Chapter 6: Substantivalism – Newton versus Leibniz

(R1) All motion is the relative motion of bodies, and consequently, spacetime does not have structures that support absolute quantities of motion.

(R2) Spatiotemporal relations among bodies and events are direct; i.e. they are not derived from relations among a substratum of space-time points that underlie events.

Stage setting

"...the best judgment emerging from the evidence marshalled in chapters 4 and 5 is that (R1) is in fact false in both the classical and relativistic settings." (p 111)

Chapter 3 supposedly shows (R1) and "determinism is possible" implies (R2)

"...if we want to allow for the possibility that particle motions are deterministic and if we want to make a substantivalist interpretation of the space-time manifold (not R2), it follows that the structure of space-time must be at least as rich as that of neo-Newtonian spacetime (not R1)." (p 55)

Definition: A theory is *deterministic* (in the sense of David Lewis) if for any nomologically possible worlds W and W', if W and W' agree on an initial segment, then $W = W'$.

Earman will argue that not-R2 and R1 imply not-determinism.

Fact: Let M be a classical spacetime with less structure than Galilean spacetime. There is a symmetry $\varphi : M \to M$ that is the identity for $t \leq 0$, but not the identity for $t > 0$. (HH agrees.) Thus, R1 implies the existence of such a symmetry.

"...we can thus produce two dynamically possible models where the world lines of the particles coincide for all $t \leq 0$ but diverge for $t > 0$, a violation of determinism."

HH: It is not clear how not-R2 is supposed to function in this argument.

Earman produces a second argument. R1 was taken to mean "less structure than Galilean spacetime". But even if we allow Galilean spacetime, we still might get failure of determinism.

Let R1' = not full Newtonian spacetime. Hence R1 implies R1' but not vice versa.

Now Earman argues that not-R2 and R1' implies not-determinism. The key fact now is that there is a Galilean transformation that is the identity at $t = 0$ but not the identity elsewhere.

Leibniz's argument(s)

Leibniz argues for (R2), in particular that absolute space is an idle wheel.

Principle of Sufficient Reason: (1) God would have a good reason to create one world instead of another. (2) Nothing happens without a cause.

Principle of the Identity of Indiscernibles: If $a \neq b$, then there is some property that a has and that b lacks, or vice versa.

Leibniz's shift argument: If space is a substance, all matter can be moved n meters to the east of its current location, and the result is a new possible world. (see p 118)

The existence of these possible worlds $\{W_r : r \in \mathbb{R}\}$ is a problem both for PSR (which should God create?), and for PIdIn (the substantivalist declares them non-equal when they agree on all properties).

Earman: For Leibniz's invocation of PIdIn to work, it would need to be supplemented by an implausible verificationist assumption. For example: if two things agree on observable properties, then they agree. ("verifiability version of PIdIn" p 120)