

# Our Knowledge of the Past:

## Some Puzzles about Time's Arrow and the *De Se*

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### 1 The Initial Puzzle

What explains the arrow of time?

- Can physics explain the arrow of time?
- Obstacle: fundamental physics is time-reversal invariant. (Some caveats)
- A theory  $T$  is time-reversal invariant (TRI)  $\text{=}_{\text{def}}$  for any sequence of events, it is possible in  $T$  if and only if its time reversal is possible in  $T$ .
- The standard solution: the Past Hypothesis—the universe started in a low-entropy state.
- Macrostate: a macroscopic description of the system in terms of volume, pressure, etc.
- Microstate: a microscopic description of the system in terms of the positions and velocities of the particles.
- Entropy measures how many microstates are compatible with a given macrostate.

#### The Mentaculus Theory ( $T_M$ )

1. The fundamental dynamical laws.
2. The Past Hypothesis (PH).
3. The Statistical Postulate (SP): a uniform probability distribution over all microstates that are compatible with PH.

### 2 The *De Se* Thesis

**The *De Se* Thesis:** Our complete theory of the physical world will include a postulate about self-locating probabilities.

#### The Indifferentist Theory ( $T_I$ )

1. The fundamental dynamical laws.
2. A uniform probability distribution over all microstates.

**Criterion A:** a theory  $T$  is **empirically adequate** only if it assigns some non-negligible probability to our current evidence  $E$ .

Distinguish between:

- Probability *de dicto*: probability about what the world is like.
- Probability *de se*: probability about where we are (in space and time). (Also called “self-locating” probability.)

To fix  $T_M$ , add the following Near Past Hypothesis to  $T_M$  to make  $T_M^*$ :

**NPH:** We are currently located in the first epoch of the universe—between the time when the Past Hypothesis applies and the first thermodynamic equilibrium (and with uniform probability over that region).

### 3 Radical Skepticism

**Radical Skepticism:** the De Se thesis leads to radical skepticism.

To resurrect  $T_I$ , add the following Medium Entropy Hypothesis to  $T_I$  to make  $T_I^*$ :

**MEH:** We are currently located in a special kind of medium fluctuation—in a state of medium entropy and strong correlations (and with uniform probability over all such states).

**Criterion B:** For any two theories  $T_1$  and  $T_2$ ,  $T_1$  is **empirically at least as adequate as**  $T_2$  if our current evidence is at least as likely on  $T_1$  as on  $T_2$ , and  $T_1$  is simpler and less *ad hoc* than  $T_2$ .

Notation.  $\geq_{emp}$ : empirically at least as adequate as.

#### The Master Argument

P1 Our current evidence  $E$  is as likely on  $T_I^*$  as on  $T_M^*$ .

P2  $T_I^*$  is simpler and less *ad hoc* than  $T_M^*$ .

C  $T_I^* \geq_{emp} T_M^*$ . (By Criterion B)

**Criterion C:** For any two theories  $T_1$  and  $T_2$ , if  $T_1 \geq_{emp} T_2$ , then our credence function should be  $cr(T_1) \geq cr(T_2)$ .

Therefore, our credence in  $T_I^*$  should be no less than our credence in  $T_M^*$ .

**Skeptical Conclusion:** most of our beliefs about the past are false. [with at least 0.5 credence]