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AN EXAMINATION OF SUPERLUMINAL MOTION

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Abstract. In this work, the debate between Yuri Balashov and Hud Hudson is reviewed in terms of the views put forward by Tim Maudlin. It seems that Maudlin's view can shed light on the debate and may ensure new discussions and perspectives. Hudson, posing an interesting thought experiment, says that superluminal motion is possible whereas Balashov argues to the contrary. If we take into account what Tim Maudlin suggests in the first chapter of his book *The Metaphysics within Physics*, namely, that "laws of nature ought to be accepted as ontologically primitive," we can interpret Balashov-Hudson debate from a new perspective. It can be said that Balashov would be taking a step forward if we were to take into account Maudlin perspective.

Keywords: Superluminality; four-dimensionalism; Maudlin; Balashov; Hudson.

1. Introduction:

In this paper[1)], I will examine the relatively recent discussion between Yuri Balashov and Hud Hudson on superluminal motion and attempt to re-analyse it in Maudlin's terms. In the second section, I will describe Hudson-Balashov discussion in detail. In the third section, I will briefly examine Maudlin's view of laws of nature and re-state the Balashov-Hudson debate within Maudlin's framework. The fourth section will consist of some concluding remarks.

2. Superluminal Motion:

Although some debates on certain interpretations of quantum mechanics seek to suggest superluminal motion or information transfer, it is not yet proven that superluminal motion or information transfer is possible. My framework in this paper, however, is not a quantum framework but more generally a special relativistic one.[2)]

Aside from quantum theory and its interpretations, Hud Hudson, in his paper "Moving Faster than Light," suggests that superluminal motion is possible if we take a closer look at the notion of 'objecthood.' He suggests an object which moves faster than light. I will first state the original argument following Hudson and Effingham, but it will, I believe, be clearer if we take the Balashov's re-statement of Hudson's argument since the original one has certain practical difficulties. I want to begin with a quote from Hudson and then continue with

the debate itself. The opening paragraph of Hudson's paper, I believe, is worth mentioning as a starting point:

> Any schoolchild will tell you that nothing moves faster than light. Perhaps some of the clever ones will tell you that something once moved faster than light — but that was just at the earliest of times when (allegedly) light moved faster than it does now. Notwithstanding this cloud of witnesses, in the brief discussion … I would like to offer a reason to think that not only are there material objects that move faster than light (without moving backwards in time), but also that, for any multiple of the speed of light you might care to specify, there are material objects that move at that speed (managing to accomplish this feat without engaging in discontinuous motion) (Hudson, 2002: 203).

There are various important assumptions that Hudson makes and it is also essential for us to mention them before shedding light to the original argument. The assumptions are as follows:

> (1) No material object moves faster than light.
> (2) There is no superluminal propagation of matter, energy, signals, or causal influence.
> (3) the doctrine of arbitrary undetached parts (i.e. a mereological principle about which subregions of the region exactly occupied by a material object contain proper parts of that object),
> (4) four-dimensionalism (i.e. a second mereological principle commonly invoked in analyses of persistence and change over time.),
> (5) a (highly intuitive) sufficient condition for motion (Hudson, 2003: 15, 16).

Moreover, this "sufficiency for motion" is defined by Effingham as follows:

> …(SFM): It is sufficient for an object to be in motion during an interval *T* that (i) it occupies one region of space at the start of the interval, and another disjoint region of space at the end and (ii) every region of space that it occupies at one instant is in almost exactly the same place as the region it occupies at the next instant (Effingham, 2011: 700).

Thus, the original argumentation is as follows: Let there be an object called Cone. "Assume [that it] is 2 light seconds in height." Additionally assume that it "exists … during an interval [of one second]; *T*." Moreover "[o]f [its] parts there are non-denumerably many cross-sectional parts, onefor every cross-sectional slice of [a three-dimensional region of space], *R*." Let it be called the "Slice Set." Thus, since *T* includes "non-denumerable number of instants," we may have a one-to-one correspondence between Slice Set and "T-set" if we assume one (Effingham, 2011: 701). According to Effingham, it is deducible that the Slice which has the larger diameter would be earlier than the Slice which has a smaller diameter. The next step is to assume perdurantism and suppose that any given Slice "has a non-denumerable

number of instantaneous temporal parts, one for every instant of *T*." Thus, there are so-called *t-slices* whose temporal parts are instants of a given slice. We can now form a set, call it "Quick Set" and the "membership" criterion is such that "for every instant *t* from the *T-set*, the *t*-part of the slice assigned to *t* is a member of the Quick Set. Given universalism the members of the Quick Set compose an object [:]" Quick. Assuming SFM, Quick is superluminal (Effingham, 2011: 701).

It is really hard to grasp in the first instance but as we said earlier, Balashov's formulation of the argument is clearer and makes more sense. He simplifies the example that Hudson gives.[3)]

Balashova sks that we assume a three-dimensional space-time, two dimensions in space (x,y,) and one dimension in time (t) (call it "Flatland"). So, we may have four objects in hand. The first (1) is "the solid rectangular object" called "Rectangle," which is ABCD. In addition, Balashov wants us to suppose that "[rectangle] is composed of non-denumerably-many, one dimensional, cross-sectional, thread-like spatial parts." As such, "Rectangle persists over time by having a distinct temporal part at every moment of its existence and, in the course of its career, fills up the spatio-temporal region ABCDEFGH (Box)," (Balashov, 2003a: 4) which can be presented as a spacetime cube. The second object (2) is called Thread, presented inside ABFE, A and B for the ground corners of the Box in the form of the spacetime cube, F and E for the upper corners on the same direction. "[It] is extended in one spatial and one temporal dimension. Thread is a fusion of its temporal parts, each occupying exactly the same region of space" (Balashov, 2003a: 5).The third object (3) is called SlowThread, presented inside the ABF′E′, where F′ stands for a point between F and G closer to F say with distance *d*; E′ stands for a point between E and H closer to E with the same distance *d*. This ABF′E′ is the collection of one-dimensional objects that have temporal parts (presented as lines). Hudson would say that it is in subliminal motion (Balashov, 2003a: 5).The fourth object (4) is called FastThread, presented inside ABF′′E′′, where F′′ stands for a point between F and G closer to G, say, with distance *d′*; E′ stands for a point between E and H closer to H with the same distance *d′*. It can again be said that it is the collection of one-dimensional objects that have temporal parts (that can be presented as lines). In addition, it is in superluminal continuous motion. It might be objected that FastThread has two dimensions, one spatial and one temporal. Thus, Balashov thickens it; calls it ThickThreadsuch that it constitutes "a genuine Flatland analogue of four-dimensional 'thick' perduring objects of the real world" (Balashov, 2003a: 5, 6).

The first point that Balashov makes after re-constructing the Hudson argument is that Hudson makes a mistake in asserting that FastThread and ThickThread and the like (such as Quick) do not move backwards in time despite the fact that their motion is spacelike. He says that they do move backwards in time as a tachyon would. In particular, "there are inertial reference frames in which the end of

FastThread's spatiotemporal career, E′′F′′, occupies an earlier moment of time than its beginning, AB" (Balashov, 2003a: 6, 7).

What is more important is that Balashov does not think that FastThread, Slow Thread, and Thread are ontologically the same. He says that what Hudson is suggesting is a step before universalism, and although it seems so on diagrams, FastThread and Slow Thread are not objects according to Balashov. He states "the distinction between them is physically robust and perspicuous." To evaluate this, Balashov introduces Wesley Salmon's distinction between causal (genuine) processes and pseudo-processes. Genuine processes "are capable of *transmitting a mark*," yet pseudo-processes are not (Balashov, 2003a: 8). Moreover, since "perduring objects are … like processes," it can easily be said that this distinction may be useful for our purposes as well. Thus, "transmitting a mark" refers mainly to "*immanent causality*" or "*genidentity*" (Balashov, 2003a: 8, 9). In our context, however, it should be noted that no spatial part will transmit a mark through space; what a temporal part will, through time. Thus, the situation is as follows: when we leave a mark on AB, it will get transmitted to the later stages of Thread but not of SlowThread or FastThread. They are like a spatial "fusion" rather than two continuous objects. What happens in the case of ThickThread is rather weird too; the mark "mysteriously fades away" since there is no immanent causation (Balashov, 2003a: 9). These three (SlowThread, FastThread and Thick Thread) cannot "form a whole in [the] way the temporal parts of Thread do. And for this reason they do not conflict with relativity – not any more than Salmon's pseudo-processes do" (Balashov, 2003a: 10).

Balashov quickly adds a further suggestion (a tentative one some might say, and I might oppose.). He notes that pseudo-processes cannot play a physical role because of their "shadowy nature." As such, we might want to call Slow-Thread, FastThread and ThickThread as "pseudo-objects or no objects at all" (Balashov, 2003a: 10).

Balashov further emphasizes that the main question surrounding Hudson's example is actually the Special Composition Question. Furthermore, the reason why we should not or cannot take SlowThread, FastThread, and ThickThread as objects is the point very similar to the point that was made against mereological liberalism which suggests that they are on the same ontological ground. He makes a striking analogy, asking whether there can be something such as an electron without having the properties of an electron. The answer is, of course, no. Moreover and although a little bit too strong, this analogy suggests that Thread and — let us say — FastThread cannot be of the same kind. Therefore, since Thread is a material object, FastThread is not (Balashov, 2003a: 10, 11).

Hudson's reply to Balashov's objection comes in the article "Immanent Causality and Diachronic Composition: A Reply to Balashov" (2003). Hudson argues that Balashov acts as if he has some kind of objecthood criterion. In addition, he raises the synchronic composition question, proposing a dispute on the synchronically existing parts of objects – let us say of human beings. He proposes certain criteria

and asserts, following Lewis, that there cannot be a restricted composition since whenever we try, we achieve a vague criterion (Hudson, 2003: 19). Accused of "isolationism," Balashov replies that he does not have a synchronic composition criterion and diachronic and synchronic composition must be taken separately (Balashov, 2003b: 24). He, nevertheless, tries to offer a criterion:

> (R) Objects that are not connected by immanent causality do not [diachronically] compose anything; they also do not compose anything unless they belong to the same moment of time in the rest frame of their centre of mass,[4)] in which case they may or may not compose something (by [synchronically] composing it), depending on one's theory of synchronic composition (Balashov, 2003b: 25).

This criterion is compatible with what Balashov says in his original paper but it seems vague again depending upon a synchronic composition criterion.

Hudson also opposes Balashov, asking "why think that objects would have to stand in causal relations to enter into composition relations across time, but not across space?" (Balashov, 2003b: 25) Balashov simply disagrees with the implication that the question tries to give. The Minkowski space-time somehow forbids such indiscrimination because of the chronological order that it has in terms of diachronically separated events (Balashov, 2003b: 25, 26).

Moreover, Balashov tries to give an illustration by taking into account the point-like or micro-objects, suggesting mark-transmission again. He says that diachronic composition is not vague at all "at the microlevel [too]" (Balashov, 2003b: 26). The idea of mark transmission works well again. However, Hudson says, rather speculatively that:

> Do we really challenge anything sacred in maintaining that there are various material objects in superluminal motion? … The common assumption that the relevant laws must govern all things material might owe a great deal to the fact that they govern those material objects we happen to care about and have familiar sortal terms for classifying and to our unfortunate tendency to let our interests and our language drive our ontology (Balashov, 2003b: 28).

Balashov strongly disagrees and defends physical laws. He says:

> The laws of physics mentioned [by Hudson] are truly universal: by their very nature, they apply to all physical objects without exception, and this, I believe, has nothing to do with any system of classification we may oppose on the World. The laws are out there to be discovered. And the system is good only to the extent that it gets them right. We have every reason to think that natural science has already discovered some universal physical laws and given their approximate statements (Balashov, 2003b: 28).

This statement may seem a little bit too realistic. However, it might be suggested that Balashov is right, at least to a certain extent. In the final analysis, Balashov opposes Hudson in that what he offers violates certain physical laws or entails

contrary conclusions to the laws, also noting that Hudson is not firm in giving a good objecthood criterion. Balashov, however, does not himself give one and suggests only a tentative criterion for objecthood (R), saying that he has not yet developed a good criterion for synchronic composition.

In the following section we will see what Maudlin would say about this issue, and what would be "sacred" according to him.

3. The Maudlin View:

I think that there are certain points that need clarification in Hudson's view; however, they are not in the argumentation but in the conclusion, namely, the suggestions regarding contra-laws-of-nature. What Balashov defends in the very last paragraph of the last section is somehow related to what Maudlin would say. Maudlin, mainly, thinks that,

> …[L]aws of nature ought to be accepted as ontologically primitive… Laws are the patterns that nature respects; to say what is physically possible is to say what the constraint of those patterns allow.
>
> Taking laws as primitive may appear to be simple surrender in the face of a philosophical puzzle. But every account must have primitives. The account must be judged on the clarity of the inferences that the primitives warrant and on the degree of systematization they reveal among our pre-analytic inferences (Maudlin, 2007: 15).

Maudlin would not say, like Balashov, that the laws of physics should be primitive. Nonetheless, in a sense some laws of physics are also laws of nature. Is the assertion (i) "speed of light is constant" or (ii) "the speed of light is constant and cannot be surpassed" or (iii) "the speed of light is 299792458 meters per second" a law of nature? It seems that at least two points can be made:

The first (1) is that the assertion (i) seems to be a law of nature according to Maudlin. An anonymous example can be given as follows:[5)] Imagine a train which travels very quickly, say 250 meters per second. Suppose further that we put two circular discs (the second of which is turning) on the train orthogonal to its route. There is a hole in each disc (and to remind you that the second is turning in the rate I would now assign) and there is a light source in the train which sends a light beam in the same direction as the train travels. So the setup is like that: we place the light source, and place the first disc after that, then the second disc. We set things up so that the distance between the first disc and the second is measured so as to allow the light to pass through when the train is at rest for an observer A (again remember that the second disc is turning but now at a rate that allows light to pass through). Accordingly, can we say that light may not pass through the second disc since the train is in motion for A, and because of the fact that the speed of light be changed and the train accelerates adding 250 meters per second to it.?[6)] Hardly so. Therefore (i) seems to be intuitive in a sense and seems to be a law of nature, (ii) follows naturally, and (iii) needs some modifications but can hardly be otherwise.

The second (2) is that backwards travel in time is somehow contradictory with the laws of nature so there cannot be anything travelling faster than light.[7)] This is so because almost all of the laws of nature, depend upon causation and when causation is flawed by such objects, there cannot be anything but a real flux.

Therefore, Maudlin would say that Balashov is right about the issue but not completely right since he depends on physical laws rather than laws of nature; however, some physical laws are also laws of nature, so in terms of superluminal motion, one can say exactly that objects like FastThread are counter-intuitive and also that they contradict some basic laws of nature.

4. Conclusion:

In this paper, I examined the debate between Balashov and Hudson, and tried to re-analyse it in Maudlinian terms. The second chapter consists of a re-examination of the Balashov-Hudson debate, and the third chapter is the interpretation of the debate within the framework of laws of nature.

Although it can still be discussed as to whether the sentence "the speed of light is constant," is itself a law of nature, if we take Maudlin as a reference point, the discussion seems to indicate that Yuri Balashov was right after all.

NOTES

1. This paper is a version of the oral presentation 'Superluminal or Not: A Contemporary Debate Re-analysed' taken place in 4th Salzburg Conference for Young Analytic Philosophy, Salzburg, Austria, 2013.
2. Within Minkowski spacetime.
3. He says four dimensions are hard to demonstrate and also it has some more contraversies.
4. Which is vague.
5. A similar example is given by Dr. Maudlin in one of his talks in Physics and Philosophy of Time Summer School, Black Forest, Germany, 2013.
6. Note that Maudlin thinks the laws of nature "is not logically derived from, and cannot be defined in terms of, other notions." (Ibid. 15.)
7. This may oppose to Maudlin's (2011) sympathetic view of tachyons in his book *Quantum non-locality and relativity: Metaphysical intimations of modern physics*.

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