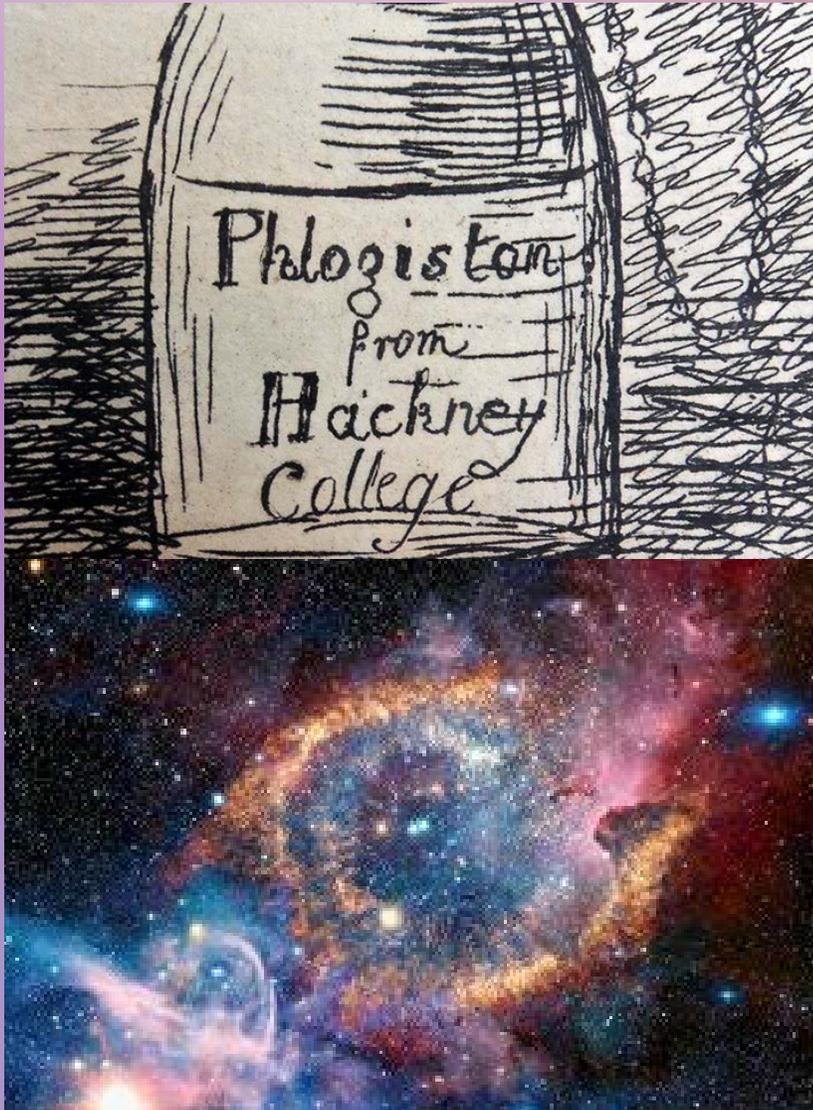




Reduction, Relicts and Realism

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work with Al Wilson)

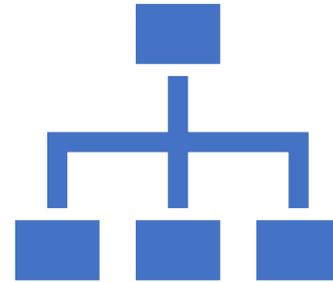


Introduction

- + Our view of the physical world expands and contracts...
- + But why do we junk caloric and phlogiston but not heat, light rays, atoms or even space and time?
- + Answering this 'puzzle of theoretical relicts' is the project here
- + Disclaimer: not going to focus on reference (cf. inter alia Ladyman 2011, Myrvold 2020).



Topic here: reduction, and its ontological consequences, specifically for theoretical relicts.



Reduction is important for both theory change, but also higher-level/scale relations.

Two types of reduction

- + A theory T_t is reduced to T_b if the equations/quantities/variables of T_t can be constructed from the equations/quantities/variables of T_b

On the face of it, there are two types:

- + Horizontal reduction: old-new theory reduction.
- + Vertical reduction: big-small theory reduction.
- + Another terminology: diachronic vs synchronic, (Crowther 2018).

Preliminary assumption

- + Vertical (big-small) theoretical reduction doesn't lead to elimination of higher-level entities, contra Nagel.
- + Even if viruses, gases and molecules can be understood from the bottom up, they are still part of the scientific realist's ontology.
- + There are various strategies for arguing for the higher-level ontology, and the only strategy that is ruled out here is theoretical irreducibility.
- + Instead, the higher-level entities are not eliminated but are emergent*
- + *fill in your favourite account. Franklin and Robertson: entities are emergent if they enter into novel laws/macrosdependencies that screen off the microdetails (one advantage: explicitly compatible with reduction).

The Plan

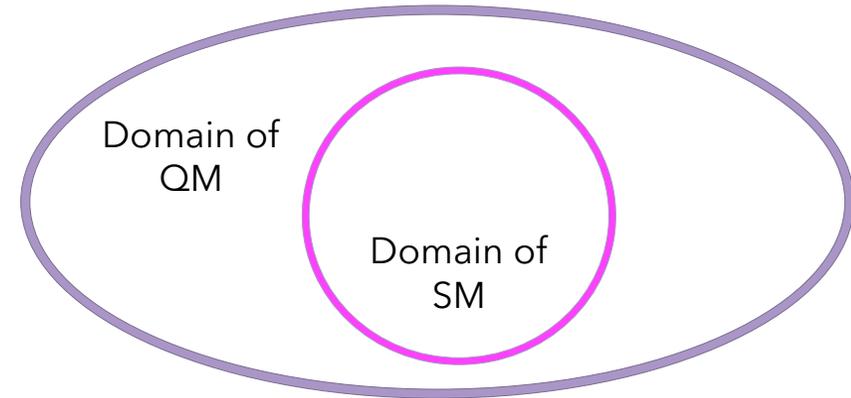
- + Here: distinguish two types of reduction: horizontal and vertical.
- + Then show how the old theory can be reinterpreted so the reduction relation is verticalized.
- + Spelling this all out will allow us to solve the puzzle of relicts.
- + The answer will be: good relict (i.e. a retained relict) is one that features in a verticalized reduced theory - and so can be considered emergent.

Horizontal reduction

Target phenomena of NM=
Target of SR.

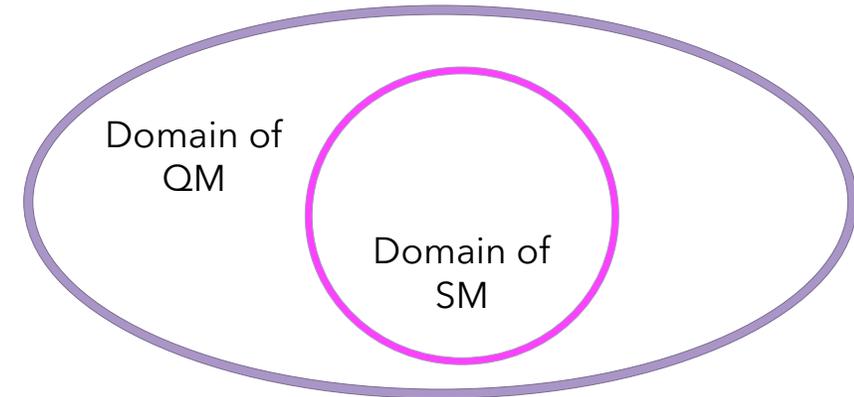
- + If T_t is reduced to T_b , then the success of the older theory is explained by its relation to the better theory.
- + T_b is the *better* theory, often because it is more accurate. But to compare accuracy, the two theories need to describe the same phenomenon.
- + T_t *approximates* T_b
- + Example: Newtonian mechanics and special relativity in the low velocity limit.

Vertical reduction



- + Here is not clear that one theory is more accurate than another. Is hydrodynamics less accurate than particle mechanics? Is biology less accurate than chemistry?
- + In order to compare, they need to make predictions about the *same phenomena*.
- + But T_t describes a different set of phenomena than T_b - even if reduced.
- + Statistical mechanics is about the bulk properties such as mean kinetic energy, and answers questions about relaxation times, whereas the underlying microdynamics is about the exact state of the system.

Vertical reduction



- + A higher-level theory can be *about* something different than a lower-level theory that underpins it.
- + Strong Cartwrightian direction: SM describes phenomena that QM doesn't (Hartmann, 2000).
- + But the uncontroversial direction: QM describes some phenomena that SM doesn't; what happens at the recurrence time, what happens with unusual initial conditions, or for systems that do not fulfil the conditions of applicability of SM.
- + T_t doesn't *approximate* T_b , but instead *abstracts away* from some of the microdetails to describe a distinct subject matter, or set of phenomena.

Distinguishing horizontal and vertical

Horizontal reduction

+ The older theory *approximates* the newer theory which gives a more accurate, or successful description of their common subject matter.

Vertical reduction

+ The higher-level theory *abstracts* away from the more detailed lower-level theory and describes a *distinct* subject matter.



Subject matters

- + Some accounts are too fine-grained (all theories will have different subject matters! Cf. Hawke 2018).
- + We understand it in terms of target phenomena, and the partitions induced by questions generated by those phenomena.
- + Examples of target phenomena:
 - As originally conceived, Newtonian mechanics aimed to describe the same phenomena as special relativity: matter in motion.
 - Phlogiston theory aimed to describe the same phenomena as Lavoisier's theory: combustion.
 - The ray theory of light aimed to describe the same phenomena as the wave theory of light: optical phenomena like rainbows.

Phenomena, partitions and questions

- + Following Bogen and Woodward (1982), phenomena cause the data that are then used to test the theory describing the phenomenon in question.
- + Phenomena generate a range of questions: what temperature does the kettle boil at? Why does the flame turn green when this ionic compound is added? Why does the football follow this trajectory?
- + The connection to subject matters a la Lewis: a question defines a partition over possible worlds (each cell corresponds to one possible answer).
- + The subject matter of a theory is how things stand with respect to the conjunction of questions connected to the target phenomena.

Testing this account of subject matters

- + The questions that an old theory aims to answer are the same as the new theory: they have the same target phenomena.
- + In contrast, a higher-level theory does *not* aim to answer the same questions as the lower-level theory: it has different phenomena as its target.
- + But note: in latter case, the set of questions answered by the higher-level theory T_t overlaps with T_b 's set!
- + This is to be expected: the subject matters are not *orthogonal* (like the number of stars, Victor's fashion sense) since there are supervenience relations between levels.

Verticalisation – *how?*

- + Reinterpret the domain of the old theory such that it is now limited to the circumstances in which it gets some nomological structure right, and so latches onto genuine dependencies.
- + In this way, T_t is now understood an *effective theory* because (in sense of an EFT, cf. Williams 2019)
- + Now T_t has a distinct subject matter from T_b
- + N.B. this is distinctness in the 'not exactly the same' sense, since there will be overlap.

Verticalisation: an objection

- + Can't we always reinterpret a theory such that it only applies for certain domains or certain degrees of accuracy?
- + Yes.
- + But this doesn't make verticalization cheap - since there are restricted circumstances as to *when* we should verticalize.



Verticalisation – *when?*

- + Why limit verticalization? We need the option that some theories should be consigned to the bin.
- + Phlogiston theory got some nomological structure *right*: as discussed by Ladyman (2011), Noretta Koertge (1968) argues that phlogiston theory demonstrates a correspondence principle, and so is arguably *reduced* to redox theory.
- + Why shouldn't we verticalize this reduction relation?
- + What is the difference between this theory and other examples? E.g. TD-SM, or NM-SR?

Verticalisation – *when?*

- + No explananda for which phlogiston theory does better than redox theory, but there are some explananda for which Newtonian mechanics does better than special relativity: *why did my football follow a particular trajectory?*
- + **Only verticalize when T_t gives better explanations than T_b for some explananda, so T_b does not strictly dominate T_t wrt to explanatory power.***
- + How to understand 'better explanation'? E.g. More proportionate explanation, or more computationally tractable. (N.B. contra Frigg and Werndl 2019, this assumes effective theories can explain).
- + N.B. restrictions on which explanatory questions is required! The questions can't be purely theoretical (how much phlogiston? Which is the frame of absolute rest?), i.e. have no *empirical* basis since they were generated not by the phenomena but only by the theory.

* Will Kuhn losses mean this condition is always satisfied? Cf. Hartmann (2000).

Verticalisation – *why?*

- + We don't have to understand our old theories as merely useful fictions.
- + Verticalisation rehabilitates the old theory: it's status changes from an old wrong theory to a higher-level theory which is correct within a limited domain.
- + This opens the door to treating such theories, and the entities in their laws, as higher-level entities, like viruses, mountains and fluids – *provided they pass the criterion for ontological commitment.*
- + On Knox's account of emergence, the connection is particularly direct: there is (by stipulation!) novel explanatory value.
- + Within certain domains, space and time exist (as emergent from spacetime). As do Newtonian forces within a particular domain, likewise heat, particles.

Conclusion: resolving the relicts puzzle

- + Which old entities should be junked and which kept?
- + If the reduction can be verticalized (and so reinterpreted as true within a domain), then the old theory's entities are (potential) *higher-level* entities.
- + Verticalisation makes our old theories effective theories, and in doing so makes "explicit the physical domains in which one can trust the theory to deliver reliable ontological information" (Williams 2019).
- + Temporal distances are not just useful fictions, but (potential) higher-level entities.
- + *Slogan*: a good relict turns out to be an emergent relict.

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Thank you for listening!

Conclusion

- + Puzzle of relicts
- + Different types of reduction
- + Under certain conditions, can verticalize. And so understand old ontology (Relicts) as higher-level relicts.
- + AI: I guess if we are saying that light rays are higher-level explainers and if they are emergent – then not really relicts but same status as e.g. viruses?



otherwise.

criptions, or equations....competing or

Reduction

- + Recap: construction idiom
- + Old-new: approximation crucial, and same target phenomenon (i.e. subject matters).
- + Big-small: no difference in accuracy, since different target phenomenon (different subject matters) – abstraction, rather than approximation.