

Being, Time, and Induction

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Introduction

- Talk concerned with choice between realism and empiricism.
- Focus on Nelson Goodman's "New Riddle of Induction" and the EPR-Paradox (1935 version)
- Goodman's paradox is itself a repudiation of an extreme form of empiricism: Quine and his "nominalist inductivism", which corresponds to
- Set-theoretical foundationalism: All class terms and predicates refer to sets; while, two sets with the same members are strictly identical.

Goodman's "New Riddle of Induction"

- Picking some arbitrary evidential claim, e.g., "all emeralds found so far were green"
- We would like to conclude that:
- "It is more likely that future emeralds be green than not."
- Furthermore (cf. Hempel) we would like to do so without introducing subjective elements, that is,
- The data should consist of sets, such that any two sets with the same members are identical ("extensionalism")
- We then argue that, at the time t of the inductive step,
- There is an indeterminate plurality of future extensions.

U[nobserved]

“s”, “t”, “u”

p, q, r, ...

O[bserved]



Unobserved

“s”, “t”, “u”

t

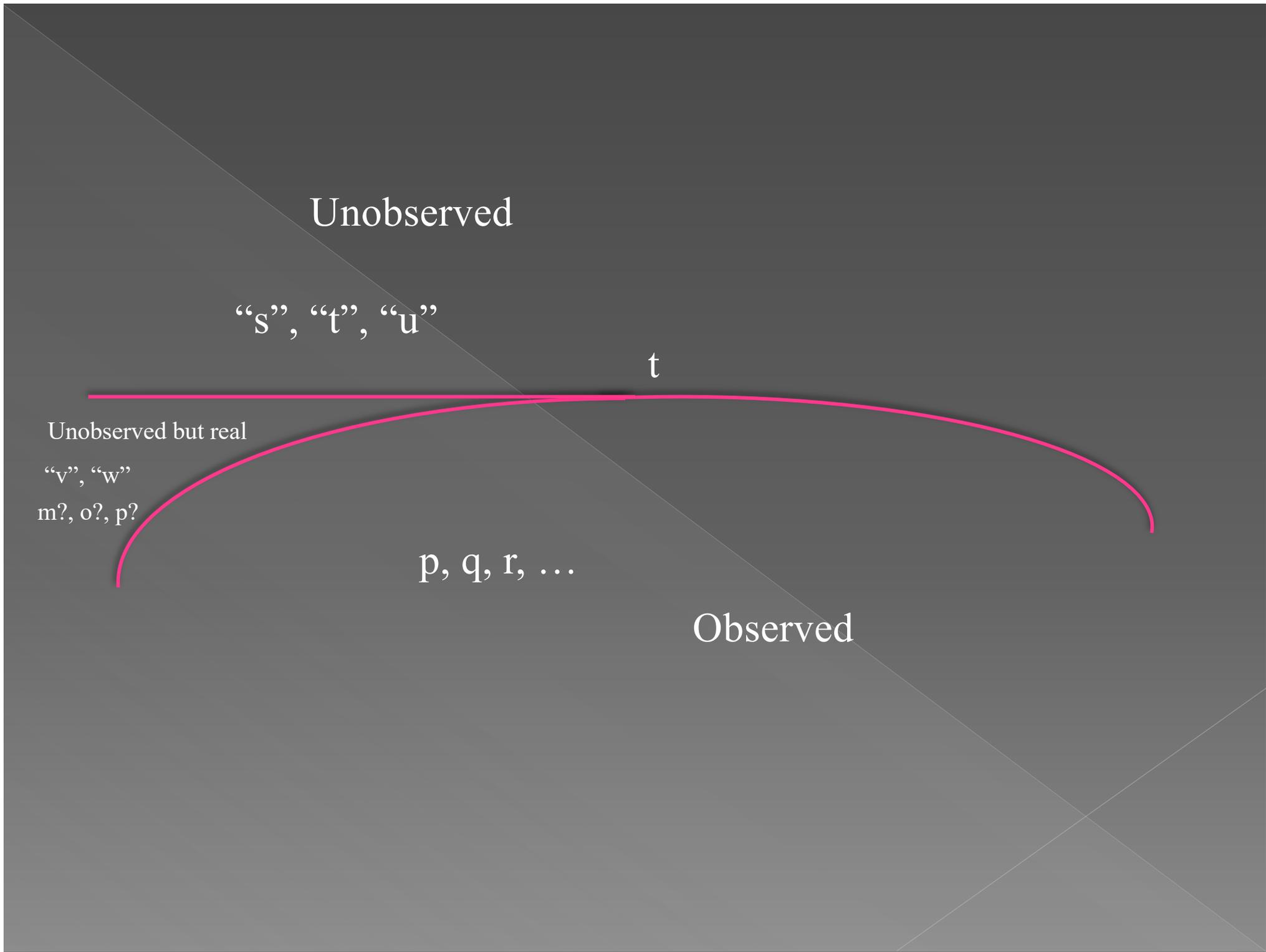
Unobserved but real

“v”, “w”

m?, o?, p?

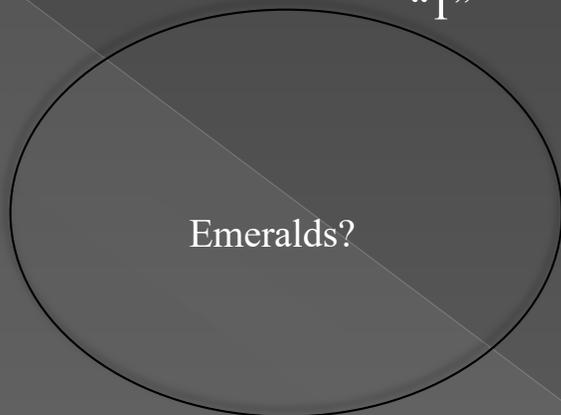
p, q, r, ...

Observed

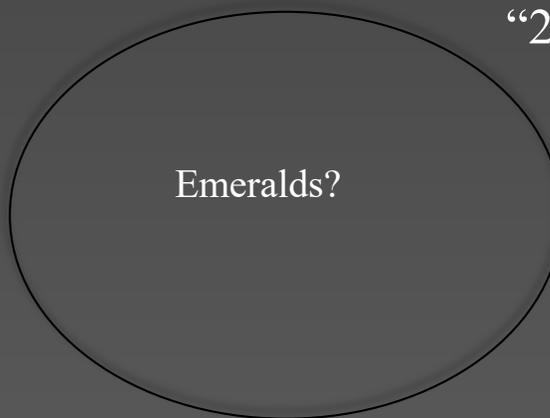


Unobserved

“1”



“2”



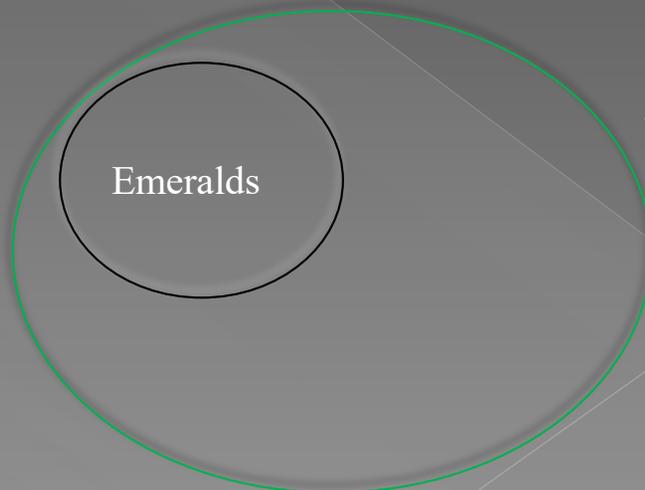
t

Unobserved but real

Observed

“Green”

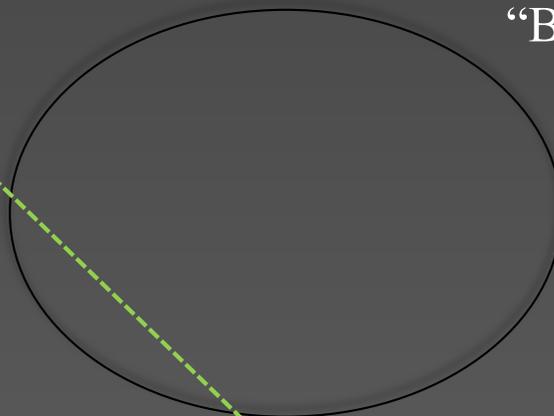
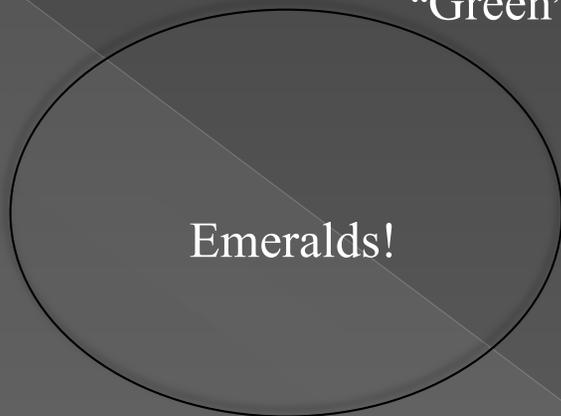
Emeralds



Unobserved

“Green”

“Blue”

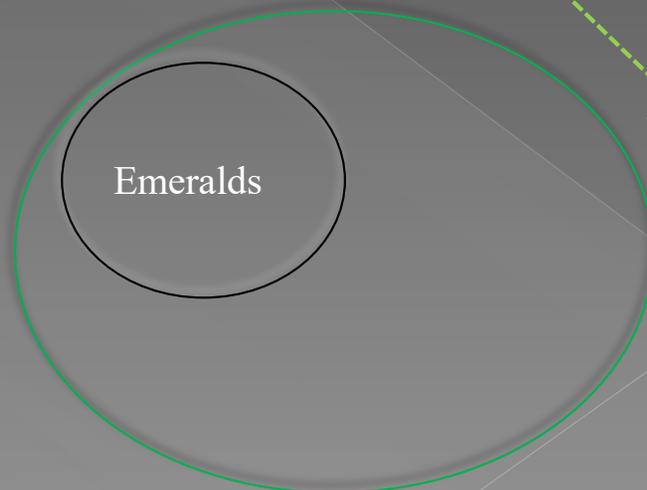


t

Unobserved but real

Observed

“Green”



Goodman's "New Riddle of Induction"

- ◉ Whether interpreted classically, or probabilistically, the result is the same:
- ◉ Without some constraints on the future extensions of the "predicate-names", e.g., Green(x)
- ◉ The future is completely undetermined.
- ◉ Thus, if the role of induction is to predict the future on the basis of past data,
- ◉ All induction presupposes an "intensional" component:
- ◉ Meanings, real properties, linguistic entrenchment etc.

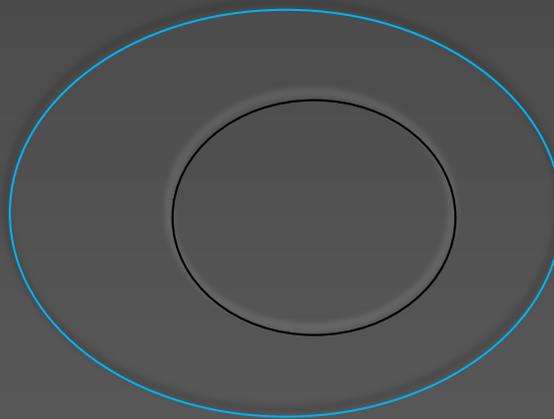
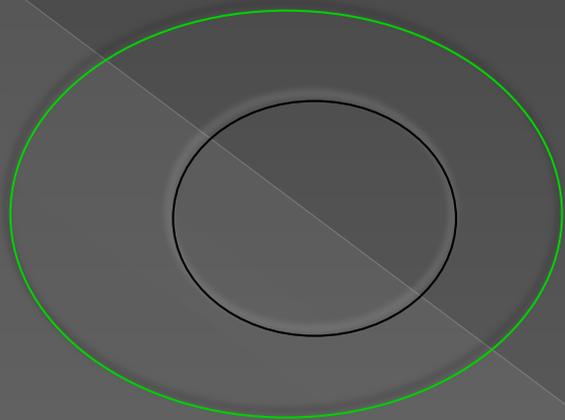
Realism vs. Nominalism

- Although “realism” is the most natural response, one thing speaks strongly against it:
- “Real properties” will only do the work we need if they are defined in terms that overshoot actually observed extensions.
- This can be illustrated by considering one of the most natural responses to Goodman’s challenge.
- It contains within it all of the standard objections
- For instance, it allows one to see that one widely discussed “alternative definition” of “grue” is obtained simply by eliminating the real-but-unobserved, i.e.
- By using classical as opposed to Einsteinian space-time.

Argument against observational predicates

- x is grue $\leftrightarrow_{\text{Def.}} [(x \text{ observed before } t \text{ and is green}) \text{ OR } x \text{ is blue}]$
- Principle of Sufficient Reason [PSR]:
- Things don't change without a reason, e.g. An object in uniform motion....
- CR: If I know with certainty that $\text{Observing}(x) \Rightarrow \text{Phi}(x)$, then $\text{Phi}(x)$
- 1. x is an unobserved green object (Assumption)
- 2. E is grue (Def. & CR)
- 3. If E is observed after t , it will be green (by 2 & 1)
- 4. If E is observed after t , it will be blue (by 2 & 1)
- 5. If E is observed after t , it will be blue (by 4 & 1)
- 6. If E is observed after t , it will be green (by 3 & 1)
- 7. Contradiction, thus either
- 8. the PSR is false
- 9. the CR is false
- 10. "grue" and other observational predicates are absurd.
- Why absurd?
- "Because introducing such a predicate provoked a contradiction."

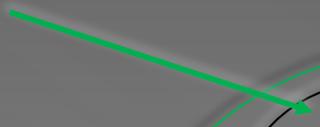
Unobserved



t

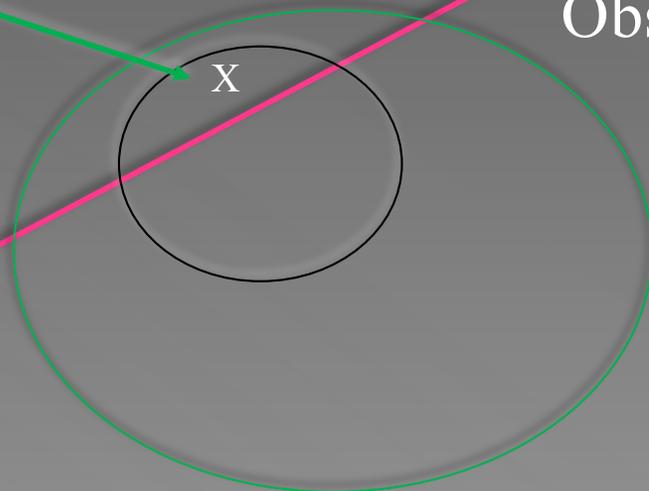
Unobserved but real

Unobserved Green Emerald

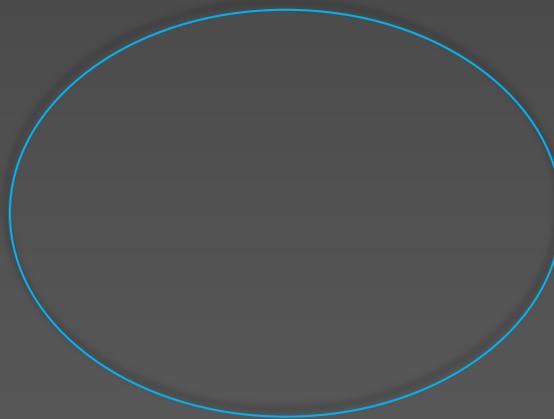
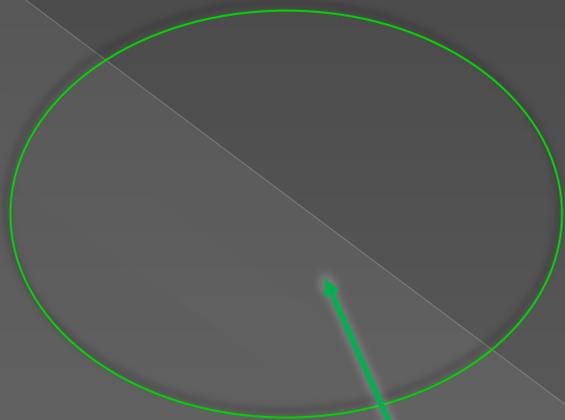


X

Observed



Unobserved



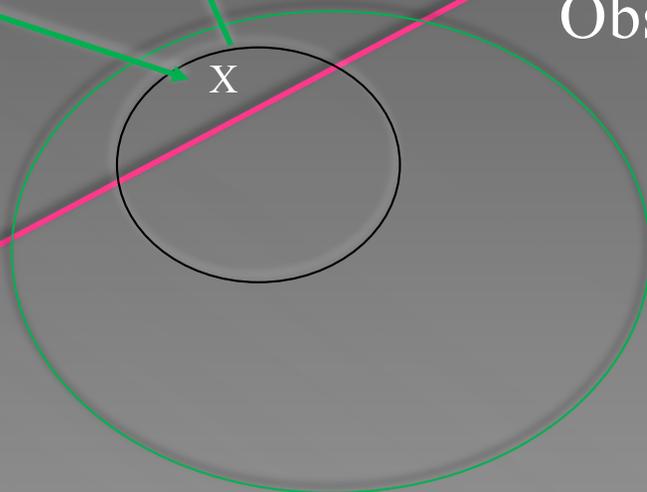
t

Unobserved but real

Unobserved Green Emerald

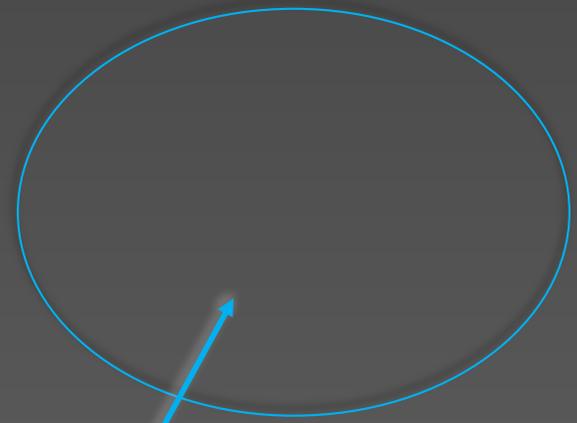
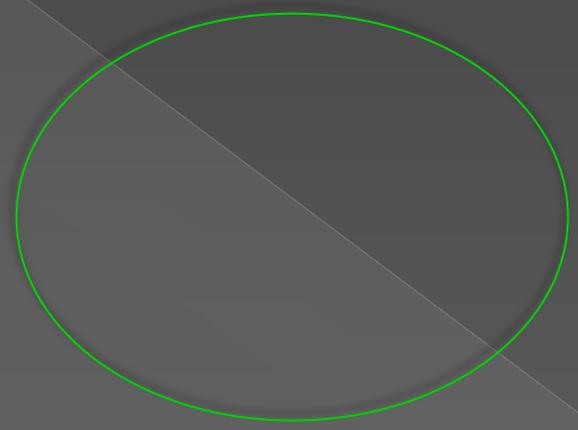
Observed

X



“x changes colour!!”

Unobserved



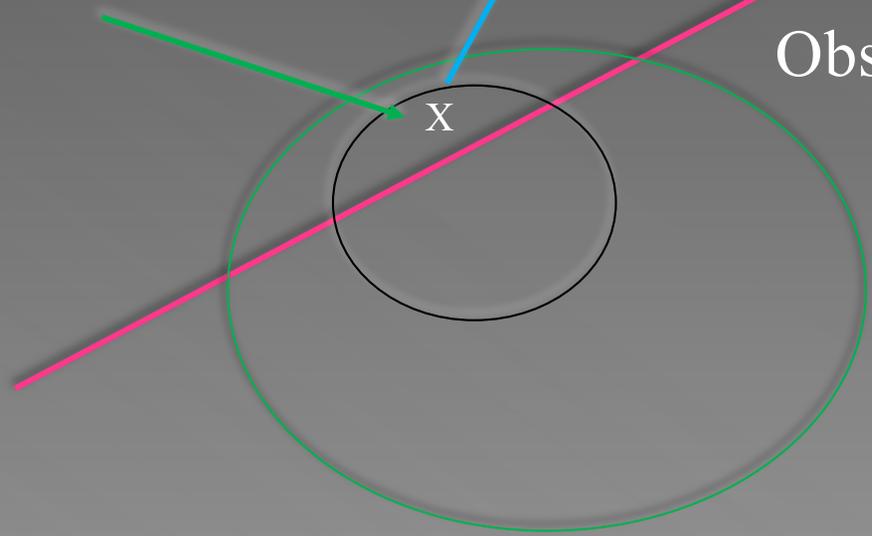
t

Unobserved but real

Unobserved Grue Emerald

Observed

x



NB: A symmetrical argument can be constructed

- ◉ We began with “green” and then showed that introducing “grue” led to a contradiction.
- ◉ We privileged, so to speak, the “inertia” of the one predicate, to prove that the other was absurd.
- ◉ But, if we had applied PSR to “grue”, it would have been green that turned to be absurd.
- ◉ If we don't know which to privilege, the argument is symmetrical.
- ◉ It proves only that the two will not be cotenable in the future (which is included in U).
- ◉ Even though they are cotenable up until time t (in O).
- ◉ The argument seemed to work, so long as we were convinced that we *knew something definite* about objects lying in an unobserved region of the world.

Entrenchment

- Goodman will say: “This just proves my point. You *do not know* anything definite about UO”
- Given this hard-anti realism concerning UO’s contents.
- The only reason to prefer green over grue is that one of them is *entrenched*.”
- Meaning: the only difference that is empirically well-defined is the fact that the *words (nomina)* were used differently in the past.
- This follows, for Goodman, because all predicates that can be appealed to must be defined in terms of extensions within O.
- And within this observed region, green and grue are strictly coextensive.

Moral

- The “direction” of the future is underdetermined by the past; and, more generally,
- The determination of a probability space depends on some classification that is not reducible to the mere extension of the members of the sample set.
- Drives a whole family of theories within HPS, beginning with Kuhn.
- For these thinkers, inspired by Goodman, social and linguistic factors are the only way to solve the impasse.
- If, on the other hand, they were also insufficient, Goodman and his followers might have to reconsider.
- Specifically: If the criteria for distinguishing between the two predicates depends on something that is not in O ,
- While distinguishing them is a condition on future determinism
- Then realism is the only alternative.
- The Einstein-Podolsky-Rosen “paradox” [EPR] presents such a challenge.

EPR and the CR

- Many versions of EPR's argument, will be discussing the original one, in the 1935 paper.
- It involves CR, while other variants do not.
- Setup: We consider two entangled systems (A and B), and one of their anticorrelated observable quantities (O_1).
- $O_{1A+} \leftrightarrow O_{1B-}$
- $O_{1A-} \leftrightarrow O_{1B+}$

Unobserved

Unobserved but real

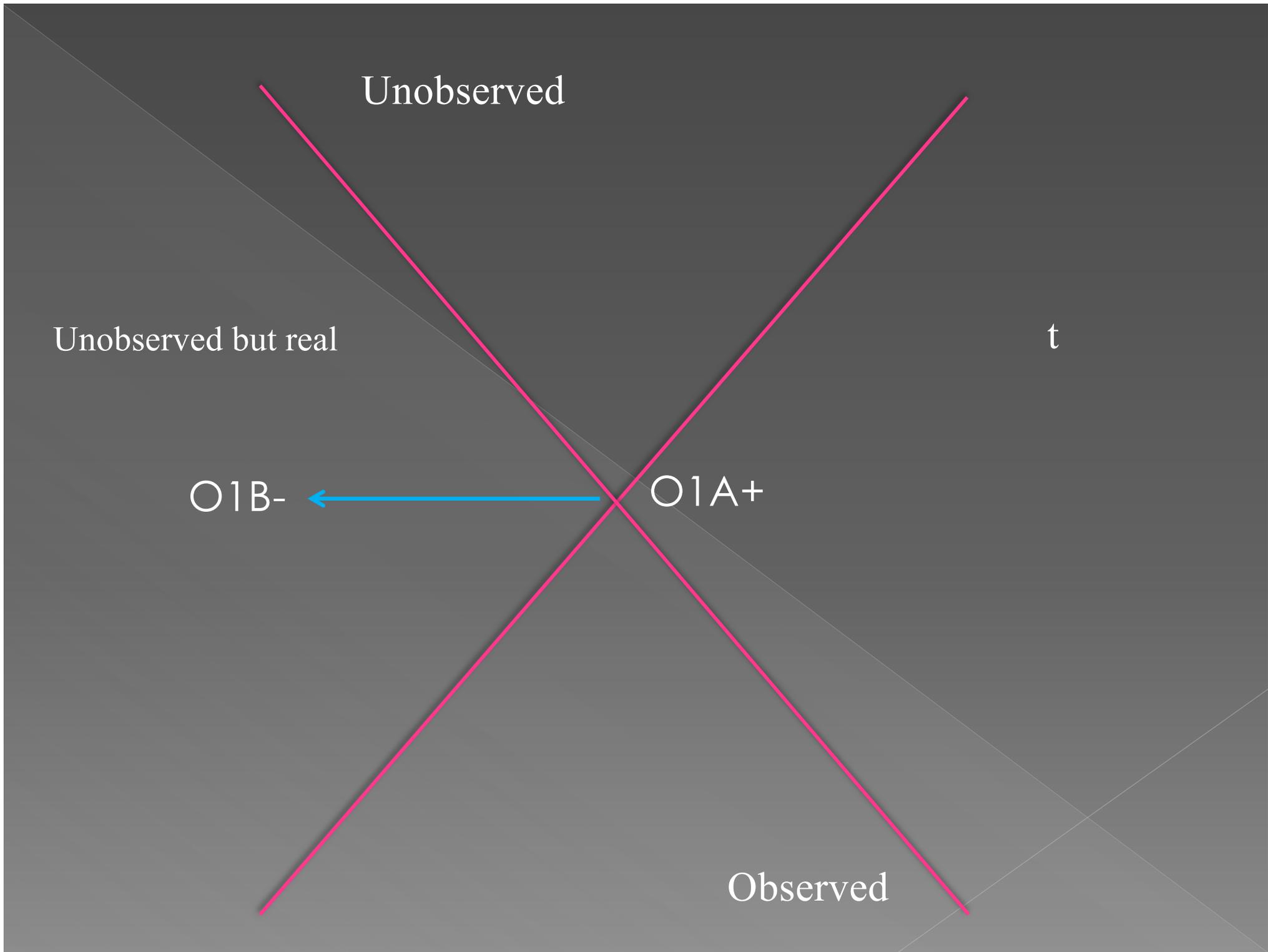
t

O1B-



O1A+

Observed



Unobserved

Unobserved but real

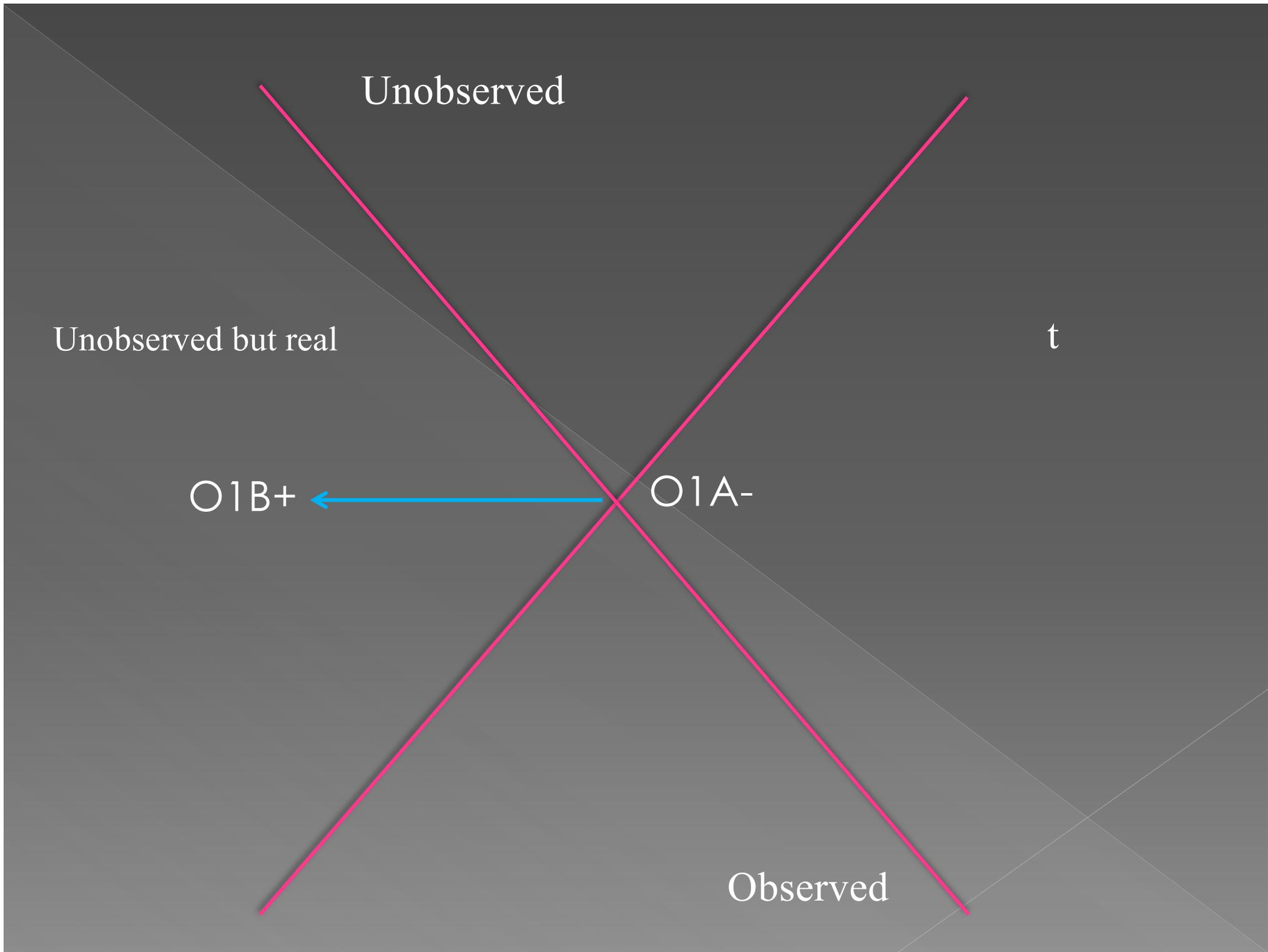
t

O1B+



O1A-

Observed



Essential Complication:

- Measurement for some other observable, O_2 on either system “spoils” measurement for O_1 on both systems. (*“when the momentum of a particle is known, its coordinate has no physical reality.”* EPR, 778)
- Thus, not only is the perfect anti-correlation *observable* only if both Alice and Bob measure for the same observable quantity.
- But, equally well, if Alice measures for O_2 , the possible values that Bob will get by measuring for O_1 will be a distribution of outcomes, with varying probabilities.
- Thus, we must also say that *only if* they measure for the same observables will we be entitled to assume such a perfect anti-correlation.
- It therefore seems unavoidable that measuring for O_1 on A somehow “affects” the state of B.

Essential Complication:

- Now, as just mentioned, the nature of this affection, and our understanding of its significance,
- Is at the very least different before and after the work of JS Bell, A. Shimony, PH Eberhard, B. D'Espagnat, A. Aspect and others.
- The Criterion of Reality plays no major role for Bell and his successors; however,
- Perfect anti-correlations remain an intrinsic feature of the theoretical background; and, just as importantly,
- They are important for many of the possible application-domains, e.g., cryptography.

Criterion of Reality

- “If, without in any way disturbing a system, we can predict with certainty (i.e., with probability equal to unity) the value of a physical quantity, then there exists an element of physical reality corresponding to this physical quantity.” (EPR, 777)
- E.g., If Alice measures for O_1 and obtains +, then she “knows with certainty” that if someone such as Bob were to measure for O_1 on system B, he would obtain -.
- Thus, after she has measured, she must say that there is an “element of reality” corresponding to “-”.

Non-interference [Locality]

- Here implemented simply as:
- “Let us suppose we have two systems A and B, which we permit to interfere from the time $t=0$ to $t=T$, after which time we suppose that there is no longer any interaction between the two parts.” (EPR, 779)
- At the very least, EPR are prohibiting counterfactual conditionals of the following form:
- If $\sim p$ then $\sim q$; for instance,
- “Given perfect anti-correlation, the fact that it’s not the case that $O1A+$, implies that it’s also not the case that $O1B-$.”
- “If $\sim O1A+$ then $\sim O1B-$ “

CR & Locality \Rightarrow Incompleteness

- Applying the CR allows them to “lock” the consequent (it’s now an “element of reality”)
- While non-interference/locality allows them to argue that O1B-, even if Alice hadn’t measured at all.
- The intuitive form of the argument is:
- “If it’s true that pushing a button implies that a light-bulb in a box is illuminated,
- While, in fact, the switch is not connected to the light.
- Then the light must already be on.”
- Whereas, in fact, and contra Einstein’s expectations,
- Pushing the button does in fact turn on the light
- Meaning in turn that Locality is violated.
- Thus we can influence the unobserved but real,
- Even though we cannot (yet) obtain information from it.

CR & Locality \Rightarrow Incompleteness

- ◉ Repeating this (highly problematic) argument for a second observable, they conclude that, according to Dirac's theory,
- ◉ QM must be "incomplete", i.e.
- ◉ There exist true statements that are not derivable within the syntax of the theory. (cf. David Hilbert, Kurt Gödel)

CR & Locality \Rightarrow Incompleteness

- What matters first and foremost is the role of the CR, which “populates” the region outside the light-cone (the “wings” of the light-cone)
- Since that region belongs to the Unobserved
- All statements concerning its contents are mediated by inferences.
- Furthermore, insofar as the Dirac-notation predicts (conditional) observation-outcomes,
- It could be argued that that region should, at least for heuristic purposes, be considered empty or indeterminate.

Incompleteness & Underdetermination

- Moral of Goodman's argument:
- Without choosing some sortal term (green, grue, ...), we had no constraints on future possibilities.
- Goodman's solution was to choose the one that had been used the most in the past—within O in other words.
- He rejected realism for the same reason: it invokes factors beyond the observable domain, as we saw.
- But some decision must be made, for without it, the space of future possibilities is completely unconstrained.

Underdetermination

- In our second case—EPR—this situation repeats itself.
- It belongs to a larger family of paradoxes that became thought-experiments, and finally actual experiments:
- EPR, double-slit, Aharonov-Bohm are all cases in which the space-like “width” of a wave-function leads to correlations that apparently involve “actions-at-a-distance”
- While strict locality implies that all relevant factors for the future evolution of a system be located within O , i.e., the “rearward light-cone”.
- Hard-anti realism concerning possibly unobserved processes in the wings of the cone is not just counterintuitive,
- But has the same consequences as in our purely philosophical case:
- The temporal evolution of the system before me is unconstrained.

Concluding

- Will conclude with two questions:
- 1. Why does this problem emerge only recently?
- 2. How is it that these two paradoxes are so similar?
- The short answer to 2. is that both are modelled on Kant's "Analogies of Experience"
- Perdurantism of Substance (1st) & Principle of Succession (2nd; PSR) = "inertia of properties", aka,
- "Uniformity of Nature"
- Negation of Principle of Simultaneity (3rd) = Locality
- These produce a causal geometry within space-time.

Einstein and Goodman

- As I've argued elsewhere, Einstein's SR rendered the principle of simultaneity incompatible with the principle of succession,
- I.e., "no actions at a distance"
- "In the Schrödinger equation, absolute time plays a fundamental role, which concept has been shown to be inadmissible through the theory of relativity." "Physik und Realität," 1936, *Journal of the Franklin Institute*, vol. 221, No. 3, 313-347, p. 342, tr. Hyder.
- EPR is a development of this criticism, which Einstein continues to make for the rest of his life.

Einstein and Goodman

- And Goodman comments on the moral of *his* solution to the paradox as follows:
- “Like Hume, we are appealing here to past recurrences in the explicit use of terms as well as to recurrent feature of what is observed.
- Somewhat like Kant, we are saying that inductive validity depends not only upon what is presented [extensions], but also upon how it is organized [sortal terms].” (96)
- For him, the only uniformity is linguistic (cf. Wittgenstein)

Why does this problem emerge only recently?

- More important than these famous names and buzzwords
- Is what Einstein and Goodman are telling us:
- The conical structure of time means that the “recurrences of observation” are always confined to O , and O has no spatial extension at the present moment.
- In classical mechanics, O has a different topology.
- For, its present includes the totality of the universe; and, furthermore,
- There is no obstacle to instantaneous actions within O at the present moment.

The real but unobserved

- Thus, if we are so inclined, we can interpret EPR and later experiments such as Aharanov-Bohm
- As refuting Goodman's nominalist-empiricist solution, in favour of realism.
- More interesting, however, is the remaining and problematic status of the real-but-unobserved.
- It is real, but it is not now,
- Yet, we can *affect it and observe the consequences at a later time*.
- This requires a new way of thinking about the real.
- Hermann Weyl:
- „Man muss sich...daran gewöhnen nicht ‚im Raum‘ und nicht ‚in der Zeit‘, sondern ‚in der Welt‘, in *Raum-Zeit* zu denken.“
- “On doit s'accoutumer à penser non pas 'dans l'espace' et non pas 'dans le temps', mais dans le monde, dans l'*espace-temps*.”
- (Weyl, *Raum, Zeit, Materie*; 1918, 119)