Against Presentist Velocities

Gijsbers (2025) has recently proposed an original theory of 'presentist velocities': the instantaneous relative positions and relative velocities of all bodies at the present instant are metaphysically fundamental, and their positions and velocities at both past and future times metaphysically depend on them. If physics is deterministic, then present such facts fully determine future such facts; if physics is indeterministic, then some past and future facts are indeterminate. For simplicity, I will focus on the deterministic case.

The theory of presentist velocities (henceforth: TPV) solves some pernicious problems faced by other theories of velocity, such as the at-at theory (present velocities supervene on positions at different times). But Gijsbers' presentation only considers classical mechanics, and does so in a relatively non-technical manner. If TPV is to succeed, it should also work for more realistic physical theories. The aim of this letter is to show that TPV falls short in this respect: once we look at the details of classical, statistical and relativistic mechanics, presentist velocities face serious obstacles.

The first problem is the *problem of four-velocities*. This occurs in the context of Newtonian mechanics, which otherwise seems hospitable to presentist velocities. The relative velocities to which the presentist is committed are *three-velocities*: three-dimensional vectors with a direction in three-dimensional space. But relative position and velocity three-vectors are insufficient for defining a notion of absolute acceleration. To see this, consider a pair of particles. Suppose that the relevant force laws entail that the relative velocity between the particles increases at a constant rate over time; hence their relative position increases quadratically. Yet this description leaves it unclear by how much each individual particle accelerates. This is left undetermined by a description of relative positions and velocities. But as the bucket experiment famously shows, absolute acceleration is necessary to articulate the dynamics of Newtonian mechanics (modulo complications related to 'dynamic shifts'). Now, the standard way to define absolute acceleration in a Galilean-invariant way is in terms of *four-velocities*, that is, four-dimensional vectors with a direction in four-dimensional space-time. The four-velocity of a particle points from the position of the particle *now* to its position *later*. The particle accelerates whenever the direction of this four-vector changes over time. The problem of four-velocities then is that TPV cannot account for such vectors on pain of circularity. For four-velocities, on the most straightforward interpretation of what they represent, require the existence of a future to point towards, but the theory of presentist velocities proposes that the future metaphysically depends on present velocities. Since presentations of Newtonian mechanics in Galilean spacetime require four-velocities, the theory of presentist velocities is not easily reconcilable with Galilean relativity.

The second problem is the *problem of time-reversal*. This occurs in classical statistical mechanics. Recall that the fundamental laws of classical mechanics are time-reversal invariant. This means that for any present state, every solution forwards in time is also a solution backwards in time. This creates an issue if we wish to explain time-asymmetric phenomena such as the increase of entropy over time. Take a system in a particular macrostate (that is, its broad features such as temperature and entropy are specified, but the exact momentum of each particle is not). The vast majority of the microstates compatible with this macrostate will increase in entropy towards the future. So, by time-reversal invariance, the vast majority of microstates compatible with this macrostate will also increase in entropy towards the past. Given a present state, then, we should expect entropy to have decreased compared to earlier times. This expectation is confuted by our memories and records. The standard solution is to postulate that in the far past the universe was in a low-entropy state. This is known as 'the Past Hypothesis'. *Conditional on the Past Hypothesis*, we should expect entropy to decrease towards the past. The problem for TPV then is that it cannot help itself to the Past Hypothesis. For TPV says that facts about the past are determined by facts about the present; but from the time-reversal invariance of classical mechanics it follows that facts about the present fail to entail that the past was in a low-entropy state. On the contrary, they entail that it was highly likely that the universe was in a high-entropy state! Of course, the advocate of TPV could nevertheless maintain that the universe at present just happens to have one of those unlikely microstates that decrease in entropy towards the past. But such an assumption is much less natural than the Past Hypothesis itself, since contrary to the Past Hypothesis it assumes that the present microstate is highly special and fine-tuned.

Finally, TPV faces a problem in the context of relativistic mechanics. This is the *problem of relativistic velocities*. It is of course well-known that it is hard to reconcile presentism and relativity. Gijsbers (*ibid*., fn. 1) suggests that relativity is mostly irrelevant to the metaphysics of time. The problem I raise is not that of the relativity of simultaneity, however. It is rather that *relative (three)-velocities are not Lorentz-invariant*. Gijsbers explicitly desires to employ quantities that are Galilean-invariant, presumably because variant quantities such as absolute velocity are unobservable due to Leibniz shift-style scenarios. But in SR, relative velocities face the same problem as absolute velocities in classical mechanics. Take any physically possible present, choose a particular coordinate system, and apply a Lorentz transformation; this yields another physically possible yet empirically indiscernible present in which the relative velocities are different. Notice that the privileged present is held constant in this scenario. For TPV to work well with relativity, then, it would have to countenance Lorentz-variant quantities *in addition* to such a metaphysically privileged present.

The above objections are specific to presentist velocities; they are not levelled at presentism *per se*. Gijsbers acknowledges, however, that other accounts of instantaneous velocity presuppose eternalism. Therefore, one can also interpret the above difficulties for the theory of presentist velocities as a(nother) reason from physics to prefer eternalism.

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