

History of Logic from Aristotle to Gödel (www.historyoflogic.com)

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Selected Bibliography on the *Master Argument* of Diodorus Cronus

Bibliography

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 "I shall consider two Diodorean models: what I call the **D**-model, constructed on the set of non-negative reals, and the **D**-model - in effect the usual one - on that of positive integers. I show that these characterise S4.3 and D, respectively. All the Diodorean models verify S4.3. It is easy to adapt the completeness proof for S4.3 given here to Diodorean models on the non-negative rationals and various other linearly-ordered sets. (The proof depends, in fact, on the linearly-ordered set having a suitable sub-set of ordinal ω_2 .) There are other Diodorean systems, but they do not seem to be of any interest." (p. 59)
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21. Ciuni, Roberto. 2009. "The Search for the Diodorean Frame." *Humana Mente: Journal of Philosophical Studies* no. 8:47-65.
 Abstract: "Diodorean modalities are logical notions that specify, in a precise way, how sentences may be true with respect to time: a sentence is diodoreanly necessary at a given instant iff it is true since that instant on. Arthur Prior has treated them as sentential operators and built up a logic for such modalities (DIOD) conjecturing that the frame for such a logic (the "diodorean frame") was the frame for S4. The Conjecture was soon proved false, through a number of counterexamples that played a role in the research on modal logics between S4 and S5. The present paper aims at showing that (i) the search for the diodorean frame benefited from such a research, and that (ii) there has been a mutual interaction between the search of the diodorean frame and some characterisation results. The paper is divided into five parts. In section 1, I will introduce diodorean modalities, while in Section 2 I will be focusing on Prior's reconstruction of the Master Argument and his characterisation of DIOD. In section 3, I present a conjecture Prior advanced about the characterisation of DIOD and some counterexamples to it. The notions of "frame" and "frame for" will be also introduced. In section 4 I summarise the connections between the search of the diodorean frame and some researches in modal logic. Section 5 presents a short conclusion.
22. Corpina, Fabio. 2016. "The Ancient Master Argument and Some Examples of Tense Logic." *Argumenta* no. 1:245-258.
 Abstract: "The Master Argument of Diodorus Cronus has been long debated by logicians and philosophers. During the Hellenistic period it was so famous that

doxographers and commentators took for granted its notoriety and none of them gave us a detailed report. The first section presents a philosophical account of the ancient Master Argument, by trying to retrace its meaning, originated from the Megarian context, and so halfway between ancient logic and metaphysics. The second section introduces a logical analysis of the Master Argument against the backdrop of the Jarmużek-Pietruszczak semantics for the tense logic K_4P ; but the main aim of the section is to deal with one of the most fascinating attempts to peruse the Master Argument, i.e. A. Prior's reconstruction. Prior stays true to the Diodorean philosophical stance even if he uses modern logical tools. The significance of the work by Prior marks the beginning of tense logic. The third section expounds an argument by Øhrstrøm-Hasle. Danish logicians do not consider additional premises for the Master Argument. They give, in primis, a sentential example for the third premise, proving its inconsistency with the first two. The deterministic conclusion is the implicit result of this stratagem. Finally, in the fourth section, we compare the strategies by Prior and Øhrstrøm-Hasle."

References

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23. Corpina, Fabio, and Øhrstrøm, Peter. 2017. "The Diodorean approach to time and modality from a historical and a philosophical perspective." In *Logic and Philosophy of Time: Themes from Prior, Volume 1*, edited by Hasle, Per, Blackburn, Patrick Rowan and Øhrstrøm, Peter, 83-101. Aalborg: Aalborg Universitetsforlag. Abstract: "Diodorus Cronus (ca. 340–280 B.C.) was an important philosopher and logician of the Megaric School. His principal contribution consists in a strong, logically oriented, characterisation of metaphysics, focused on the temporal aspects of important logical notions, in particular the understanding of conditionals and modality. Furthermore, he is well known for his so-called Master Argument which was designed to demonstrate that if something is possible then either it is the case already or it will be the case later. In this way Diodorus suggested a close connection between time and modality. According to Diodorus time can be seen as a series of temporal atoms. At any such atomic moment a proposition may be true or false. Since we do not have the details of Diodorus' original argument, several scholars have tried to reconstruct the Master Argument as it might have been. In this paper, we consider two attempted reconstructions of the argument: one based on a certain interpretation of Diodorus' notion of implication, and one suggested by A.N. Prior and based on a tense-logical approach to time and reasoning. We argue that both reconstructions are possible from a historical point of view, but that the latter is more interesting than the former if the argument should be conceived as an argument in favour of determinism."
24. de los Ríos Gutiérrez, Iván. 2018. "Kyrieuon Logos. Diodoro Crono y el problema del determinismo a la luz de *Metaphysica* IX, 9, 3." *Trans/Form/Ação* no. 41:9-30. Resumen: "El presente artículo tiene por objetivo la reconstrucción del argumento dominador (*kyrieuon logos*) atribuido a Diodoro Crono y su revisión filosófica a la luz de la crítica aristotélica al actualismo extremo de la Escuela de Mégara en *Metafísica* IX, 3. Desde esta perspectiva, el trabajo aspira a situar el proyecto teórico de Diodoro en el marco de su disputa filosófica con la metafísica aristotélica y su concepto de δόξα, con el fin de traducir esta querrela dialéctica en lo que, a nuestro juicio, constituye una disputa teórica de importantes consecuencias prácticas: la disyunción excluyente entre el azar y el destino como paradigmas de interpretación conceptual y de acción moral."
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 "Richard Gaskin's *The Sea Battle and the Master Argument* (1995) falls into two roughly equal sections each corresponding to one half of its title. The first explores Aristotle's treatment in *De Interpretatione* 9 of his puzzle about tomorrow's sea-battle; the second puts some of these results to work in developing a novel account of the Master Argument of Diodorus Cronus. Moreover, throughout the book, Gaskin pays detailed attention to rival interpretations from the mass of commentary that has accumulated around these topics since ancient times, and that continues to accumulate ever faster in our own. On this aspect of Gaskin's book, I will have little more to say than that he discusses all the rival interpretations with a general good sense, and with a patience that I for one could not so long sustain. Moreover, I propose merely to summarise the salient points in Gaskin's own understanding of Aristotle. In the bulk of this critical notice, I will examine at much greater length what I myself take to be Gaskin's most interesting achievement: a reconstruction of the Master Argument that, whatever its faults, is both more plausible historically and more interesting philosophically than all but a handful of the umpteen reconstructions that are now on offer." (p. 166)
27. ———. 1999. "The Master Argument of Diodorus Cronus. A Near Miss." *Logical Analysis and History of Philosophy / Philosophiegeschichte und logische Analyse* no. 2:239-252.
 Abstract: "Diodorus' Master Argument was intended to show that whatever is possible either is or will be true. The intended conclusion does not follow from the extant premisses of the Master Argument. The Near Miss argues however, from those premisses alone, that nothing can be more than momentarily an exception to the Master Argument's intended conclusion. Strong arguments support even the most contentious of those premisses ("every past truth is necessary"). We therefore cannot easily ignore the Near Miss. Moreover, there are various supplementary premisses that would turn the Near Miss into an argument with the full force of the Master Argument itself. Each of Diodorus' ancient rivals, since they accepted such doctrines as eternal recurrence, temporal atomism, and the "extended" present, would grant him at least one of these supplementary premisses. So too would any modern who holds that time is not circular, has no beginning, and does not branch."
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 Abstract: "Diodorus' Master Argument was intended to show that whatever is possible either is or will be true. The intended conclusion does not follow from the extant premisses of the Master Argument. The Near Miss argues however, from those premisses alone, that nothing can be more than momentarily an exception to the Master Argument's intended conclusion. Strong arguments support even the most contentious of those premisses ("every past truth is necessary"). We therefore

- cannot easily ignore the Near Miss. Moreover, there are various supplementary premisses that would turn the Near Miss into an argument with the full force of the Master Argument itself. Each of Diodorus' ancient rivals, since they accepted such doctrines as eternal recurrence, temporal atomism, and the "extended" present, would grant him at least one of these supplementary premisses. So too would any modern who holds that time is not circular, has no beginning, and does not branch."
35. Giannantoni, Gabriele. 1981. "Il *kyrieion logos* di Diodoro Crono." *Elenchos* no. 2:239-272.
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37. Goodman, Lenn E. 1999. "The Diodorean Modalities and the Master Argument." In *From Puzzles to Principles? Essays on Aristotle's Dialectic*, edited by Sim, May, 15-37. Lanham: Lexington Books.
- "My purpose in this chapter is to examine the modalities of Diodorus and the logic of his argument in their behalf, the so-called Master4 Argument." (p. 19)
- (...)
- "What Diodorus seems to me to be saying is that if there is a state of affairs that will never occur, then (for example) it was always true that it would never occur (and always true to say so, as in the version of the argument that Aristotle considers). So the event cannot occur without falsifying that truth or claim, thus, without making over the past, which Aristotle concedes is impossible. Diodorus seems to me to generalize this approach, by assuming that there is always some truth about the past that any falsehood about the future will contradict. The inference is that all falsehoods about the future are impossible and all truths about the future necessary. We need not speculate that this line of argument was in fact taken by Diodorus, for we have the testimony of Cicero's *De Fato* to confirm our reconstruction. The core of the argument that Cicero links to the name of Diodorus is this: If p ('Fabius was born at the rising of the Dogstar') entails q ('Fabius will not die at sea'), then the entailment of q by p (a necessary proposition, since it deals with the past) renders q necessary as well, and it becomes impossible for Fabius to die at sea. (27)
- The strength of the Diodorean position lay in its capacity to refute the conception of possibility put forward by Aristotle, and that by arguing from his own premisses.(28)
- If real possibility is indeed an incoherent notion and there are no possibilities that are not at some time to be realized, then all truths become necessary and the time dimension itself is called into question. For necessity is timeless. Even though Diodorean necessity was achieved through quantification over time, it has the effect of bracketing or erasing time." (pp. 21-22)
- (...)
- "With the elimination of real possibility, modality as an independent category is effectively suppressed. A system of modality which does not allow for possibilities that may never be realized cannot distinguish possibility from actuality except in point of temporal placement. Modality as such becomes vacuous; and the distinction of, say, natural from logical necessity, otiose. The Aristotelian, then, and indeed anyone who would retain modal concepts in describing change, causality, or nature has an interest in refuting the Master Argument." (p.22)
27. See Cicero, *De Fato*, vi 12, vii 13; cf. Michael J. White's discussion in "Facets of Megarian Fatalism: Aristotelian Criticisms and the Stoic Doctrine of Eternal Recurrence," *Canadian Journal of Philosophy* 10 (1980): 203-4.
28. For the reliance of the Master Argument on Aristotelian premisses, see, Peter Øhlstrom, "A New Reconstruction," 61 ; and O. Becker, "Zur Rekonstruktion des 'Kyrieion Logos' des Diodorus Kronos," in *Festschrift für Theodor Litt*, J. Derbolav and F. Nicolin, eds. (Düsseldorf, 1960).
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39. Gundersen, Lars. 1997. "The Master Argument and Branching Time." *Logic and Logical Philosophy* no. 5:49-60.
Abstract: "It is argued that reconstructions of the so-called 'Master Argument' of Diodorus Cronos to the effect that possibility should be understood as present or future truth, essentially relies on two axioms: i) that every true proposition concerning the past is necessary, and ii) that it follows necessarily from a proposition being true that it always has been the case that it would be true. It is furthermore argued that these two axioms are inconsistent in the sense that any tense/modal semantics which incorporates both collapses either modally (fails to distinguish between truth simpliciter and modalised truth) or temporally (fails to offer a plausible semantical account for propositions about the future). This finding is, furthermore, taken as indicator for the more general claim that there are principled difficulties involved in construing semantics for combined tense/modal logical systems."
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Abstract: "Die von Aristoteles in *De Int.* 7 eingeführte „indefinite Aussage“ verweist nach meiner Deutung auf ein Universale, welches anteilig an widersprüchlichen akzidentellen Prädikaten teilhat. Dem korrespondiert auf semantischer Ebene die graduelle Wahrheit beider Widerspruchsglieder. In gleicher Weise ist für Aristoteles auch die Aussage, daß ein Individuum zu einem Zeitpunkt seiner kontingenten Zukunft so-und-so bestimmt sein wird, nach *De Int.* 9 offenbar als graduell-wahr einzustufen. Das Einzelne kann hinsichtlich seiner kontingenten Zukunft nämlich noch nicht betrachtet werden, sofern es faktisch wäre, sondern nur, sofern es zeitübergreifend ein Universale exemplifiziert. In diesem Zusammenhang werden zugleich fundamentale Bezüge zwischen indefiniter Aussage einerseits und Aristotelischer Modallogik, Statistik und Wissenschaftstheorie andererseits deutlich."
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42. ———. 2017. "The Megarian and the Aristotelian Concept of Possibility: A Contribution to the History of the Ontological Problem of Modality." *Axiomathes*. Translated by Frédéric Tremblay and Keith Peterson.
Abstract: "This is a translation of Nicolai Hartmann's article "Der Megarische und der Aristotelische Möglichkeitsbegriff: ein Beitrag zur Geschichte des ontologischen Modalitätsproblems," first published in 1937. In this article, Hartmann defends an interpretation of the Megarian conception of possibility, which found its clearest form in Diodorus Cronus' expression of it and according to which "only what is actual is possible" or "something is possible only if it is actual." Hartmann defends this interpretation against the then dominant Aristotelian conception of possibility, based on the opposition between *dynamis* and *energeia*, and according to which there is always an open multiplicity of simultaneous "possibilities," the outcome of which remains undetermined. Since, according to Hartmann, reality suffers no indetermination, the Megarian conception of possibility is an account of *real possibility*, whereas the Aristotelian one is merely an account of *epistemic possibility* (Frédéric Tremblay)."
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Revised reprint as Chapter IX in: J. Hintikka, *Time and Necessity. Studies in Aristotle's Theory of Modality*, New York: Oxford University Press, 1973, pp. 179-213.

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In collaboration with Unto Remes and Simo Knuuttila.
45. Ide, Harry A. 1992. "Chrysippus's Response to Diodorus's Master Argument." *History and Philosophy* no. 13:133-148.
Abstract: "Chrysippus claims that some propositions perish. including some true conditionals whose consequent is impossible and antecedent is possible, to which he appeals against Diodorus's Master Argument. On the standard interpretation, perished propositions lack truth values, and these conditionals are true at the same time as their antecedents are possible and consequents impossible. But perished propositions are false. and Chrysippus's conditionals are true when their antecedent and consequent are possible, and false when their antecedent is possible and consequent impossible. The claim of the Master Argument that Chrysippus rejects, then, is stronger than usually supposed."
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Abstract: "This paper deals with the Aristotelian problem of Sea-fight tomorrow, but it is analyzed from a Diodorean point of view. Precisely, we examine whether the lost argument of Diodor Cronus, called Master Argument, could be conducted within a frame of future open time. Since we do not know the argument itself, we follow the known reconstructions of Master Argument. Each of them requires special logical assumptions, but also semantic constraints concerning a frame of time. The last detail interests us the most. Showing shortly, step by step, all constraints, we come to the conclusion that the strictly treated reconstructions of Master Argument must prefer a linear model of future."
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Ristampato in: M. Mariani, *Logica modale e metafisica. Saggi aristotelici*, Pisa: Edizioni ETS 2018, pp. 319-330.
Abstract: "Come risulta chiaro già dal titolo, il libro di Gaskin è diviso in due parti: la prima, che comprende i capitoli 1-14, tratta del famoso e famigerato argomento fatalista di *De Interpretatione* 9, mentre la seconda, che comprende i capitoli 15-25, è dedicata al quasi altrettanto famoso e dibattuto "Argomento Dominatore" di Diodoro Crono, nonché alle sue possibili relazioni con la "Battaglia navale" aristotelica. Seguono poi tre appendici, la prima dedicata ad alcune interpretazioni arabe e medievali di *De Interpretatione* 9, le altre due al tema della prescienza e della contingenza in Alessandro di Afrodisia. Si tratta – è già chiaro da questo sommario – di un libro ricco e stimolante, la cui disamina approfondita richiederebbe molto più spazio di quanto ne ho a disposizione. Mi limiterò dunque a discutere innanzitutto la sua interpretazione della "Battaglia navale", e in secondo

- luogo il rapporto che la sua ricostruzione dell'"Argomento Dominatore" stabilisce tra Diodoro e Aristotele."
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Philosophiegeschichte und logische Analyse, Vol. 2.
Inhalt / Contents: Einleitung 1; Uwe Meixner: Die Zentralität der analytischen Methode für die Philosophie, insbesondere die der Antike 25; Fernando Ferreira: On the Parmenidean misconception 37; Erwin Tegtmeier: Parmenides' problem of becoming and its solution 51; Theodor Ebert: Der fragende Sokrates : Überlegungen zur Interpretation platonischer Dialoge am Beispiel des Menon 67; Katarzyna Paprzycka: Socrates meets Carnap : explication in the Theaetetus 87; Burkhard Hafemann: Indefinite Aussagen und das kontingent Zukünftige 109; Fernando Inciarte: Aristotle and Aquinas 139; Nicholas White: Intrinsically valued parts of happiness: Aristotle, Butler, and Mill 149; Verity Harte, Meilssa Lane: Pyrrhonism and Protagoreanism : catching Sextus out? 157; Christian Schäfer: Proklos' Argument aus De malorum subsistentia 31, 5-21 in der modernen Interpretation 173; Hermann Weidemann: «Aus etwas Möglichem folgt nichts Unmögliches»: zum Verständnis der zweiten Prämisse von Diodors Meisterargument 189; Richard Gaskin, Richard: Tense logic and the Master Argument 203; Michael J. White: The lessons of Prior's Master Argument 225; Nicholas Denyer: The Master Argument of Diodorus Cronus 239-252.
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Chapitre 2: L'argument de Diodore Kronos 7; 2.1 L'argument rapporté par Epictète 8; 2.2 L'argument du pseudo-Diodore (1965) 8; 2.2.1 Exposé de l'argument 8; 2.2.2 Analyse de l'argument 10; 2.3 Retour à l'argument de Diodore (350 av. J.-C.) 14-16.
"L'« argument dominateur » de Diodore est plus souvent qualifié d'« aporie(1) » que de « paradoxe ». Cela peut s'expliquer par le fait que la prétendue contradiction produite par la conjonction des trois énoncés n'est en rien intuitive. En effet, Vuillemin, après d'autres, s'est efforcé de donner une démonstration formelle de la contradiction, démonstration qu'il corrigée par la suite(2). Pour des raisons de simplicité, je ne reprendrai pas ici les arguments que Vuillemin donne en faveur de sa reconstruction formelle qu'il veut à la fois fidèle à l'histoire et à la philosophie de Diodore. Les reconstructions formelles de l'argument qui ont été données n'entrent pas dans le cadre de cet ouvrage et je ne ferai donc que les mentionner à l'attention du lecteur qui souhaiterait approfondir la question.

- Mon intention est de donner une explication rigoureuse mais intuitive de l'argument de Diodore (appelé « argument dominateur ».) La section qui suit est un « détour » qui devrait permettre de rendre plus transparent et plus aisé le sens réel de l'argument, présenté d'une façon plus simple. On reviendra à la présentation axiomatique dans la section suivante." (p. 8)
- (1) On nomme « aporie » (en grec *aporia*, absence de passage, difficulté, embarras) une difficulté à résoudre un problème. Les premiers dialogues de Platon sont dits « aporétiques » parce qu'ils s'achèvent sur une absence de réponse au problème dont il est question dans le dialogue. Ce n'est que par extension de la signification originelle de ce terme que l'on désigne souvent aujourd'hui par « aporie » un problème insoluble et inévitable.
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"This third section responds to a version of Wiggin's article which has been slightly altered. But since the causes of our disagreements have not changed, I did not think it necessary to change my response.
The first of these disagreements concerns the economy of Diodorus' axioms; it results in part from a misunderstanding, my critique not having taken account of my *retractio* (see note 2). The second disagreement concerns the original axiom E, for which Wiggins substitutes the forms E' and E", without having reflected on the

- clauses of external hindrance assumed by the Ancients in the notion of the possible. The third, fundamental disagreement is of a philosophical kind: in order to found the analysis, one of us reverts to the suggestions of natural language, the other of us criticizes them in the name of scientific language."
- (2) For the old, faulty version, see J. Vuillemin, *Nécessité et Contingence* (Les Editions de Minuit, 1984), chapter 2, pp. 27-57. For the new version, see J. Vuillemin, "Zur Rekonstruktion des Meisterschlusses, Antwort an Helmut Angstl." *Allgemeine Zeitschrift für Philosophie*, Frommann Holzboog, 113, 1986.
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 Abstract: "Diodorus' Master Argument was intended to show that whatever is possible either is or will be true. The intended conclusion does not follow from the extant premisses of the Master Argument. The Near Miss argues however, from those premisses alone, that nothing can be more than momentarily an exception to the Master Argument's intended conclusion. Strong arguments support even the most contentious of those premisses ("every past truth is necessary"). We therefore cannot easily ignore the Near Miss. Moreover, there are various supplementary premisses that would turn the Near Miss into an argument with the full force of the Master Argument itself. Each of Diodorus' ancient rivals, since they accepted such doctrines as eternal recurrence, temporal atomism, and the "extended" present, would grant him at least one of these supplementary premisses. So too would any modern who holds that time is not circular, has no beginning, and does not branch."

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