

A Response to Grünbaum on Creation and Big Bang Cosmology

Dr. William Lane Craig

William Lane Craig is Research Professor of Philosophy at Talbot School of Theology in La Mirada, California. He lives in Atlanta, Georgia, with his wife Jan and their two teenage children Charity and John. At the age of sixteen as a junior in high school, he first heard the message of the Christian gospel and yielded his life to Christ. Dr. Craig pursued his undergraduate studies at Wheaton College (B.A. 1971) and graduate studies at Trinity Evangelical Divinity School (M.A. 1974; M.A. 1975), the University of Birmingham (England) (Ph.D. 1977), and the University of Munich (Germany) (D.Theol. 1984). From 1980-86 he taught Philosophy of Religion at Trinity, during which time he and Jan started their family. In 1987 they moved to Brussels, Belgium, where Dr. Craig pursued research at the University of Louvain until 1994.

In response to my article "Creation and Big Bang Cosmology" Adolf Grünbaum argues against God's being a simultaneous cause of the Big Bang and against the inference that the Big Bang had a cause. His critique of simultaneous causation, once validly formulated, is based on an obviously false premiss, namely, that in order for simultaneous causation to be possible we must have a generally accepted criterion for discerning such causes. His most important reason for rejecting the causal inference with respect to the Big Bang is predicated on a B-Theory of time, which I find good reasons to reject.

Source: "A Response to Grünbaum on Creation and Big Bang Cosmology." *Philosophia Naturalis* 31 (1994): 237-249.

It is an exhilarating experience to be on the receiving end of one of Professor Grünbaum's trenchant critiques, and I am grateful both for his criticisms and this opportunity to respond. Without further ado, then, let us get down to the enjoyable details.

Grünbaum's lengthy critique is actually directed at only two paragraphs of my original article (the fourth and the fifth). In the first of these I charge that Grünbaum's objection that the Big Bang singularity cannot have been caused (because it could have had neither a subsequent cause nor an antecedent cause) is a pseudo-dilemma because the cause of the initial cosmological singularity could be simultaneous (or coincident^{1}) with that singularity. In response, Grünbaum presents the following argument:

1. Only events can qualify as the momentary effects of other events or of the action of an agency.
2. The Big Bang singularity is technically a non-event.
3. Therefore, the singularity cannot be the effect of any cause in the case of event causation or agent causation.

If this argument is sound, then it is imply irrelevant whether the putative cause of the Big Bang singularity is antecedent to, simultaneous with, or subsequent to the singularity, since any sort of cause of the singularity is excluded.

It seems to me, however, that this argument is invalid, since it equivocates on the meaning of the term "event." The sense in which the initial cosmological singularity is not an event is, as Grünbaum notes, a technical sense employed in GTR. Since that singular point is not Hausdorff isolated, that is to say, since its coordinates cannot be specified independently of all other space-time points, it cannot be classed as an event as that term is technically used in GTR. But the word "event" as it is used in (1) cannot be this *terminus technicus* if (1) is to be plausibly regarded as true. For we can easily envision happenings which are not "events" in the technical sense in which that word is used in GTR, but which do qualify as the momentary effects of other events or agent causes: (i) The initial cosmological singularity is causally linked to later space-time points and events, so that in this case we have events which are the momentary effects of a non-event. Now consider the final cosmological singularity in a universe caught in gravitational self-collapse: here we have a case in which a non-event is the momentary effect of other events, which contradicts (1), if that premiss uses "event" in the technical sense at issue. (ii) In the quantum realm, occurrences take place (such as the collision of two elementary particles) which cannot be termed "events" in GTR's technical sense. Classical conceptions of space and time finally break down within the quantum regime. Yet these quantum occurrences are doubtlessly causally conditioned by macroscopic physical states which are classifiable as (series of) events (such as a quantum experiment's being carried out by a researcher). (iii) The technical sense of "event" in GTR is inapplicable to mental events such as the perception of an object or the experience of being surprised. Yet such occurrences in consciousness are clearly in part the momentary effects of events in the physical world and also, plausibly, of the action of agents, as, say, when I force myself to concentrate on some subject or to get my mind off something else. (iv) If God exists, why could He not cause momentary effects which are not events in the GTR sense of the word? Could He not create a universe not governed by GTR in which there are momentary effects of His action which are not "events" in the technical sense of the term? Since GTR is not metaphysically necessary, why is this impossible? And why could not mental processes, quantum occurrences, and singularities be causally produced by God? In short, (1) is plausibly true only if "event" is understood in a broader, non-technical sense (for example, "that which happens") than the sense which that term carries in GTR. But in that case (3) does not follow from (1) and (2), since the notion of "event" in these two premisses is not univocal. {2}

The failure of Grünbaum's general argument forces upon us again the question of whether the cause of the Big Bang singularity might not have been simultaneous with it. Although he presents four objections to my suggestion, only the last specifically addresses the issue of simultaneous causation. Let us therefore temporarily bypass the other three and deal immediately with Grünbaum's misgivings about the Big Bang's having a simultaneous cause. Grünbaum presents the following argument:

4. The proponent of simultaneous, asymmetric causation must give us a criterion for distinguishing one of two causally connected simultaneous events as the cause of the other.
5. There is no generally accepted account of causal directionality.
6. Therefore, there can be no simultaneous, asymmetric cause of the Big Bang.

Now as an argument against simultaneous, asymmetric causation in general and of the Big Bang in particular, this objection is singularly unimpressive. At face value, the argument is invalid, since there is just no logical connection between premisses (4) and (5) and the conclusion (6). Let us therefore try to tighten up the reasoning a bit. The "must" in (4) suggests that Grünbaum understands (4) as a conditional. Grünbaum insists that he does not deny the existence of simultaneous, asymmetric causation in the world, but he seems to think that the obtaining of such causal relations somehow depends on our having a

conceptually sound explication of causal priority which licenses their possibility. Accordingly, (4) is plausibly taken to lay down a necessary condition for the possibility of such causation. We may cast Grünbaum's reasoning in a valid argument form by replacing (4) with

4.' The proponent of simultaneous, asymmetric causation must give us a criterion for distinguishing one of two causally connected simultaneous events as the cause of the other, if simultaneous, asymmetric causation is possible.

Unfortunately, the argument is still not valid, since (4') requires only that *some* criterion be given, while (5) refers to the absence of a *generally accepted* criterion. So we must replace (4') with

4." The proponent of simultaneous, asymmetric causation must give us a generally accepted criterion for distinguishing one of two causally connected simultaneous events as the cause of the other, if simultaneous, asymmetric causation is possible.

From (4") and (5) it follows that simultaneous asymmetric causation is impossible, which entails (6).

The argument is still unsound, however, because (4") is so evidently false. (i) Why must the proponent of simultaneous, asymmetric causation furnish a *generally accepted* criterion of causal directionality in order for such causation to be possible? Is this not an extravagant demand? What Grünbaum's gloss on Woodward's communication masks is that there is no generally accepted account of the direction of causation *überhaupt*, including accounts which appeal to temporal priority as a condition of causal priority. Indeed, I should dare to say that there is no generally accepted account of causation at all today. But should we therefore infer that causation is impossible or non-existent? Compare the situation in contemporary epistemology. There is today no generally accepted account of justification or rational warrant with respect to beliefs we hold as true; but should we therefore infer that knowledge is impossible? {3} Deconstructionists and other post-modernists may think so, but I doubt that Grünbaum would be ready to follow in their train. There is no reason to think that the possibility of simultaneous causation depends upon our being able to come up with an uncontroversial criterion of causal directionality. (ii) Indeed, what reason is there to think that the possibility of simultaneous, asymmetric causation depends upon my being able to come up with any kind of criterion of causal directionality at all? My enunciation of a criterion for distinguishing a cause from its effect is an epistemic affair; the existence of simultaneous causation is a matter of ontology. A criterion helps us to *discern* simultaneous, asymmetric causes in the world; but to suggest that said criterion somehow *constitutes* such causal relations in reality is verificationism at its most implausible. Grünbaum has not suggested any incoherence or difficulty in simultaneous, asymmetric causation; if there are such causes in the world, they do not have to wait around for us to discover some criterion for distinguishing them. (iii) There is no reason to think that in order for specific cases of simultaneous, asymmetric causation to be possible or discernible, one must be able to furnish a general criterion broad enough to cover all such alleged cases. All one needs is a way of distinguishing cause from effect in the specific case. Now in the case of the hypothesis of theological creationism, we have, as I noted, a logically airtight means of distinguishing cause from effect, namely, it is *metaphysically impossible* for God to be caused by the world, since if God exists, His nature is such that He exists necessarily, whereas the world's existence is metaphysically contingent (as is evident from its beginning to exist). That entails that there is *no possible world* in which God is caused by the Big Bang singularity. Hence, it is easy for the theist to explain in what sense God is causally prior to the universe or the Big Bang: God and the universe are causally related, and if the universe were not to exist, God would nevertheless exist, whereas there is no possible world in which the universe exists without God. {4} Grünbaum responds that my distinguishing God as the asymmetric cause of the universe based on the metaphysical impossibility of God's having a cause is "unavailing" in the face of Grünbaum's demonstration of the failure of my argument for a (simultaneous) cause of the Big Bang. He thus tacitly acknowledges that his argument against the notion of a simultaneous, asymmetric cause of the Big Bang cannot stand alone, but ultimately collapses back into his first three arguments against the Big Bang's being caused *simpliciter*. If the Big Bang has, then, an external cause, no independent reason remains to deny that the cause could operate simultaneously (or coincidentally) with the Big Bang. {5}

Let us turn, then, to Grünbaum's three arguments against inferring a cause of the Big Bang, which strike against the second of my two paragraphs on which he comments. The first objection is based on my claim that the universe came into being out of absolutely nothing. Grünbaum asks,

But in what sense and on what grounds does Craig claim that the universe did *become* actual if, as he grants, there was no 'empty time prior to the singularity'? It does not follow from the *de facto* or actual existence of the universe that it ever 'became' actual! Precisely by postulating such '*becoming* actual,' Craig begs the question when he offers such purported *actualization* as grounds for inferring that there must have been a 'potentiality of the universe's existence.'

I think that this is an extremely important and interesting objection which goes right to the heart of the difference between us. Grünbaum is a well-known advocate of what J. M. E. McTaggart called a B-theory of time, according to which events in time are ordered by tenseless relations of *earlier than*, *simultaneous with*, and *later than*, while the distinction between past, present, and future is merely a subjective feature of consciousness; temporal becoming is not objective, and all events are on an ontological par, existing tenselessly at their appointed stations. On such a metaphysic of time, the universe, while having a beginning, never really came into existence. It is tenselessly actual and begins to exist only in the sense that a meter stick has a beginning. By contrast, I subscribe to what McTaggart called the A-theory of time, according to which the distinction between past, present, and future is objective, not merely subjective. There are tensed facts about the universe, and temporal becoming is real, the future being a realm of unrealized possibilities. Temporal events are not on an ontological par, and events do not tenselessly subsist; rather they elapse, and things come into being and pass away. On such a metaphysic, the initial cosmological singularity does not tenselessly exist as merely the front edge, so to speak, of the tenselessly existing four-dimensional block universe. Rather it *happens*, and this happening is tensed. It is the initial exemplification of temporal becoming, the first actualization of a physical state of affairs, and yet it becomes actual without any antecedent physical conditions to bring about its actualization. It is in that sense that it came to be out of nothing.

The debate between us therefore comes down to whether the A- or the B-theory of time is true. In this short paper, I can only outline my justification for preferring the metaphysic of an A-theory of time:

I. Arguments for the A-Theory

- A. Linguistic tense, which is ineliminable and irreducible, mirrors the tensed facts which are characteristic of reality. {6}
- B. The experience of temporal becoming, like our experience of the external world, should be regarded as veridical. {7}

II. Refutation of Arguments against the A-Theory

- A. McTaggart's Paradox is based upon the illicit assumption that there should exist a unique tenseless description of reality, as well as the illicit conflation of A-theoretic becoming with a B-theoretic ontology. {8}
- B. The passage of time is not a myth, but a metaphor for the objectivity of temporal becoming, a notion which can be consistently explicated on a presentist metaphysic. {9}

III. Refutation of Arguments for the B-Theory

- A. Temporal becoming is wholly compatible with Relativity Theory, as can be shown in a number of ways. {10}
- B. Time, as it plays a role in physics, is an abstraction of a richer metaphysical reality, omitting indexical elements such as the "here" and the "now" in the interest of universalizing the formulations of natural laws. {11}

IV. Arguments against the B-Theory

A. In the absence of objective distinctions between past, present, and future, the relations ordering events on the B-theory are only gratuitously regarded as genuinely temporal relations of *earlier/later than*. {12}

B. The subjective illusion of temporal becoming involves itself an objective temporal becoming of contents of consciousness. {13}

C. The B-theory entails perdurantism, the view that objects have spatio-temporal parts, a doctrine which is metaphysically counter-intuitive, is incompatible with moral accountability, and entails the bizarre counterpart theory of transworld identity. {14}

I plan to develop all these points in a forthcoming book entitled *God, Time, and Eternity*. If I am correct that an A-theory of time turns out to be preferable to a B-theory, then Grünbaum's first objection is voided, and the demand for a cause of the universe's coming to be seems to be quite justified.

Grünbaum's second objection is irrelevant to our *Auseinandersetzung*, since it concerns a cause of the *being*, rather than of the *becoming*, of the universe. It concerns divine conservation, not creation, of the universe. It is natural that as a B-theorist who believes that the universe never came into being, but just exists tenselessly, Grünbaum should enquire after the arguments for a cause of the universe's being; but as my arguments in no way rest upon the success of arguments for divine conservation, we may leave it to those whom Grünbaum criticizes to defend their own views. {15}

Given that an A-theory of time is true, would the beginning of the universe require a cause? Grünbaum's third and final objection seeks to undercut an affirmative answer to this question. He asserts that there is no reason *a priori* or *a posteriori* to think that whatever begins to exist *ex nihilo* has a creative cause. Now the first thing to notice is the modesty of this objection. It does not essay to *refute* the causal premiss; it merely denies that there are any grounds for *affirming* it. {16} Such an objection is, however, wholly compatible with the view that the causal principle is a sort of metaphysical first principle, a properly basic belief. I have maintained from the beginning that any argument for the principle is apt to be less obvious than the principle itself. In the absence of any good reason to deny the causal principle, I am quite content to rest my case on the perspicacity of that very principle.

But to consider Grünbaum's objection on its own merits: in the case of *a priori* knowledge of the causal principle, Grünbaum fails to distinguish between strictly logical necessity and metaphysical necessity. I have always maintained that the causal principle is not strictly logically necessary, in that its negation is not a contradiction. In that sense, an uncaused beginning *ex nihilo* is not analytically impossible. But such considerations only prove that the causal principle is synthetic, not that it is metaphysically contingent. Indeed, given the A-theory of time, it is very plausible to take the causal principle as a synthetic, metaphysically necessary truth, since, as I have argued, the becoming actual of the first physical state plausibly requires a cause. Grünbaum's only response to that argument was to deny the A-theory of time on which it was predicated. {17}

In the case of *a posteriori* knowledge of the causal principle, all Grünbaum does is allege that the Steady State model does not require a supernatural cause for the creation of matter *ex nihilo*, since it posits a physical cause of matter creation. But the failure of that model to require a divine creative cause does absolutely nothing to support Grünbaum's objection that there is no empirical evidence for the causal principle. (In fact, in positing a physical cause of matter creation the model actually supports the causal principle.) I should say that the empirical evidence overwhelmingly confirms the principle that things do not come into existence uncaused out of nothing. Even the late J. L. Mackie, himself no friend of philosophical theism, in his critique of theological creationism conceded that "this principle . . . is constantly confirmed in our experience (and also used, reasonably, in interpreting our experience)" [Mackie (1982), p. 89]. In short, I think we have quite good reasons, both philosophical and empirical, for sticking with the intuitively plausible causal principle.

In summary, I hope to have sustained my original charge that Grünbaum's rejection of theological creationism is based on a pseudo-dilemma. Since the universe began to exist, it plausibly requires a cause of its origination, even if the initial cosmological singularity is not an "event" in the technical sense of that term in GTR. Since the cause cannot be physically prior or subsequent to the Big Bang, it must be simultaneous or coincident with the Big Bang, a conclusion which is in no way obviated by the want of a generally accepted criterion of causal directionality.

Endnotes

{1} The terminological issue here is analogous to Grünbaum's complaint that the initial cosmological singularity is not technically speaking an "event." If nothing can be, technically speaking, "simultaneous" with the singularity, since it is not an instant of time, then we can substitute other locutions to convey the idea, like "coincidence," *i.e.*, two incidents co-occurring, or occurring together. If this is not clear enough, we can say further that two incidents co-occur iff they both occur and there is no time between their occurrences. One might note furthermore that even though $t = 0$ is not an instant of time, nevertheless it functions *logically* like an instant of time, so that it makes perfectly good sense to say that God created the universe at $t = 0$.

{2} Permit me to note that, *pace* Grünbaum, I have never asserted the ontological legitimacy of Grünbaum's case (i) scenario as support for *creatio ex nihilo*. My own position has been to regard the initial cosmological singularity as ontologically equivalent to nothing, so that $t = 0$ is a mathematical idealization and any initial interval of time is open in the *earlier than* direction [Craig and Smith (1993), pp. 43-44, 146-147, 224-227, 258-261]. Since Grünbaum brought up the case (i) scenario, I have argued *ex concessione* that the initial cosmological singularity, if ontologically real, requires a cause, whether or not any arbitrarily chosen initial temporal interval is closed or open in the *earlier than* direction. I must say, too, that I see no reason to think that Lovell or the Pope (of all people) was presupposing a case (i) ontology [Lovell, A.C.B. (1961), p. 106; Pius XII (1952), pp. 143-146].

{3} See the excellent survey of the field in Plantinga (1993).

{4} It is very interesting that Hausman's criterion for causal priority fails not only in the case of God, but (on the hypothesis of naturalism) also for the Big Bang singularity. For the initial cosmological singularity is causally connected to everything else, so that Hausman's condition that in order for X to cause Y there must be something causally connected to Y, but not to X, fails. Hausman tries to escape this counter-example by alleging that "there is no reason why one need regard the complex state of the world just after the big bang as having a single cause or causal condition [Hausman (1993), p. 447)], but this reply is clearly inadequate, as the initial cosmological singularity is the source and therefore causal condition of everything physical. Hausman senses the difficulty and goes on to confess, "I might also be able to justify making an exception in the case of the big bang, which is surely an exceptional event." --Indeed, as is God's creation of the universe, which is also a plausible exception to Hausman's analysis.

{5} The rationale behind Grünbaum's discussion of purported instances of simultaneous, asymmetric causation is unclear. For if he were arguing that from the actuality of such causation we could infer in the absence of any sound criterion the possibility of such causation, that would contradict (4"). Perhaps he would say that in the very act of experiencing simultaneous, asymmetric causation we should apprehend a criterion for distinguishing cause from effect. But that seems enormously implausible. When I hold a pencil in the air, I am intentionally aware that it is I who am the simultaneous, asymmetric cause of its suspension, rather than its being the support upon which my hand rests, and I need no criterion of causal directionality to know this. It is thus hard to avoid the impression that on Grünbaum's view it is impossible ever to discern simultaneous, asymmetric causation through experience alone, which seems to be just the sort of *a priori* theorizing about causation against which he warns.

Notice that his chief difficulty with the considered examples is not the simultaneity of the cause and its effect, but their *asymmetry*. I suppose that the implication is that the cause of the Big Bang must have a

symmetric causal relation with the singularity. His argument fails because in the examples he does not show causal symmetry *in the same respect*. In the example of the ball resting on the cushion, the ball is the asymmetric, simultaneous cause of the depression in the cushion; the depression is in no way the cause of the ball's resting on it. Of course, due to its elasticity, the cushion exerts force against the ball, but that is simply irrelevant and in fact constitutes another example of simultaneous, asymmetric causation, since in this case the cushion supports the ball; the ball does not support the cushion. In the case of the Big Bang, one could allow, I suppose, other respects in which the Creator and the singularity are differently related, *e.g.*, perhaps the singularity's occurring asymmetrically causes the Creator to know the truth of the proposition "The singularity is occurring." But even such a concession is far from necessary, since causal relations between material objects will not be isomorphic to relations between an immaterial being and a material object.

My rejection of the relevance of the finite velocity of physical causal influences in STR is not question-begging because (i) as the Creator of physical space-time, the Creator must transcend space and so be non-physical and immaterial and (ii) so long as it is even *possible* that God created the universe, it is not necessary that all causal influences be physically mediated. I can clarify my point that even remote causation involves simultaneous causation by stating that the remote cause produces its effect through the final mediation of a simultaneous cause. In physics, such mediation is through contact forces, *i.e.*, forces which are such that the effect is not produced until the mediating photon is actually absorbed by the patient entity. I am not claiming that all causation is like this, but the assertion that an upper bound to velocity precludes simultaneous causation is thereby seen to be fatuous. Finally, proponents of simultaneous, efficient causation are certainly not unaware of causal chains, such as pregnancy resulting from intercourse, but insist that in any such chain the final link will be simultaneous with the commencement of the effect. That is not obviously absurd.

{6} For an outstanding defense of this point, see Smith (1993). In choosing to collaborate with Smith, an ardent A-theorist, in his battle against theological creationism, Grünbaum may have unwittingly admitted a Trojan horse within his walls.

{7} One of the most eloquent spokesmen for this point of view has been George Schlesinger (1980), pp. 34-39, 138-139.

{8} The most helpful here are still Broad (1938) and Dummett (1960).

{9} This point needs further work, but see Prior (1968), pp. 1-14; Loizou (1986), pp. 44-45.

{10} See Smith (1993), chap. 7 and McCall (1994).

{11} See the remarks of Black (1962).

{12} There is no good treatment of this yet, but see Gale (1968), pp. 90-97 and Mellor (1981), p. 140.

{13} Again, this point needs to be better developed, but see Geach (1972), p. 306 and McGilvray (1979).

{14} See the excellent study by Merricks (1994); see also Lewis (1986) and the incisive piece by Van Inwagen (1990).

{15} Just a note to say that Grünbaum conflates three versions of the cosmological argument. The *kalam* version, which I have defended, says nothing about a *causa/ratio essendi*. The Thomist version, as it comes to expression in Aquinas's *Tertia Via*, argues for a *causa essendi* on the basis of the real distinction between essence and existence in contingent things, a distinction which disposes them to nothingness. The Leibnizian version in no way presupposes a disposition toward nothingness in contingent things, but seeks a *ratio* for the existence of anything, even an eternal thing which has no disposition to nothingness, in a

being which is metaphysically necessary. Other philosophers and theologians merely seek to explicate the notion of divine conservation, accepted on the basis of revelation or church teaching, without trying to construct an argument for God's existence from contingency. Thus, Grünbaum's demand for evidence of the spontaneity of nothingness is not in every case a relevant demand.

{16} Smith's arguments, alluded to by Grünbaum, against the necessity of the causal principle are refuted in Craig and Smith (1993), pp. 271-275.

{17} It must be said that Grünbaum misrepresents Swinburne's views on this question. Swinburne is arguing against the antithesis of Kant's First Antinomy concerning time for the eternity of the universe. Arguing for the possibility of the universe's beginning to exist, Swinburne states that the antithesis "assumes as a logically necessary truth that every state has a cause in the sense of a preceding state which brings it about" [Swinburne (1981), p. 250]. I should agree that this principle is not necessary; indeed, it is false. Swinburne therefore justifiably rejects any attempt to rule out the standard Big Bang model because in it the first state of the universe is a state uncaused by a precedent state [pp. 254-255]. He does not deny that a first state requires a cause which is an agent cause, rather than a precedent physical state [p. 251, n. 1]. For more on God as the agent cause of creation, see Craig [1994].

References

- Black, Max. [1962]. Review of *The Natural Philosophy of Time*. *Scientific American* 206 (April), pp. 181-183.
- Broad, C.D. [1938]. *An Examination of McTaggart's Philosophy*. 2 vols. Cambridge: Cambridge University Press.
- Craig, William Lane. [1994]. "Prof. Grünbaum on Creation." *Erkenntnis* 40, pp. 325-341.
- Craig, William Lane and Smith, Quentin. [1993]. *Theism, Atheism, and Big Bang Cosmology*. Oxford: Clarendon Press.
- Dummett, Michael. [1960]. "A Defense of McTaggart's Proof of the Unreality of Time." *Philosophical Review* 69, pp. 497-504.
- Gale, Richard. [1968]. *The Language of Time*. International Library of Philosophy and Scientific Method. London: Routledge & Kegan Paul.
- Geach, Peter. [1972]. "Some Problems about Time." In *Logic Matters*, pp. 302-318. Berkeley: University of California Press.
- Hausman, Daniel M. [1993]. "Linking Causal and Explanatory Asymmetry." *Philosophy of Science* 60, pp. 435-451.
- Lewis, Delmas. [1986]. "Persons, Morality, and Tenselessness." *Philosophy and Phenomenological Research* 47, pp. 305-309.
- Loizou, Andros. [1986]. *The Reality of Time*. Brookfield, Ver.: Gower.
- Lovell, A.C.B. [1961]. *The Individual and the Universe*. New York: New American Library.
- McCall, Storrs. [1994]. *A Model of the Universe*. Clarendon Library of Logic and Philosophy. Oxford: Clarendon Press.

- McGilvray, James. [1979]. "A Defense of Physical Becoming." *Erkenntnis* 14, pp. 275-299.
- Mackie, J.L. [1982]. *The Miracle of Theism*. Oxford: Clarendon Press.
- Mellor, D.H. [1981]. *Real Time*. Cambridge: Cambridge University Press.
- Merricks, Trenton. [1994]. "Endurance and Indiscernibility." *Journal of Philosophy* 91, pp. 165-184.
- Pius XII. [1952]. "Science and the Catholic Church: Two Documents." *Bulletin of the Atomic Scientists* 8, 142-146, 165.
- Plantinga, Alvin. [1993]. *Warrant: the Current Debate*. New York: Oxford University Press.
- Prior, Arthur N. [1968]. "Changes in Events and Changes in Things." In *Papers on Time and Tense*, pp. 1-14. Oxford: Clarendon Press.
- Schlesinger, George. [1980]. *Aspects of Time*. Indianapolis: Hackett.
- Smith, Quentin. [1993]. *Language and Time*. New York: Oxford University Press.
- Swinburne, Richard. [1981]. *Space and Time*. 2d ed. London: Macmillan.
- Van Inwagen, Peter. [1990]. "Four Dimensional Objects." *Nous* 24, pp. 245-255.