall 2015

## Handout 18

### Laws, deductive systems, *ceteris paribus*: Earman, Cartwright

**Lewis' proposal.** Two possible worlds are exactly the same with regard to their natural laws if they are exactly alike with regard to where in space and where in time there are instantiations of X-properties. These properties are 'rare' and 'perfectly natural'. Which true statements are statements of laws depends on the facts about space-time's geometry and the global distribution of X-properties. (The characteristics of X-properties will be discussed in a moment.) Also dependent on the global distribution are facts about single-case objective probabilities, such as this atom's having a 50% chance of decay in the next *n* seconds.

What are the mysterious X-properties? They have the following characteristics:

(1) They are not abundant (the property 'is white and electrically charged and ... ' is out).
(2) They are categorical (that is, non-modal: the property 'would burn if put in contact with fire' is out).
(3) They are qualitative (the property 'is solid and rectangular' is out).
(4) They are possessed intrinsically by a space-time point or its occupant (the property 'is heavier than the Sun' is out).

*Question* 1. 'Two possible worlds are exactly the same with regard to their natural laws only if they are exactly alike with regard to where in space and where in time there are instantiations of X-properties.' What, if anything, is wrong with this claim?

Thus, in effect, Lewis' proposal is to examine various deductive systems. These systems contain true statements about instantiations of X-properties and also statements ascribing some probability to different X-properties' subsequent instantiation if certain X-properties have already been instantiated. For example, one such statement would be a statement that, for any *t*, any $^{210}$Po atom at *t* has a 50% chance of decaying in 138.39 seconds after *t*.

In evaluating deductive systems, we look at the following criteria. The systems must be *simple* in, for example, the number of axioms in the deductive system. They must *fit the world* better in assigning the 'right' probabilities. Thus, e.g., the statement 'All $^{210}$Po atoms have a half-life of 138.39 seconds' has a better fit than the statement 'All $^{210}$Po atoms have a half-life of 5 days.' Finally, they must be *informative* in ascribing probabilities to possible arrangements of X-property instantiations (clarified in a moment). Thus the statement 'All emeralds are green' is more informative than the statement 'All emeralds are green before 2050.'

*Question* 2. Compare the informativeness of the two statements.

*Remark* 3. There is an evident tension between simplicity and informativeness. A system specifying the decay periods of every atom of polonium-210 would be very informative. It will, however, be fairly complex.

**Two dividends.** We may be able to deal with unrealised possibilities. Consider Coulomb's law:

$$\mathbf{F}_1 = \frac{1}{4\pi}\frac{q_1 q_2}{r_{12}^2}\mathbf{r}_{12}. \tag{18-1}$$

We take our candidate for the best system $S$ (according to the criteria above) and replace Coulomb's law in it by a generalisation which agrees with Coulomb's law save for any case of an electric charge of 1.111 statcoulombs located exactly 10 metres from an electric charge of 9.999 statcoulombs. We then obtain another system $S'$. Let the replacing law in $S'$ yield a different magnitude of force that Coulomb's law yields. And suppose that there actually has never been, nor will be, such a configuration of charges and the distance. But the system $S'$ is still more complex than $S$, as it provides a special treatment to one particular case. Hence $S$ is a better system than $S'$, and natural laws should include Coulomb's law, rather than the proposed replacement.

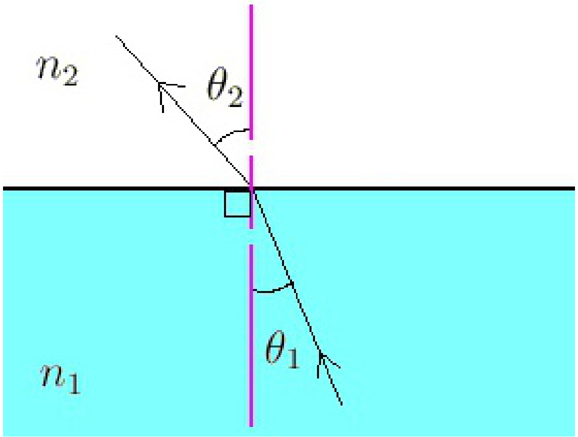
We are also able to distinguish between laws and accidental generalisations. The latter may not sit well together with other true statements to generate the best system. But: the worry is that laws do not seem to be completely determined by instantiations. For example, the laws of our world would have been the same even if there were no class today.

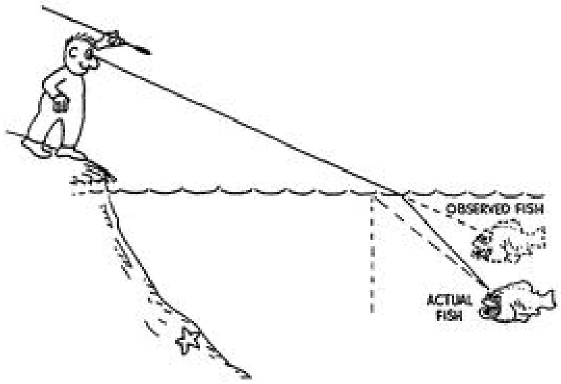
**Two problems.** Suppose there is a world *w* with a lone particle moving uniformly in it. Then the best system for *w* would include a statement 'At all times there is only one body.' However, there is also a world *w*′ where such a statement is an accidental generalisation. Such a world, indeed, is compatible with our actual world, for all we know. In the world *w*′ some (many!) of the laws would be idle. But so are many laws in the actual world. So the problem of accidental generalisations is not really resolved.

Another problem: As discussed by Earman at the end of the selection, axiomatic systems are tied to language. Thus it may be possible that a system axiomatised in one language will deliver laws different from the system axiomatised in another language.

**Laws and explanations.** Cartwright argues that many laws, as stated in science textbooks, implicitly include a *ceteris paribus* clause. Literally put, when stripped of that clause, they are false. Nevertheless such laws can explain—in contrast to what the D-N model of explanation implies (as well as other models). Covering laws required by the D-N model are *scarce*.

*Example* 4 (Snell's law). When light transits to the medium where it travels slower, it bends toward the normal. The bending angle is calculated by Snell's law: $\sin\theta_1 / \sin\theta_2 = n_2/n_1$.




*Remark* 5. Apparently broken objects in water (explained by Snell's law) are cited in Descartes' *Meditations* to show how senses are not reliable. See also Joyce and Joyce, 'Descartes, Newton, and Snell's law' (1976).

**Every law is born to fail?** Snell's law has an implicit *ceteris paribus* clause: the media where light travels should be isotropic. In anisotropic media (crystals and also media submitted to external electromagnetic influences) where velocity depends on the direction of propagation the law no longer holds (since a light ray splits there into two). Hence Snell's law is literally false. Furthermore, the *ceteris paribus* clause cannot be interpreted as 'for the most part', since most media are anisotropic.

**Using ceteris paribus laws.** The use of *ceteris paribus* laws is justified even though they are false. Explanations can invoke *ceteris paribus* laws to show what factors are relevant for explaining. Objection: but this means that *ceteris paribus* laws offer at most elliptical, metaphorical, non-literal explanations. Reply: this idea presupposes extreme regularity in nature, so that most of it (or all) is governed by laws. This assumption is unwarranted. Another reply (more important, I think): *ceteris paribus* laws do in fact explain. This idea is familiar to us from van Fraassen.

**The irrelevance of covering laws.** When *ceteris paribus* laws conflict, very rarely we are able to produce covering laws. As Cartwright says, 'most real life cases involve some combination of causes; and general laws which describe what happens in these complex cases are not available.' But in any event, we are able to explain in their absence. This is further illustrated by the example of camelias.

*Question* 6. What is the story of camelias? How does it establish the explanatory role of *ceteris paribus* laws?

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