

Time in Stoic Physics¹

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Abstract: In this article we will try to present a picture of what was the Stoic position on time; we will show the background ontology of the Stoics and in particular their idea of continuity. Through the theme of the continuum we will see the Stoic conception of the temporal instant and how they tried to answer Aristotle's aporias on time.

Keywords: Time, Stoics, Aristotle.

1. The physics of the Stoics and the continuum

Physis – nature – for the Stoics is the force or principle that creates and give cohesion to the world; it is a physical principle that determines the appearances of our sensitivity and is endowed with the rationality par excellence, the logos.

The Stoics identify this principle with the *pneuma*, which means ‘spirit’ or ‘breath of life’, and is a compound of air and fire with continuous properties, whose main physical characteristics are the elasticity of the air and the heat of the fire. The *pneuma* has the task of holding matter together, through the elastic properties of air, and of giving shape to it, through the thermal properties of fire; in essence it represents the tool that the Stoics use to differentiate reality.

The diversification, in addition to the presence of different quantities of the two constituent elements, is determined by the motion of the *pneuma* which takes the name of ‘tensional motion’ and is borrowed from the motion of a standing wave; for example, Nemesius affirms that “in the substances there are tensional motions which move simultaneously inwards and outwards. The outward movement gives rise to quantity and quality, while inward movement produces unity and substance” (Sambursky 1953, p. 172).

The *pneuma* has a cosmic value, as it pervades the whole universe, and through its movement it determines the unity of the cosmos and the close link between its parts².

The interaction between the *pneuma* and the substrate allows to determine the stoic categories which are four: the substrate, the qualified, the disposition and the relative disposition. The substrate or substance corresponds to matter and represents the passive principle of the Stoic Physics; it is never isolated but is always permeated by the *pneuma* that characterizes its properties – the qualified. The disposition, on the other hand, is a category that allows us to analyze not the specific and permanent characteristics of an entity, but the various accidental ways of being³; time belongs to this grouping. Finally,

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² An example of the cosmic value of the *pneuma* and the interconnection of the parts of the universe is the discovery of the tides made by Posidonius (Sambursky 1953, p. 174).

³ An example of a disposition is the statement "Cato walks", which shows how Cato's walking is a disposition of Cato.

there is the relative disposition which has the function of classifying the relationships between entities (Long, Sedley 1987, p. 166).⁴

The Stoics also deal with the continuum from a mathematical point of view and to exemplify the importance of their contribution consider how a paradox of Democritus was resolved by Chrysippus (Sambursky 1953, p. 189, Sorabji 1983, p. 341). Democritus considers a cone cut from different planes parallel to the base and wonders if the surfaces obtained from the section are all different or the same (in size); in the first case the cone would become irregular and stepped, while in the second case the cone would be reduced to a cylinder. Chrysippus resolves the aporia by stating that "sometimes one thing is greater than another, without escaping" (Sambursky 1953, p. 190), thus highlighting a definition similar to that of a differential element: when a differential is added to a quantity, the size grows but its increase is infinitely small, so it does not come out. In the case of the cone, the tendency to zero of the distance between the sections leads to the tendency to zero of the differences in their surfaces and a perfectly smooth cone results. The Stoic reflections on the continuum, which lead to the concept of limit, will be useful for understanding their definition of time.

2. Aristotle's theory of time

To understand the Stoic theory of time it is necessary to start from the Aristotelian contribution which identifies time as "number of change [motion] in respect of 'before' and 'after'. There is therefore a link between time and change, but there is no identity between the two concepts; the Stagirite in fact maintains that change is always associated with the particular object that alters its state, while time is always equal to itself and is not associated with anything (Aristotle 1991, Phys. 218b, 18). Furthermore, the change can be 'fast' or 'slow' while time flow smoothly. Although there is no identity, in any case time is an aspect of change.

Aristotle derives some properties of time from change. First, it uses the relation of 'following' to determine the continuity of time: if a thing *a* is followed by a thing *b*, then some properties of *b* can be determined by some properties of *a*, but the passage from one state to the next must occur continuously, since the properties that undergo the change for Aristotle are continuous quantities. In fact, he states:

Since the changing thing changes from something to something and any magnitude is continuous, the change follows the magnitude. For it is because the magnitude is continuous that the change too is continuous, and because the change [is continuous, so is] the time (Aristotle 1991, Phys. 219a, 10-13).

The directionality of time – which he refers to through the "before and after" periphrasis – is a second property that Aristotle derives from change. Also in this case the property is determined by means of the *magnitude*; in fact he affirms:

⁴ An example of a relative disposition is the statement "being seated on my father's right", which shows how being on someone's right is a relative disposition.

The before and after in place is first. There, it is in position. Since the before and after is in magnitude, the before and after must also be in change, by analogy with what is there. But the before and after is in time too in virtue of the fact that the one always follows the other (Aristotle 1991, Phys. 219a, 14-19).

The numerical characteristic of Aristotle's temporal definition arises from the consideration that when we identify a "before and after" relation we are identifying two successive temporal instants (now) and in essence we are using an ordering; time is therefore the order in which the change occurs.

The definition of instant – which we have just talked about – is problematic and leads to some aporias which undermine its reality and which we will see of interest also for the Stoics. One of these aporias is associated with the following definition of time:

In the case of anything that consists of parts, whenever it is, either all or some of its parts must be. But of time, which consists of parts, some have been and others will be, and none is. The now is not a part, for the part measures [the whole], and the whole must be composed of its parts. But time does not seem to be composed of nows (Aristotle 1991, Phys. 217b, 33-218 a 3).

The instant is therefore the equivalent of a point on a line that divides time into two segments – the past and the future – to which the point does not belong: the instant therefore has no temporal dimension and cannot be used to measure time.

Another aporia of the instant consists in establishing whether it, considered as a 'boundary' between past and future, is always the same or differs from time to time. According to Coope (2005) and Waterlow (1984), the instant has both characteristics. If we consider a movement, for Aristotle the instant follows the object in motion as time follows its movement; for example, if we consider the 'extended over time' action of Coriscus who walks from the Lyceum to the Agora, it will have its existence until Coriscus reaches the Agora; the same relationship that exists between Coriscus and his motion exists between the instant and the time taken to perform the action. By deriving the instant from the object in motion, Aristotle has the possibility of asserting that the instant is always the same. Still from the same example it can be obtained that the instant also has a divisive purpose; in fact when Coriscus is in motion from the Lyceum to the Agora, he is first at the Lyceum and then at the Agora, but these two instants are different precisely because the "Coriscus at Lyceum" and "Coriscus at Agora" events – to whom the instants are associated – are different.

Aristotle's reflections on time had an inevitable influence on the thinkers who followed him and the Stoics also had to reflect on Aristotle's contribution.

3. Time as “diastema” of motion

If Aristotle establishes a relationship between number and movement, the Stoics follow another path and try to identify time as an interval/extension of motion. The definitions

they furnish are different, but substantially reduce to those provided by Zeno and Chrysippus that we report below, both given by Stobaeus:

Zeno: Zeno said that time is the diastema of motion and the measure and criterion of fast and slow, in whatever way <each thing> has it. All things which come about and perish come about, and all things which are are, in accordance with time. (Stobaeus 1912, Ec. I.8.40e.2-6)

Chrysippus: Chrysippus <said> that time is the diastema of motion, according to which measure fast and slow are spoken of; or the diastema accompanying the motion of the cosmos, and in accordance with each thing both moves and is (Stobaeus 1912, Ec. I.8.42.25-29)

As can be seen, the two definitions are based on the Greek term *diastema*. Bobzien (2015), analyzing the use of the term in Sextus Empiricus, associates it with three meanings related to the context in which the term occurs. Although the proposal is linked to the interpretation of the skeptical author's passages, it is also useful for understanding the use of *diastema* in the Stoic context.⁵ *Diastema* is used with the meaning of 'interval' of motion whenever it refers to a portion/period of a motion, thus representing the basis of our ability to measure periods of time. If we consider the two definitions of time reported above, Bobzien (2015) associates this interpretation with Chrysippus, especially because it refers to the cyclic motion of the cosmos. The term *diastema* also means extension of motion whenever time refers to a completely general motion in which no periodic or duration aspect is indicated. Bobzien (2015) believes that this meaning is to be attributed to *diastema* when considering the definition of time proposed by Zeno.⁶

If we compare what Bobzien highlighted for the Stoics with what Aristotle presented, we immediately note that time is no longer seen as a "number of the movement", but as an interval/extension of it. The Stoics – whose ontology, as we have seen, is linked to the continuum – arrive at this definition by accepting the criticisms that Strato addresses to Aristotle; the disciple of the Stagirite in fact considers the number not suitable for the definition of time because it is a discrete quantity, while temporality is a continuous property (Sorabji 1983, p. 377, Sambursky 1959, p. 100).

We also observe (Sambursky 1959, p. 101) that the definition of time provided by the Stoics is essentially relative: in fact, time is a comparative measure of fast and slow motions, as we can compare the durations of similar motions along the temporal dimension. Finally, we note how in the Stoic definition of time explicit reference is made to speed (the periphrasis "fast and slow" in each definition of time); Sambursky (1953, p. 186) believes in this definition there is the 'first' recognition of the functional dependence between speed and time which will be one of the fundamental discoveries of the physics of the 17th century.

⁵ Sextus Empiricus offers comments on Stoic philosophy in his works.

⁶ The third meaning of *diastema* is dimension of motion which takes place when the term is used in context where either all motion or motion in general is at issue; it is an abstraction of the second meaning, but it is not used by the Stoics.

4. The problem of the instant

The theme of the instant and the reality of time – which was first tackled by Aristotle – is also examined by the Stoics as the following passage from Stobaeus shows us:

And he [Chrysippus] says most manifestly that no time is wholly present. For since the cutting of continua proceeds to infinity, then, according to this division, in every time too the [cutting] proceeds to infinity. Therefore, no time is said to be present in a narrow sense, but in a broad one. But he says that only the present belongs, whereas the past and the future subsist, but not belong in any way, just as only predicates that express current attributes [of bodies] are predicates that belong, for instance, walking around belongs to me when I walk, but it does not belong when I lie down or sit (Stobaeus 1912, Ecl. 1.106, 13-23).

Chrysippus's reasoning is divided into five steps (Ricardo 2018). (1) Consider a certain time interval and divide it into parts. (2) Pay attention to the portion of time that also includes the 'present', so that the entire interval seems present as a whole. (3) If we consider this interval in more detail we will realize that it will not be totally present, but will in turn be made up of past/future parts. (4) We can consider a smaller time interval assuming that it is totally present, but even this interval will be divisible into past/future parts and so on indefinitely. (5) From the above reasoning, it can be deduced that “No time is wholly present”, in the sense that every time interval – whatever its size – is not totally present, as it contains parts of past and parts of future. In this sense, the present moment cannot be defined precisely, but only vaguely. Unlike Aristotle, who considered the instant as punctual and 'boundary' between past and future, in the case of Chrysippus we are faced with a definition based on a continuous and non-discrete ontology.

If we examine the passage of Stobaeus, we realize that the present is the center of a very small, albeit finite, portion of time, that is, time elements are finite quanta and not points without extension. To use the language of differential calculus, the present becomes a differential of time (Sambursky 1953, p.187) and is the limit towards which a smaller portion of time tends (Sambursky 1959, p. 104). In this case we are faced with an analogy with the definition of body: for the Stoics the surface that identifies a body is interpreted as a double infinite sequence of converging surfaces that inscribe and circumscribe the body. In the case of time, the limit process consists of an infinite approach to the punctual instant, on the one hand coming from the past and on the other moving from the future; in this way the 'present' – as a limiting process – keeps within it both aspects of the past and the future.

If we analyze the second part of the Chrysippus's passage, we must clarify the use of the term 'belong' and 'subsist' with respect to time. Ricardo (2018) develops a Stoic theory of events, in which an event is the exemplification of certain properties of bodies. The important point of Ricardo's proposal is to specify a correct meaning for the terms 'belong' and 'subsist'. In Stoic logic, predicates have the function of expressing the properties of a subject: in the example of Chrysippus the predicate 'walking', when referring to me, expresses the property I have of walking (when I walk). The terms 'belong' and

'subsist' are used to indicate when a predicate is satisfied with reference to a certain instant of time. When I walk in this instant, the property of walking belongs to me; when I am seated in this instant, the property of walking subsists in me, but it does not belong to me.

But what is 'my walking'? It is an extended action that certifies that an 'accidental' property occurs, or in stoic terms, 'walking' is a disposition that belongs to me if I am walking. In general terms, whenever an event occurs consisting in the exemplification of a property by a body, then the predicate that expresses the property 'belong'; otherwise, when the event does not occur and no body exemplifies the property, the predicate 'subsist'. There is a strong link between a predicate of a property of a body and the instant in time when the predicate is said. When a property of an entity occurs at a time that overlaps with the now, e.g. today, time 'belong' and is, therefore, present; otherwise, when the exemplification does not occur at a moment that overlaps the now, e.g. yesterday, time simply subsist – therefore it is past or future. In this sense the present 'belong' while the past and the future 'subsist'.

5. Conclusions

In this article we presented the salient properties of the Stoics concept of time, also highlighting some aspects that link it to the physics of the continuum and to the aporias highlighted by Aristotelian reflection.

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