Beyond A-Theory and the Block Universe: A non-circular derivation of “before”, change, and local asymmetric time

by

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Challenge: asymmetric time compatible with relativity?

Answers in the literature:

- Cosmic A-theory: e.g. W. L. Craig, D. Zimmerman, Unger & Smolin
- Block universe: O. C. de Beauregard, K. Gödel, B. Skow
- Branching spacetimes
- Time real but local: S. Savitt, J. Harrington

→ My proposal: Aristotelian theory; time in terms of substances, powers, causation; does *not* rely on causal asymmetry!

Steps:

1. Defining “before” non-circularly
2. Defining change
3. Defining local time
4. Epistemological realism
5. Derivation of local time‘s asymmetric character: linearity, “one way street”, fixity of past and openness of the future.

1. Defining “before” non-circularly

A.1: Substances exist, and they can exist in different states characterized by non-essential intrinsic properties.

→Substance *A,* non-essential intrinsic properties *p: A-with-p* and *A-without-p* “states” of *A.*

A.2: For any substance *A*, different states of it exist only if it is subject to causal interactions, either with its environment, or among its own parts.

1. Defining “before” non-circularly

→ non-essential intrinsic properties as “records”, substances as “recorders”.

Simple examples (e.g. moon): asymmetry *in the existence of states* of recorder *A*

1. Defining “before” non-circularly

D.1: An amended recorder is a recorder *A* such that each event affecting it produces a record in *A*, and does not affect other records in *A*.

But what if record *r** twice?

D.2: An ideal recorder is an amended recorder which is able to fully specify its own state.

→ r^*_a and r^*_b discernible

1. Defining “before” non-circularly

D.3: *x* is before *y* iff there is a state of *A* with r_x, and a state with r_x and r_y, but no state with r_y and without r_x.

Note: no explicit quantification over all states of *A* needed!

2. Defining change

D.4 A substance *B* changes iff it acquires or loses a property *p*, where "*B* acquires *p*" iff $r_{B\text{-without-}p}$ is before $r_{B\text{-with-}p}$ for *A*, and "*B* loses *p*" iff $r_{B\text{-with-}p}$ is before $r_{B\text{-without-}p}$ for *A*.

Note: "for *A*" → for any recorder.

3. Defining time

A in state with r^*_a and r^*_b . Collection of r^*_a and r^*_b : r^*_2.

A with r^*_2 plus another instance of r^* → collection of r^*_2 and r^* : r^*_3, etc.

D.5: If *A* is an ideal recorder, or a sufficiently good approximation thereof, then for all r^*_i in *A*, $i \equiv t$.

3. Defining time

Writing "*A-with-*r_x" as "*Ax*", we identify:

I.1: $A_t = Ax_1,\ldots,x_n$, for some *n*.

Also:

D.6: If a record *r* is produced in A_t, then $r \equiv r_t$.

3. Defining time

D.7: Time is a local parameter *t* established through a recorder *A* on the basis of repeated instances of records of the same type *r** in *A,* such that *t* is used to quantify processes of change in substances which can causally affect *A.*

4. Epistemological realism

V: set of rules of inference v. R^A: set containing records r^A in A. Then:

A.3: From the fact that the rules $v \in V$ apply, and from the existence of records $r^A \in R^A$, it follows that some propositions $p_R{}^A$ are true, the set of which will be called $P_R{}^A$.

5. Local asymmetric time

Consider: *A* in state $A_{t\alpha}$, where $t_\alpha > 0$. $A_{t\alpha}$

- will in general bear records of causal interactions (identification I.1)
- is a substance → can receive more records (assumptions A.1 and A.2)

5. Local asymmetric time

- Records in *A* associated with locally measured times *t* (definition D.6).
- For each time *t* less than t_α, there is a set $R^A{}_t$ of records $r^A{}_t$ in *A*.
- Existence of records $r^A{}_t$ in $R^A{}_t$, plus rules of inference *v* in *V* → truth of some propositions associated with records $r^A{}_t$ → We call them $p^A{}_t$, and the set containing all of them and only them will be called $P^A{}_t$.

→ all times *t* less than t_α associated with sets $P^A{}_t$, all times *t* greater than t_α not.

5. Local asymmetric time

Linearity:

Given: two locally measured times *t* and *t'*, records $r^{A}{}_{t}$ in $R^{A}{}_{t}$ indiscernible from records $r^{A}{}_{t'}$ in $R^{A}{}_{t'}$ → two type-identical sets of propositions $P^{A}{}_{t}$ and $P^{A}{}_{t'}$.

But $P^{A}{}_{t}$ and $P^{A}{}_{t'}$ not identical: all propositions contained in $P^{A}{}_{t'}$ involve $A_{t'}$ rather than A_{t}.

→Every local time *t*: *unique* set $P^{A}{}_{t}$.

→ "Same happens again" does not mean "the past recurs".

5. Local asymmetric time

Fixity of the past:

State $A_{t\alpha}$ of *A:* propositional content of local time *t* less than t_α given by P^{A}_{t} .

- Let $(p^{A}_{t})^* \in P^{A}_{t}$. "I wish not-$(p^{A}_{t})^*$!" → impossible, because $(p^{A}_{t})^*$ implied by true statements: 1. existence of records in $A_{t\alpha}$, associated with local time *t; 2.* rules $v \in V$.
- Let $(p^{A}_{t})+ \notin P^{A}_{t}$. " I wish $(p^{A}_{t})+$!" → impossible, because P^{A}_{t} contains all and only the propositions which follow from rules $v \in V$ and existence of $r^{A}_{t} \in R^{A}_{t}$.

→ Notion of changing local past implies a contradiction.

5. Local asymmetric time

Openness of the future:

Propositional content of local times *t* greater than t_α can be influenced:

- $A_{t\alpha}$ state of substance *A.* Substances can acquire records through causal interactions → sets of propositions (assumption (A.3)).
- Propositional content of a time less than t_α cannot be changed (shown above)
- No such argument for times greater than t_α, because no records in $A_{t\alpha}$ for such times.

→ Local future is open: each time *t* greater than t_α is not associated with a unique *P*-set, but can be occupied by infinitely many such sets. Propositional content of such times “branches”.

5. Local asymmetric time

Time's anisotropic character:

Revisiting the past → contradiction.

→ Time can only move "forward".

Conclusion

- Time is something purely local.
- Local times have asymmetric character: fixed past, open future, unidirectional flow → horsetail model.
- No conflict between relativity theory and our experience of the passage of time (unlike e.g. in Gödel, Unger & Smolin).
- Events do not change their ontological status, as in classical A-theory, i.e. not: “future events become present, then past”.
- Time is neither merely subjective, nor independent of measuring operations. It is an *ens rationis cum fundamento in re.*