Avoiding the Block Universe: A Reply to Petkov

Peter Bokulich
Boston University
pbokulic@bu.edu
Draft: 3 Feb. 2006

Key Points:

1. Petkov assumes that the standard relativistic interpretations of measurement procedures are to be respected, but this is precisely what 3D-er (the 3-dimensionalist) will deny. Petkov's apparent contradictions are due to the fact that he considers an inconsistent *mixture* of 3D ontology and the *standard interpretation* of special relativity.

2. The 3D-er will obviously have to make a distinction between apparent time-flow and absolute time flow; the absolute fact of the discrepancy in ages of twins with differing histories establishes this.

3. One natural way of establishing the apparent flow of time and apparent lengths will still be to interpret measurements using the assumption of the constancy of the speed of light, since the empirical adequacy of SR establishes that there is no way to use the laws of physics to determine the absolute frame of reference. However, this conventional choice will not be invested with fundamental ontological significance by the 3D-er.

4. The *real* three-dimensional world, on this picture, will constitute an absolute, preferred frame of reference. This, of course, runs counter to the standard interpretation of the formalism of special relativity, but (as we'll see) no inconsistencies arise from this assumption as long as one includes all necessary compensations. Further, if the absolute frame is pointed out (by a signpost from the gods, or by the cosmic background microwave radiation), then any observer will be able to infer the *true* facts from measurements performed in her lab (frame of reference) and knowledge of the absolute velocity of her lab (frame).

5. Measurements performed in the absolute frame (i.e., in labs that are at rest in the real 3D world) will reveal the true lengths of objects and the true temporal duration of processes (i.e., the rods and clocks in this frame reveal absolute distances and durations).

6. The speed of light will be isotropic in the preferred frame, but it will be non-isotropic in other frames of reference (i.e., in laboratories that are in absolute motion). It will, nevertheless *seem* isotropic to an observer who does not know that her laboratory is in (absolute) motion.

7. Clocks synchronized using the Einstein convention will only *truly* be synchronized in the absolute rest frame; observers in other frames will *mis-synchronize* their clocks if they assume that the speed of light is isotropic. To have a clock register true time rather than apparent time, one would need to compensate for the non-isotropy of signal propagation *and* for the velocity dependence of clock rate.

8. The actual length of objects (e.g., measuring rods) and of processes (e.g., clocks) will depend on the absolute motion of the object (i.e., the object's velocity in the preferred rest frame). This is to say that the Lorentz contraction and time dilation measured in the preferred frame is *real* and ontologically fundamental. Apparent contraction and dilation reported by observers not at rest (i.e., in non-preferred frames) are generally illusory, and will be due to the use of non-absolute, non-fundamental, coordinates (lengths and durations); that is, they are misled by their use of Lorentz-contracted rods and slow clocks.

9. We know that this scenario won't harbor any contradictions, for the story that will be told will be precisely the one told from the "point of view" of someone at rest in the frame of reference that happens to be ontologically preferred. It is, of course, trivial that a consistent account of the entire history of the universe can be offered from this perspective: any contradictions would speak against special relativity even as standardly interpreted.

10. The primary fallacies of Petkov's arguments are that he fails to develop consistently the story within the preferred frame (i.e., tell a single story about a 3-D world) and that he fails to recognize the *objective and absolute* length contraction and time dilation that occurs for any system in absolute motion (according to the 3-dimensionalist account).

11. We face a choice when speaking about what different observers would "measure" or "see" or "experience": either we can assume that these observers *know* about the objective frame of becoming, and therefore account for velocity-dependent effects in their measurements and descriptions, or we can assume that they will treat their own rods as uncontracted, their own clocks as reliable, and the speed of light as isotropic. In the former case, the observers will report the ontological facts (e.g., they'll say "my clock and I are now running slow by a factor of γ"); in the latter case the observers will report *apparent* distances and durations that are generally systematically mistaken, illusory.

12. Petkov's claims that it is impossible for a 3D-er to account for Lorentz contraction and the age of twins rest on a misconstrual of how a 3D-er should describe the situations. "[I]f the rod existed only at its present moment and therefore were a three-dimensional object . . . no length contraction would be possible – A's rod of length L_A would exist for B as well and B would measure the same rod with the same length L_A" (p. 10). The fallacy here lies in the connection between "existence" and "measurement": the mere stipulation that there is a single, objective, absolute length does not imply that a single measurement process will reveal that length in the same way to all observers. Instead, the formalism of special relativity teaches the 3D-er that length measurements will only reveal the true length of an object when we properly incorporate facts about retarded clocks and contracted rods (which retardation and contraction is velocity dependent).

14. This resolves Petkov's worries about whether our two observers are measuring the "same rod" (p. 10-11). In the case under consideration, at least one of the observers' measurements will register *parts* of the rod at different absolute times. This, together with the length contraction of her own measuring rods, explains why her naive measurement fails to reveal the true length of the rod.

15. There is a slide (all to common in the history of the philosophy of physics) from the *consistency* of a certain interpretation to the claim that such an interpretation is *necessary*. Consider Petkov's claim "[B]oth A and B know that the rod *exists for each of them*, but this is only possible if there are two different three-dimensional cross-sections of the rod's worldtube. . . . [I]t is easily demonstrated that the same conclusion follows directly from the relativity of simultaneity" (p. 11, emphasis added). But obviously the 3D-er rejects the relativity of (absolute) simultaneity, so this last appeal fails to address the issue. The notion of "existing for an observer" is highly problematic and threatens to obscure the ontological issues in question, but it is open to the 3D-er simply to point out that both A and B are correct in saying that the rod exists, but this doesn't imply that their two characterizations of *when* the rod was *where* need to be treated equally. If B is in absolute motion while A is at absolute rest, then B simply misdescribes his measurement if he claims that his registrations of the position of each part of the rod all occurred simultaneously. Such a claim rests on the use of clocks that do not reflect absolute time.

16. For these same reasons, Bell's account of Lorentizian pedagogy (p. 11) is untouched by Petkov's criticism. I'd need to look at the details of the muon experiment mentioned by Petkov to offer a consistent 3D-er account of this scenario, but we have every reason to believe that it can be done without difficulty.

17. The 3D-er will respond to Petkov's more detailed account of the measurement of rod length by means of cameras with clocks (p. 14) in exactly the same way as indicated above in Point 12: Petkov assumes that the measurements performed by the two observers are ontologically equivalent, despite the fact that these measurements utilize the Einstein convention to synchronize clocks and assume that measuring rods reveal true lengths. The 3D-er obviously will reject both of these assumptions, and thus the mere fact that one observer happens to have a collection of photographs (which all have the same time printed on them and that all show a blue light on a part of the rod) does not imply that the "what exists *for*" that observer is *actually* what is depicted in those photographs. The 3D-er will simply point out that these measurements failed to take into account the facts about velocity-dependent clock retardation. If one of these observers is actually at rest in the preferred frame, then this person really will measure the rod's length at an instant. The observer who is *moving* in the absolute frame has simply measured the location of the *parts* of the rod at different times; she has *not* "measured a different three-dimensional rod."

18. Petkov's arguments sometimes leave the impression (as do some of Maxwell's old arguments) that one has some sort of instant access to distant events that one judges are occurring "now." "The observers A and B will be convinced that the only way to explain their pictures is to assume that the rod they measured exists equally . . . at all moments of its history in time. Their reason is that the experiment directly confirmed this conclusion: parts of the rod's past, present, and future . . . exist *simultaneously as* B's present rod" (p. 16). But obviously this is *not* the "only way" to explain their pictures, and equally obviously, these experiments do not "directly" yield this conclusion. Instead, the measurements require *interpretation*, and these interpretations rest on assumptions about the one-way speed of light and the status of moving rods and clocks; however, one can adopt other assumptions (viz. the 3D interpretation).

19. I don't quite follow the argument on pp. 16-17 between the "philosopher of science" and "A and B." Petkov doesn't seem to be considering the case in which one considers an absolute 3D world with appropriate velocity dependent dynamical effects that are captured by the formalism of SR.

20. The 3D-er will have no problem accounting for the so-called twin paradox: it is, on the 3D view, an objective fact that clocks (and biological processes) slow down when they are in motion in the absolute frame (by a factor of γ). The traveling twin will therefore be younger. Petkov simply misunderstands how to fit clock retardation into the 3D interpretation of special relativity. That is, it is *not* the case that on the 3D picture the "acceleration to which B is subjected [is the] cause for the slowing down of B's time" (p. 18); rather it is the *velocity-dependence* of clock retardation that is "the cause" of the age difference.

21. The so-called proper time of the standard interpretation will be considered mere "apparent time" in the 3D interpretation. When one travels at seven-tenths the speed of light (in the absolute rest frame), all of the physical, biological, psychological processes in one's system slow to one-half their usual rate, but, of course, one will not perceive this slowing in the moving laboratory because everything slows equally (in that moving frame). It *seems* that half a year has passed (apparent time), though actually a whole year of absolute time has elapsed; the claim that time flows objectively need not imply that all systems/observers/clocks experience/register that time in the same way.

22. Thus a three-dimensional world is perfectly compatible with all experimental results which confirm the theory of special relativity. This success of this theoretical formalism teaches the 3D-er that there are real velocity dependent effects of length contraction and time dilation, and these effects need to be taken into account for a proper *interpretation* of experimental results. The 3D is, of course, different from the standard interpretation of SR, but the 3D picture is self-consistent and consistent with all our experimental data.

23. Petkov's reply to Balashov fails to grasp the position of the 3D-er, a position Balashov neatly and accurately summarizes. Four-dimensional Minkowski space-time, on this 3D view, will serve as a representation of the entire *history* of the real three dimensional world, but this will not imply the reality of the past and future. As Balashov points out, the 3D reinterpretation of special relativity implies that there is no measurement that one could perform to determine which frame is the privileged one. The "privileging" here is not empirical, but ontological; Petkov's claim that the privileged hypersurface "should be objectively distinguishable from the three dimensional cross-sections of the other reference frames" (p. 20) simply fails to recognize the 3D-er's proposed reinterpretation.

24. Petkov's Footnote 17 (p. 20) displays this same misunderstanding of the 3D-interpretation and Balashov's straightforward explanation of it. To claim that "[e]very inertial observer measures the velocity of light in his own reference frame, so no apparent distance and no apparent time are involved in his calculations," is to rely on the standard interpretation of SR that is explicitly being rejected by the postulation of the privileged reference frame. The apparent time and apparent distance referred to by Balashov are simply the time and distances measured

by an observer in motion whose rods and clocks are objectively slowed down and contracted. If this observer uses the Einstein convention to synchronize her clocks, then she will (mistakenly) measure the speed of light to be *c*.

25. Concluding points: A 3D interpretation of SR is perfectly consistent. This does not mean, however, that it is as attractive an interpretation as the standard 4D interpretation of SR. The virtue of the 4D picture is that Lorentz contraction and time dilation are beautifully explained by the geometry of the spacetime.