

Momentum and Context

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Abstract

A sentence's meaning may depend on the state of motion of the speaker. I argue that this context-sensitivity blocks the inference from special relativity to four-dimensionalism.

It's no surprise that the meaning of a sentence can depend on the context of utterance — e.g. the person who asserts the sentence, the location, place, time, etc. For example, whether “I am hungry” is true depends on who is speaking, and whether “it's sixty five degrees Fahrenheit” is true depends on where and when it is asserted.

The point of this note is to argue that the context of utterance should include — at least in applications in physics — the speaker's momentum.¹ There are many reasons for recognizing momentum-relativity, not the least of which is that it shows that Einstein's theory of relativity does *not* entail four-dimensionalism. In particular, each observer can consistently maintain that “exists” is synonymous with “exists now.”²

The fact that context of utterance includes the speaker's momentum might seem obvious to anyone who is aware that momentum attributions are context sensitive. For example, whether the statement

(S) The boat is moving at four meters per second.

¹Momentum is usually defined as mass times velocity. For the most part, we can assume that the mass is set to 1 in some appropriate units, and so we can treat momentum and velocity as synonymous.

²I won't go so far as to say that special relativity is consistent with presentism, because some presentists might be uncomfortable with non-trivial context-sensitivity.

is true or false depends on the momentum of the person uttering it.³ For a person with the same momentum as the boat, *S* is false, whereas for a person sitting on the shore, *S* might be true.

But wait, how can the context of utterance include momentum when there are no absolute momenta?

The puzzle here is easily solved. Think again about time-dependent sentences. A sentence may be true at one time and not at another, but that doesn't require any sort of notion of absolute time: it only requires that there be different times. Similarly then with momentum. In order for statements to be momentum-dependent, we don't need any notion of absolute momentum, we only need to assume that there are different momenta.

The fact that momentum attributions are implicitly relative to the speaker's momentum shows that momentum should, in general, be included in the context of utterance. But where things get interesting and philosophically controversial is when we see how many other statements are sensitive to a speaker's state of motion. For example, If Einstein's theory of relativity is true, then claims about simultaneity are context sensitive. In particular, the simultaneity relation is a three place relation $\text{sim}(x, y, v_e)$, where x and y are events, and v_e is a context, which includes both a location e and a 4-momentum vector v_e in the tangent space over e . Here the vector v_e characterizes a speaker's instantaneous state of motion, and it picks out the three-dimensional spatial hypersurface $(v_e)^\perp$ of events that are simultaneous for that speaker.⁴

Including momentum in the context of utterance blocks the famous old argument by Hilary Putnam (Putnam, 1967) for the reality of the future — an argument that has played no little role in convincing philosophers that special relativity favors four-dimensionalism. Putnam's transitivity of reality axiom says: if b is real to a , and c is real to b , then c is real to a . But it didn't occur to Putnam that the meaning of “ c is real” might depend on the complete state of the person uttering the sentence, including that person's state of motion. In particular, if “ b exists” is true relative to (a, v_a) , and

³Many of us learned to say that such statements depend on a “frame of reference.” But for the purpose of metaphysical inquiry, we'd do best to replace talk of frames of reference with talk of the properties of an observer that determine her frame of reference. In the present case, I am assuming that a frame of reference is determined by an observer's position and momentum.

⁴Recall Malament's (1977) theorem which shows the uniqueness of the binary simultaneity relation relative to a timelike vector v_e .

“ c exists” is true relative to (b, v_b) , it does not automatically follow that “ c exists” is true relative to (a, v_a) .

But isn't it madness to think that the truth value of a statement of existence might depend on one's state of motion? Isn't that rank subjectivism? I think that the feeling of subjectivism here stems from not taking momentum seriously enough as a physically significant quantity — i.e. as a feature of your state that is just as significant as *where* and *when* you are speaking. In recent years, there has been a tendency for philosophers to think of momentum as a summary of positions occupied at various times — making it causally inert, and superfluous in the description of an observer's state. However, if one resists this trend (as I think presentists should) and takes momentum to be a real quantity that cuts nature at the joints, then one might be inclined to allow momentum to feature non-trivially in the context of utterance. If momentum belongs to an observer's physical state, then it is an empirical question which of that observer's statements need to be relativized to this feature of her state.

Consider an analogy. We wouldn't include a person's hair color in the context of utterance, because then we might end up saying silly things like “the atom decayed relative to blondes but not relative to brunettes.” But you don't have to rely on my intuitions to treat momentum differently from hair color: physics itself indicates that features of reality depend on momentum in a way that they do not on one's hair color. In particular, physics says that what's true relative to one state of motion might be false relative to a different state of motion. For example, in the Unruh effect, infinitely many Rindler quanta exist relative to one state of motion, but none exist relative to another state of motion (see Clifton and Halvorson, 2001). However, we don't need exotic examples from quantum field theory to appreciate the momentum-relativity of existence claims; we already have it in classical special relativity.

What I'm saying here may sound like Kit Fine's fragmentalism (Fine, 2005), but it's not the same. While I won't engage in detailed Fine exegesis, I am certainly not committed to the idea that there are many different independent realities. While there is just one reality, there are many different correct descriptions of that reality; and Einstein's special theory of relativity provides a translation manual (viz. Lorentz transformations) for converting a true description relative to one context into a true description relative to another context. Nonetheless, it is the same reality that is described. If there were multiple realities, then there wouldn't be much point to translating the one description into the other.

If you now ask me for an observer-free description of this one reality, then I must demur — because I am an observer, and any correct description I give is relative to my context.

References

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