Interventions in the spotlight

Delimiting possibility in Woodward's interventionist theory of causation

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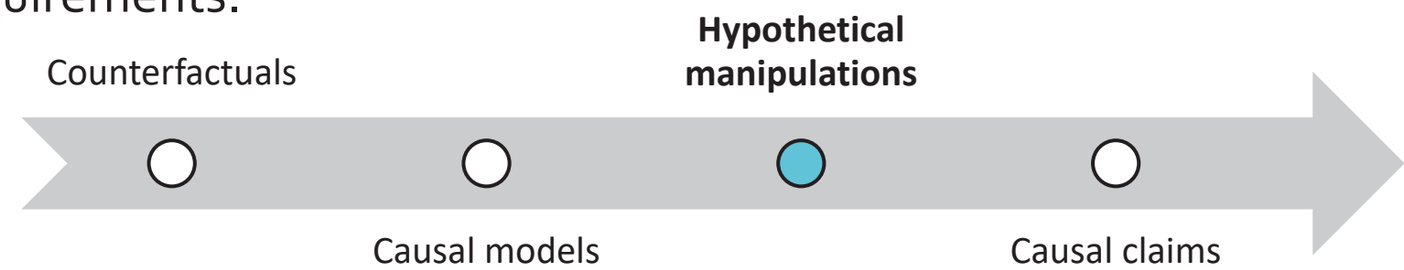
TALK PLAN

1. What are interventionist theories of causation? Requirements of interventions
2. Causation in practical contexts: the drug treatment example
3. In what sense must interventions be possible? Causation in theoretical contexts: the moon-tides example
4. Woodward's invariance scheme
5. Revisiting the moon-tides example: very weak physical possibility (VWPP)
6. Concluding remarks

1. What are interventionist theories of causation?

- The counterfactuals on which causal claims are based are mind-independent.
  - ✓ Actual possibilities/ beliefs about which possibilities are actual (serious possibilities)
  - ✓ Naturalistic, evolutionary perspective on causal information.
- X is a cause of Y iff there is a possible ideal intervention on X that changes Y (Woodward 2003, p. 45)
- Intervention: manipulation of the value of a variable in a causal model according to certain requirements.



1. Intervention requirements

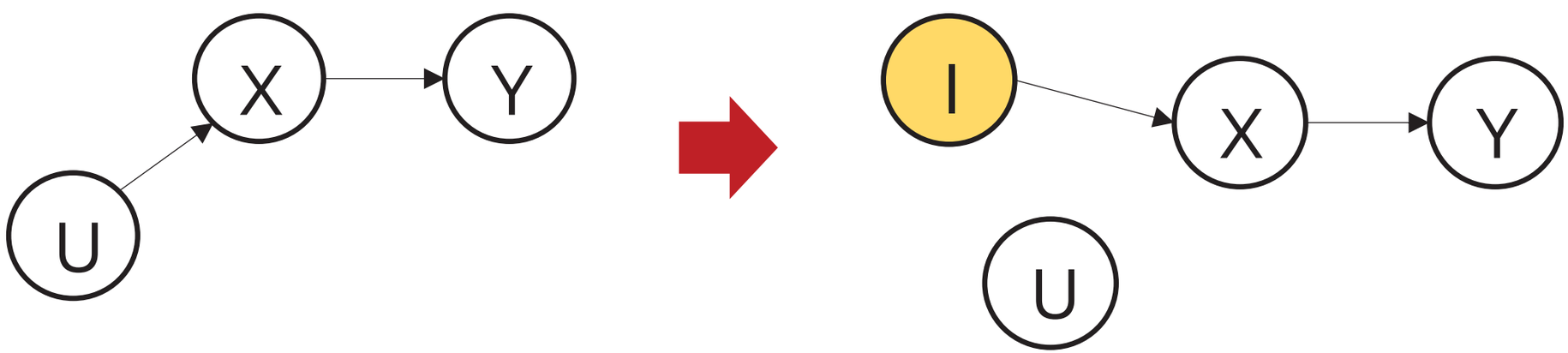
Type level causation

I is an intervention variable for *X* with respect to *Y* iff (Woodward 2003, p. 98):

(IV)

I1. *I* causes *X*.

I2. (**Arrow-breaking** criterion) *I* acts as a switch for all the other variables that cause *X*.



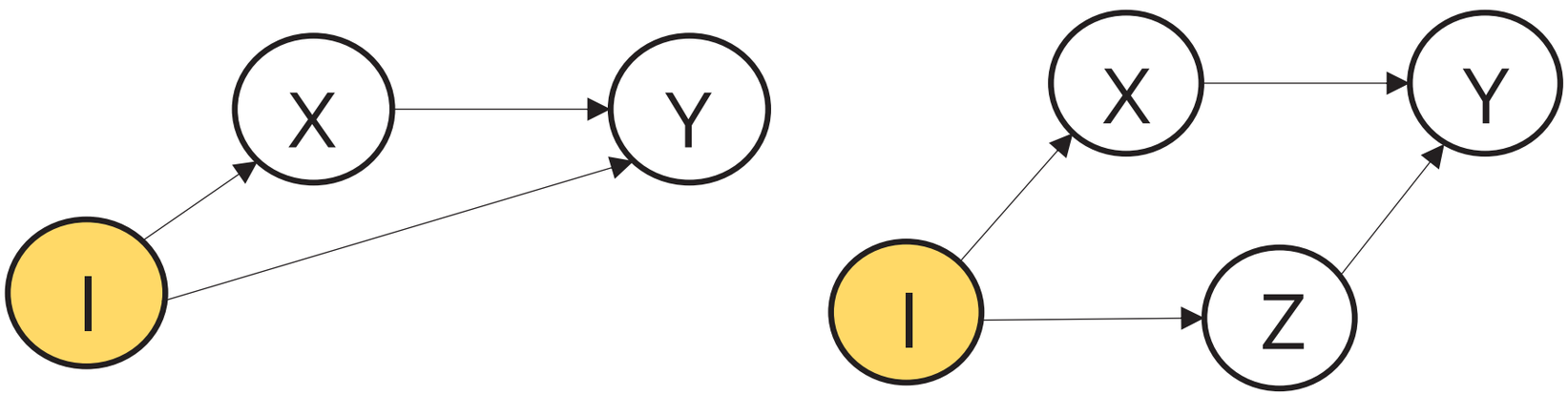
1. Intervention requirements

Type level causation

I is an intervention variable for *X* with respect to *Y* iff (Woodward 2003, p. 98):

(IV)

I3. (**Surgicality** criterion) Any directed path from *I* to *Y* goes through *X*. That is, we rule out:



1. Intervention requirements

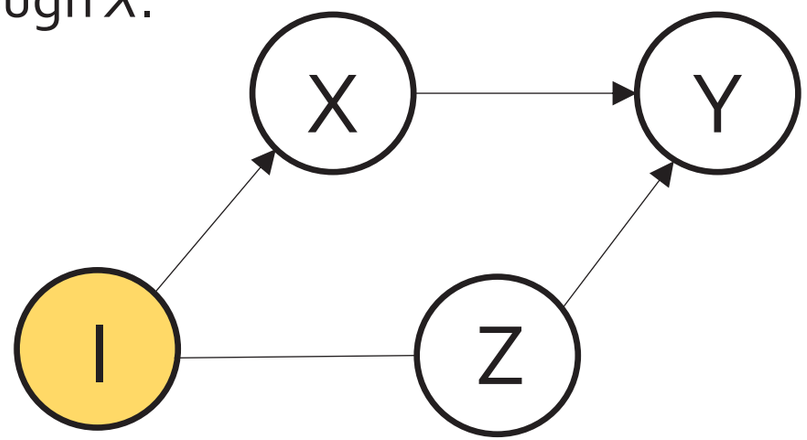
Type level causation

I is an intervention variable for *X* with respect to *Y* iff (Woodward 2003, p. 98):

(IV)

I4. *I* is (statistically) independent of any variable *Z* that causes *Y* and that is on a directed path that does not go through *X*.

That is, we rule out:



2. Causation in practical contexts

The drug treatment example

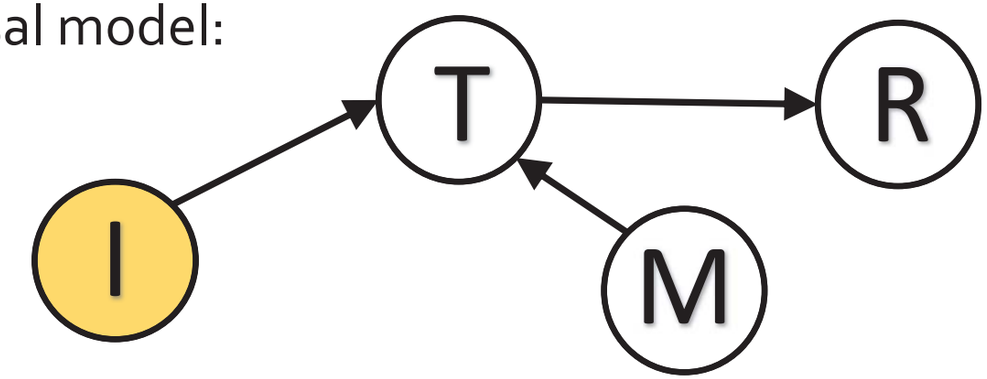
T = 0, 1 (w/o drug, w drug)

R = 0, 1 (recovery)

M = 0,1 (access to medical care)

u_i = individual subjects i=0, 1, …, n

Causal model:



$T(u_i) = 0$ i=1,2,3 $R(u_i) = 0$

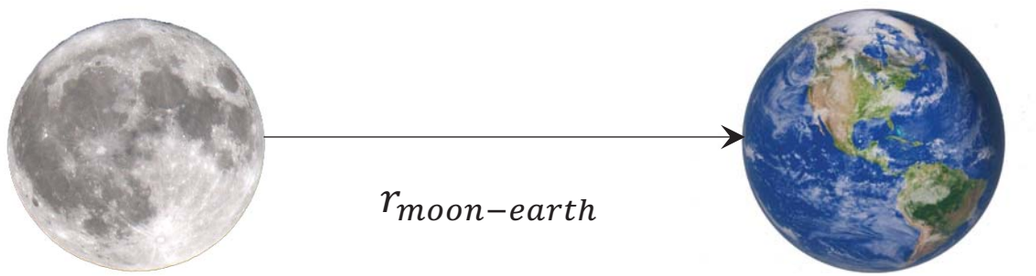
$T(u_i) = 1$ i=4,5,6 $R(u_i)$=1?

3. In what sense must interventions be *possible*? Causation in theoretical contexts

The moon-tides example

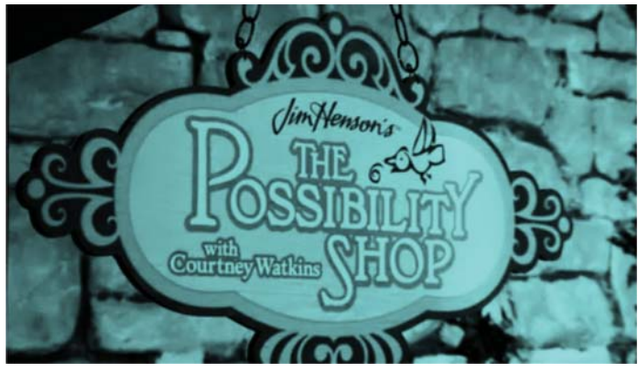
Consider the true claim (Woodward 2003, p. 129):

Moon-tides: Changes in the position of the moon with respect to the earth and corresponding changes in the gravitational attraction exerted by the moon on various points on the earth's surface cause changes in the motion of the tides.



Do changes in $r_{moon-earth}$ cause changes in the motion of the tides?

Would there be changes in the motion of the tides if an intervention on $r_{moon-earth}$ were to occur?



Possibility notions:

- Physical possibility
- Conceptual possibility
- Metaphysical possibility
- Logical possibility

Strong Physical Possibility (SPP): consistency with the laws of nature and the actually obtaining initial conditions ICs.

Weak Physical Possibility (WPP): consistency with the laws of nature and some set of ICs, not necessarily those that actually obtain.

SO: Physical possibility = nomic possibility

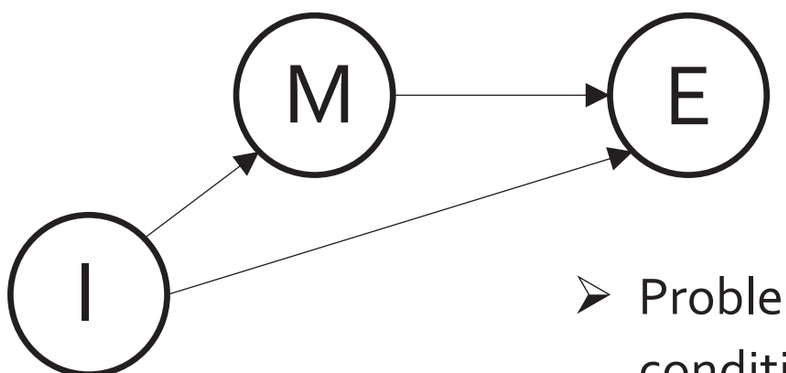
T: Interventions on *moon-tides* are not possible in the sense expressed by WPP.

E.g. intervention $r_{moon-earth} \rightarrow r' = 2r_{moon-earth}$:

a. Change in the position of another body, say, mars.

b. Impact of a massive body, say, a planetoid, on the moon.

c. Use your imagination.



$$M = moon$$
$$E = earth$$
$$I = mars, planetoid$$

- Problem: a. and b. don't satisfy the surgicality condition, & wouldn't presumably satisfy the arrow-breaking condition either.

T: Interventions on the *moon-tides* are not possible in the sense expressed by WPP.

C1: There is no WPP intervention that changes the position of the moon & satisfies the intervention requirements.

C2: WPP is not the right kind of possibility to tell us which interventions are possible.

> "We have already noted that for this purpose [to give us a purchase of what we mean when we claim that X causes Y], it isn't necessary that an intervention actually be carried out on X. All that is required is that we have some sort of basis for assessing the truth of claims about what would happen if an intervention *were* carried out. Similarly, I suggest that **as long as there is some basis for assessing the truth of claims about what would happen if various interventions were to occur, it doesn't matter that it may not be physically possible for those interventions to occur**." (Woodward 2003: 130)

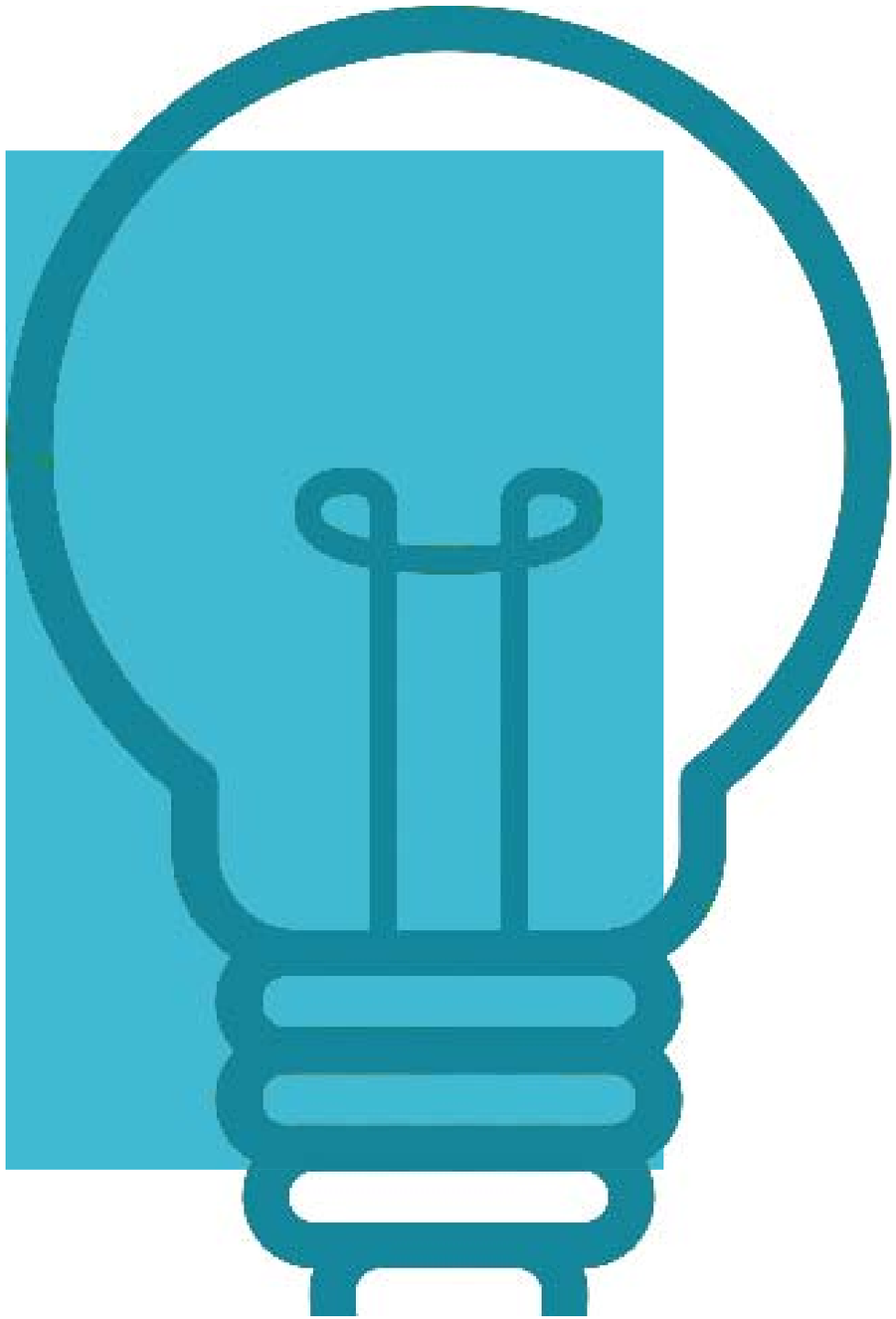
Comments on C1 & C2:

- Woodward's argument does not rule out WPP per se, but rather its combination with intervention requirements for *physical systems of this kind*.

  Interventionist accounts of causation not suitable to describe changes on an object's motion – additional forces in the gravitational field neither erase any of the other forces nor shield the object against those forces (Frisch 2014, p. 82). Three possibilities:

  1. Interventionism not applicable to fundamental physics, and so it is a defective theory of causation.
  2. Interventionism not applicable to fundamental physics, and so causal notions play no role in fundamental physics.
  3. There are two notions of causation, one applicable to practical contexts (interventionism) and one applicable to theoretical contexts –fundamental physics (interventionism amended: preservation of counterfactual dependence, dispense with interventions → counterfactual theory of causation).

- Move away from physical possibility motivated by his aim to give a general account of causation –that can be extended to the high-level sciences/any field involving causal relations. *Unfortunate example!*



Recapitulating

Two research questions at this point:

1. The question of applicability: are interventionist theories of causation suitable to describe systems in fundamental physics?

vs.

2. **The question of possibility: what kind of modal notion is at play in hypothetical manipulations of systems in fundamental physics?**

"… an intervention on X with respect to Y will be "possible" as long as it is **logically** or **conceptually possible** for a process meeting the conditions for an intervention on X with respect to Y to occur." (Woodward 2013, p. 132)

- Conceptual possibility is too broad, and thus uninformative.

  CP (Handfield 2004): P is conceptually possible iff not-P is not a priori.

- Not clear how conceptual possibility is going to give us access to *real* causes.

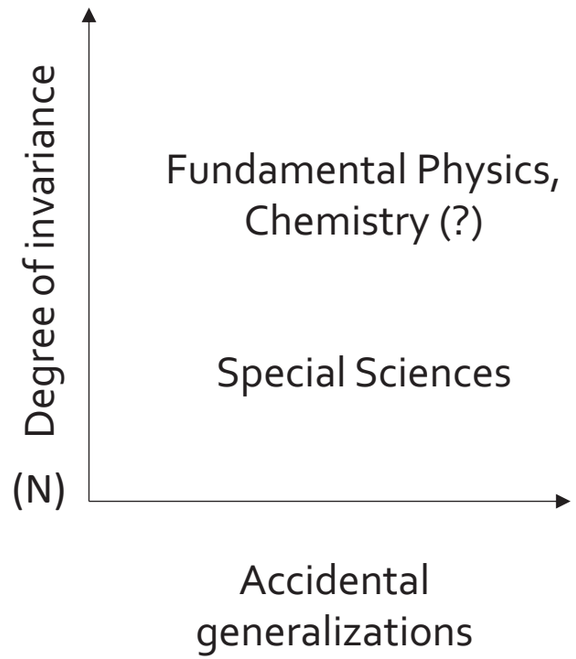
- What tells us which hypothetical manipulations are allowed in the moon-tides example? Tentative answer: (some) physical laws.

4. Woodward's invariance scheme

A necessary condition N for a generalization to be a law is that G be stable/invariant under *some* testing interventions (Woodward 2013, p. 64):

(N) If G is a change-relating generalization that is a law, then it is invariant under some testing interventions.

- Change-relating generalization: causal generalization that associates different values of some dependent variable Y with values of some independent value X. That is, G: Y=f(X)
- Testing intervention: intervention on X that changes its value from x1 to x2, where f(x1)=y1 ≠ f(x2)=y2.



4. Woodward's invariance scheme

"My suggestion is thus that there is nothing more to lawfulness than, so to speak, ***de facto* invariance under** some appropriately large range of **changes in initial/boundary conditions**, including changes under interventions." (Woodward 2013, p. 66)

- Psillos (2004, p. 300): This is circular!
- Woodward (2013, p. 68/ 2018, p. 17): It is not laws that give us the conditions to assess the strength of invariance of a causal generalization, but actual possibilities.
  - ✓E.g. dropping a rock and observing whether it falls, moving a conductor through a magnetic field and observing whether it induces an electrical current.
- **Problem: What gives us the conditions to assess invariance when active experimental manipulation is not possible?**

5. Revisiting the moon-tides example

Very weak physical possibility (VWPP)

Ingredients:

- Woodward (2013, p. 131): Newtonian gravitational theory + rules about the composition of forces → A mathematical trick? A violation of a physical law?
  - The right counterfactuals to assess causal claims might require tiny miracles –small violations of physical law.
- Lange (2009b) + Woodward (2018): informational independence between laws.
- Lange (2009b): second-order laws (e.g. symmetry principles, conservation laws, the law of composition of forces, and fundamental dynamical laws –such as Newton's 2nd law of motion) govern first-order laws (non-fundamental dynamical laws).
- Maudlin (2007): proposal of a Fundamental Law of Temporal Evolution (FLOTE)

5. Revisiting the moon-tides example

Very weak physical possibility (VWPP)

Very Weak Physical Possibility (VWPP): consistency with second-order laws of nature and some set of ICs, not necessarily those that actually obtain.

- It is conceptually possible for first-order laws to be different.

  E.g. it is possible to conceive a different set of ICs that obey a different law of gravitation –the same causal model applies to such situation.
- It is physically impossible for second-order laws to be different.

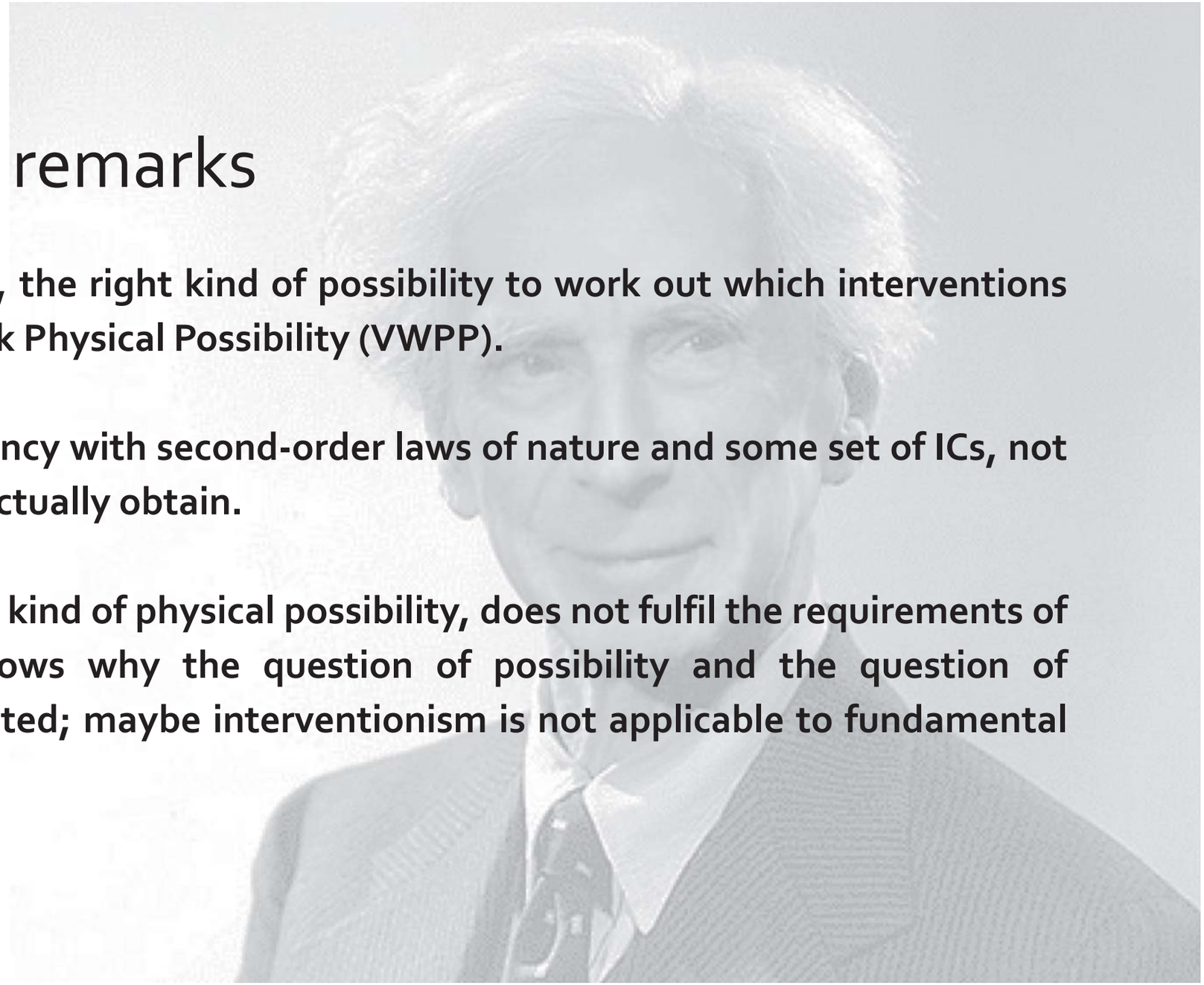
  E.g. we cannot modify $F = m \cdot a$
- VWPP stronger than conceptual possibility, but still no justification of the hierarchical picture of laws.
  - Metaphysical answer: second-order laws hold with a higher degree of necessity.
  - Ontological answer: second-order laws as primitives.

6. Concluding remarks

In fundamental physics, the right kind of possibility to work out which interventions are possible is Very Weak Physical Possibility (VWPP).

VWPP requires consistency with second-order laws of nature and some set of ICs, not necessarily those that actually obtain.

But VWPP, as any other kind of physical possibility, does not fulfil the requirements of interventions. That shows why the question of possibility and the question of applicability are connected; maybe interventionism is not applicable to fundamental physics after all.



Thank you!
Bedankt!

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[5] Psillos, S. 2004. "A Glimpse of the *Secret Connexion*: Harmonizing Mechanisms with Counterfactuals." *Perspectives on Science*, No. 12, pp. 288-319.

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[7] Woodward, J. 2013. "Laws, causes, and invariance." In *Metaphysics and Science*, ed. Stephen Mumford and Matthew Tugby, 48-72. Oxford: Oxford U.P.

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Additional material

Token level causation

Given the notion of an intervention variable, an *intervention* may be defined as:

(IN) *I*'s assuming some value $I=z_i$, is an intervention on *X* with respect to *Y* iff *I* is an intervention variable for *X* with respect to *Y* and $I=z_i$ is an actual cause of the value taken by *X*.

- ❖ (IV) and (IN) constitute a non-anthropomorphic characterization: interventions need not necessarily be carried out by humans.

- ❖ (IV) and (IN) constitute a regulative ideal: they tell us what should be true of the relationship X-Y if X causes Y.

Additional material

"Although it may be true that any actual physical process that changes the position of the moon will also directly influence the tides, **Newtonian theory and familiar rules about the composition of forces** tell us how to subtract out any direct influence from such a process so that we can calculate just what the effect of, say, doubling of the moon's orbit (and no other changes) would be on the tides, even though it also may be true that there is no way of actually realizing this effect alone. In other words, **Newtonian theory itself** delivers a determinate answer to questions about what would happen to the tides under an intervention that doubles the moon's orbit, and this is enough for counterfactual claims about what would happen under such interventions to be legitimate and to allow us to assess their truth." (Woodward 2003, p. 131)

Additional material

"In other words, rather than, as the subjectivist supposes, the organism's beliefs, attitudes, and expectations somehow creating or constituting the difference between causal and correlational relationships, **it is the prior, independent existence of an objective distinction between cause and correlation (and the fact that sensitivity to this difference may have important fitness consequences for the organism) that explains why organisms have the different beliefs, attitudes, and expectations regarding causal and noncausal sequences that they do.** We are willing to infer, on the basis of a single experience, that the relationship between consumption of a certain sort of mushroom and subsequent nausea is causal precisely because it is often or at least sometimes true that nausea is caused by (and not merely correlated with) what we eat, and there are great practical advantages to recognizing the difference between a causal and a merely correlational relationship in this sort of case." (Woodward 2003, p. 121)