Chapter 3 of *World Enough and Spacetime* is challenging because it has heavy technical *and* philosophical components. I assume that the majority of you would prefer to focus on the philosophical component, so let's start with that. The technical component leaves open many questions — on which it is possible to make some definite progress. But it's doubtful that we'll make that progress in the session today.

What does it mean to "choose a spacetime"? And what kind of reasons can one have for doing so?

1. One might think of "choosing a spacetime" as a simple exercise of first-order metaphysical theorizing. Consider e.g. the reasons that David Builes has for preferring monism to other views in metaphysics. One might adduce similar reasons for thinking that spacetime is fully Galilean and not just Maxwellian (or vice versa)

   (a) For example, is there reason to believe that spacetime has a preferred foliation?

   (b) Granted: we are all convinced now that spacetime is Einsteinian (e.g. a Lorentzian manifold), and none of these. But this is an exercise in historical reconstruction. What reasons were there for the participants in this debate. And we will come later to the questions that face us today. e.g. does GTR posit too much spacetime structure?

2. Material versus formal mode (Carnap)

   The metaphysician's question is posed in the material mode. There is a parallel question in the formal mode: what reasons can we have for adopting a spacetime theory. The difference here is that the metaphysical implications of adopting a theory are not fully transparent. What *does* one believe if one adopts Galilean relativity? I myself am not convinced that adopting Galilean relativity is tantamount to asserting that spacetime has the structure of a quadruple $\langle M, h^{ab}, t_c, \nabla \rangle$ with certain specified properties.

   (a) Carnap thought that the philosopher's job is to ask questions in the formal mode. Earman was reacting against the logical postivists and poses the question in the material mode.

   (b) Earman's approach is tied together with the semantic view of theories, i.e. a theory is a collection of models and believing the theory is tantamount to believing that the world is represented by one of them

3. Empiricist criteria, e.g. eliminate unobservable structure

   Earman doesn't like these — neither the stronger (positivist) view that "I don't know what that means" nor the weaker view that "I won't believe it if I can't see it".

Nonetheless, he is perfectly ok with *Ockhamism* as a methodological principle. His view here is influential, or at least widely shared.

4. Symmetry principles

Earman's technical definitions

Definition. A classical theory of motion T is associated with a family $\mathfrak{M}_T$ of models. Each model has the form $\langle M, A_1, A_2, \dots, P_1, P_2, \dots \rangle$ where the A_i represent "fixed spacetime structure" and the P_i represent "the physical contents of spacetime".

No reason to write out the full list, or even to specify that the A_i and P_i are "geometric-object fields". We can just say: $\langle M, A, P \rangle$, where A represents (fixed) spacetime structure, and P represents material contents. There are various ways we could do the specification. e.g. A might be a metric in the sense of a function $d : M \times M \to M$, and P might be a curve representing the trajectory of a particle.

But: there is an ambiguity in Earman about whether P represents fixed material contents, or is a specification of possible material contents.

Assumption. For any two models $\langle M, A, P \rangle$, $\langle M', A', P' \rangle$ in $\mathfrak{M}_T$, there is an isomorphism in the relevant category from $\langle M, A \rangle$ to $\langle M', A' \rangle$.

There is also an ambiguity about the role of "diffeomorphisms" in the specification of $\mathfrak{M}_T$. This ambiguity appears in the following:

Definition. Let Φ be a diffeomorphism of M onto M. We say that Φ is a *dynamical symmetry* if for any model $\langle M, A, P \rangle$ in $\mathfrak{M}_T$, the structure $\langle M, A, \Phi^* P \rangle$ is also in $\mathfrak{M}_T$.

For example: a map Φ that takes straight lines to bent curves is *not* a dynamical symmetry of Galilean relativity.

Definition (General covariance)**.** The laws of T are *generally covariant* just in case whenever $\langle M, A, P \rangle \in \mathfrak{M}_T$ then $\langle M, \varphi^* A, \varphi^* P \rangle \in \mathfrak{M}_T$.

A mini hole argument

1. Earman claims that the spacetimes with less structure than Galilean correspond to indeterministic theories. In particular, there are models M and N and an isomorphism $\varphi : M \to N$ such that $\varphi|_{t<0} = \mathrm{id}$ but $\varphi \neq \mathrm{id}$.

2. But doesn't the fact that $\phi : M \to N$ is (according to T) an isomorphism mean that M and N are (according to T) really the same model?

3. There is, in fact, something syntactically wrong with the statement above: $\varphi|_{t<0} = \mathrm{id}$ makes sense only if $M = N$. (The identification of the underlying sets M and N is permitted by Earman's setup, but we have to wonder if this setup isn't problematic.)

4. Wouldn't a real violation of determinism be two models that are isomorphic on an initial segment but not isomorphic subsequently?