Theoria

THEORIA

SPECIAL ISSUE ARTICLE OPEN ACCESS

Contemporary Reflections on Substantial Kind Change in Avicenna

Tuomas E. Tahko

Department of Philosophy, Cotham House, Cotham Hill, University of Bristol, Bristol, UK

Correspondence: Tuomas E. Tahko (tuomas.tahko@bristol.ac.uk)

Received: 18 October 2024 | **Accepted:** 11 December 2024

Keywords: Avicenna | essence | essentialism | existence | natural kind essentialism | natural kinds | neo-Aristotelian essentialism | substantial kind change

ABSTRACT

Contemporary metaphysics, and especially neo-Aristotelian metaphysics, tackles many of the same problems as Avicenna did. One of these problems is the possibility of substantial kind change. For instance, is it possible for an animal to change its species? Aristotle and Avicenna both regarded species to be eternal, but their metaphysics might allow for individuals to change their kinds—what is important is that one kind cannot change into another kind. From a contemporary perspective, this may seem odd, given what we know about the evolution of species. Moreover, phenomena like beta decay seem to suggest that a given sample of an element may change into another element, so one might think that contemporary science allows both changing kinds and substantial kind change. Yet, I suggest that the essentialist metaphysics that has developed from Aristotle to neo-Aristotelian metaphysics, via Avicenna, may already possess the necessary tools to accommodate all this.

1 | Introduction

This paper connects several topics discussed in the present volume's Avicenna scholarship. These include essence, modality and existence. Each of these topics and the connections between them is enormously complex in its own right, so I have decided to tie them together by targeting a somewhat more applied question, namely, the problem of *substantial kind change*. This is a classic metaphysical problem, familiar to Aristotle scholars and many contemporary metaphysicians alike, but it continues to cause some puzzlement in both contexts (see, e.g., Lowe 2012, Keinänen and Hakkarainen 2017, and Tahko 2023). Simply put, the problem concerns the question of whether an individual can change the kind that it belongs to *while retaining its individual identity*. However, there are related questions in the vicinity of this specific formulation of the problem, one of these concerning the problem of variation in the identity criteria of the kind itself. Both of these questions may be formulated in terms of the *essence* or *nature* of the individual or kind in question, and both of them also have immediate modal implications, for example, whether it is *necessary* for an individual to belong to the very kind that it belongs to.[1]

We also need to distinguish between *individual* versus *general* essence. Individual essence, in this context, concerns the question of whether it is essential for an individual to be of kind *K*, while general essence is something that each member of a given kind *K* shares (cf. Lowe 2008: 35). Every entity will have a general essence in the sense that it is a member of a given ontological category or kind, but it may or may not be essential to the individual that it is a member of that kind. Accordingly, general essences are not sufficient for individuating the distinct members of a given kind. The general essence of *K* may involve one or more properties that are essential to *K*'s members.

Finally, questions of existence are also intertwined, albeit sometimes implicitly, with the previous questions: does an individual cease to exist if it loses its kind membership, and does a kind cease to exist if it does not have any members? Answering any one of these questions will have implications for our answers to the other questions, so an overall theory is needed.

To this end, I shall begin Section 2 by outlining a contemporary take on *natural kind essentialism*—a view that, if appropriately understood, addresses (most of) the mentioned questions. Once this framework has been outlined, we are in a better position to analyse how Avicenna might be viewed through this particular contemporary lens, although I should hasten to add that the purpose of this paper is not to advance Avicenna scholarship in its own right. Rather, I aim to bring themes from contemporary science and metaphysics into a fruitful dialogue with Avicenna. This is our task in Section 3. We shall see that while some departures from Avicenna may be necessary, there are some clear implications that we can draw regarding certain thorny questions in Avicenna scholarship, as reflected in the contributions to this volume. The background for this analysis is the assumption that, like I believe is also appropriate with Aristotle, we should consider Avicenna as a 'system builder' in his metaphysics, that is, as someone who is attempting to put forward a consistent and complete analysis of the nature of reality. Importantly, the nature of reality should here be considered to include the natural world, that is, the world studied by natural science. If we concede this naturalistic system-building approach, it is not only appropriate but in fact necessary to take into account the scientific context in which we are developing our theories. We can clearly see this effort being reflected in the contributions by McGinnis and Richardson in this volume. Beyond this, I make no claims about Avicenna's original motivations.

2 | Contemporary Natural Kind Essentialism

To see how essence, modality and existence interplay in contemporary accounts of natural kinds, it will be helpful to distinguish three closely related views (as defined in Tahko 2024, cf. also Tahko 2015):

1. It is essential to individual x that it belongs to kind K (*individual essentialism*).
2. Each individual member of a given kind K has a general or natural kind essence, which may consist of one or more properties that are essential to all members of K (*natural kind essentialism*).
3. The kind K (a sui generis entity) has an essence, which may also include the fact that each of its members has certain shared properties (*sui generis kind essentialism*).[2]

We can immediately see that the problem of substantial kind change creates tensions with regard to some, although not all, of these definitions. Consider a simple, radical, example: is it possible for an individual cat to become a dog while retaining its individual essence, that is, remaining the same entity? Note that we are considering this question as it pertains to *metaphysical possibility*, so we can, at least for the moment, set aside the issue of whether it would be *physically* or *biologically possible* for this type of substantial kind change to occur—although we will consider some less radical examples below. In any case, if this type of change of species membership is possible in the relevant sense, then this would clearly violate (1). It cannot be essential to an individual to belong to a given kind if it can survive a change in its kind membership. However, there is a more nuanced answer available: one might think that even if it were possible for an individual cat to undergo a change in kind membership and become a dog, it would *not* be possible for a cat to become, say, a statue or some other kind of inorganic object. According to this line of thought, if such a radical kind change were to occur, the cat would not retain its individual essence. In this way, (1), the view labelled *individual essentialism* may gain some mileage, as it may be understood to restrict substantial kind change only in a limited sense. This limited restriction might concern only the most 'important' or general kind that an individual is a member of, for example, the kind *organism* rather than *cat* in the case of the individual cat. Such an approach will, of course, require an analysis of why it is that, say, membership in the kind *animal* or *organism* would be more important to the individual cat than membership in the kind *cat*, but there are possible strategies to justify this. This insight will have some significance later, beyond the context of individual essentialism.

Consider another potential example, from physics: β^--decay, where weak interaction converts an atomic nucleus into a different atomic nucleus (atomic number increases by one). Keinänen and Hakkarainen (2017) discuss such a case, namely, the possibility of the radioactive ^{14}C atom decaying into ^{14}N. Cases such as this are extremely interesting, but perhaps less likely to convince a sceptic about the possibility of substantial kind change. The reason is simply that it is difficult to see how individual atoms could have any individual essence other than in terms of their physical and chemical properties, which are of course entirely dependent on their membership in a given kind. Moreover, every atom of, say, ^{14}C, seems to be identical in this regard. Accordingly, if there are any individual essences at play here, the most plausible reaction to the above cases is perhaps to say that when a ^{14}C atom decays into ^{14}N, one entity goes out of existence and another entity emerges—there is no individual here that 'survives' a change in kind membership.

Whatever lessons we may draw from these examples, it is clear that even if substantial kind change does violate (1), it does not seem to directly affect (2): individual members of a kind K may or may not change their membership in the kind, but either way that will not have a bearing on the identity—the general essence—of K. So, one can be a *natural kind essentialist* in the sense of (2) regardless of the problem of substantial kind change. There is also a tempting, simple solution available: to deny the existence of individual essences. If only general essences exist, then the question of whether an individual can survive substantial kind change does not arise in the same sense since any essential properties that the individual may have will be determined entirely by its general essence. The general essence is something that each individual of a given substantial kind shares, while substantial kinds themselves may be treated as universals, as I will specify in a moment. The upshot might be either that we accept substantial kind change as a trivial matter, or we take it that any individual that loses its general essence will be destroyed as discussed in the case of radioactive decay. In either case, (1) has become redundant and there is no violation of (2). I should add that I take some form of natural kind essentialism, emphasising general essences only, to be closer in spirit to Aristotle's essentialism than any version of individual essentialism, albeit I will not engage in any direct Aristotle exegesis here.[3] I will, however, suggest that this is also the approach that we should take when interpreting Avicenna through a contemporary lens.

I should also add that interpreting Avicenna's essentialism is by no means an uncontroversial matter, and I certainly do not aim to settle the matter. For instance, Fedor Benevich (2022, especially section 4) has argued that Avicenna does have a notion of individual essence, according to which an individual cannot retain their identity through a change of essential properties but *can* retain their identity through a change of accidental properties. Consider: 'we say that Socrates is a human when we are asked what he is, because we can suppose that all other attributes of Socrates be totally different, yet he would remain the same individual' (Benevich 2022: 424). Now, the key question is this: does Socrates share his essence with all other humans or does he have some essential properties that distinguish him from other humans? This is not immediately clear because the essential properties attributed to individuals tend to be general (rather than, say, something along the lines of Kripkean necessity of origin, which clearly varies from individual to individual). Nevertheless, Benevich's analysis does suggest some key differences between Avicenna's analysis of individual essences and kind essences, where, according to Benevich, the latter is part of Avicenna's *conceptualist essentialism*.[4] I will need to set aside some of these complications and will follow the broader Aristotelian picture in setting out the framework for natural kind essentialism.

Before we move on, we should also briefly address (3) *sui generis essentialism*. If kinds are understood as something over and above their members (say, as *sui generis* universals), then we may also ask what is essential to the kind *K* (the entity, such as a universal) itself, rather than the *individuals* that instantiate the kind. This type of question is related to more general issues surrounding ontological categories (see Keinänen and Tahko 2019, and Hommen 2021 for further discussion). However, if natural kinds are *sui generis* entities, then this could have some implications for our approach to (1) and (2) as well. Specifically, we may ask: what is the relationship between natural kinds—the ontological category—and other categories such as properties? One answer to this question, as developed by E. J. Lowe, suggests that natural kinds or *substantial kind universals* are related to *non-substantial universals* (i.e., properties and relations) via the formal ontological relation of *characterisation* (a simplified version of Lowe's ontological square is pictured in Figure 1). Formal ontological relations describe 'formal structures' among objects and their parts (see Smith and Mulligan 1983).[5] They are internal relations in the sense that they hold necessarily, given the existence of their relata. These formal ontological relations include relations such as dependence, identity and instantiation. In Lowe's four-category ontology, substantial kind universals generically depend on their instances and non-substantial universals generically depend for their existence on their particular instances.[6] We need not dwell on the details of Lowe's particular framework, but the important upshot for the present discussion is the following: if there is a formal ontological relation between substantial kind universals and non-substantial universals, then this relation will need to inform the analysis of issues such as substantial kind change, or indeed any analysis that has a bearing on the relationship between a natural kind and the properties that its members share (see also Tahko 2022).

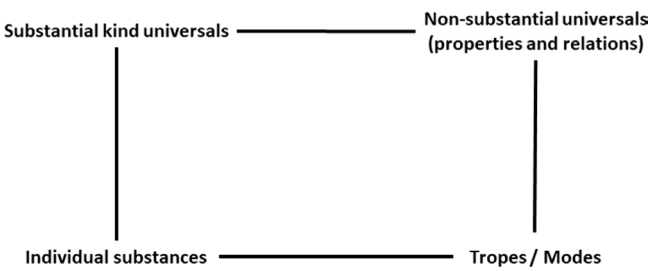

FIGURE 1 | A version of the 'Ontological Square' (Lowe 2006: 22).

This concludes our very brief analysis of contemporary natural-kind essentialism. This analysis clearly has an Aristotelian flavour. An analysis of Avicenna's philosophy is unsurprisingly rather easier from this shared Aristotelian background, but it just so happens that this is my preferred approach to natural kind essentialism in any case. Let us now put these tools to use in the context of Avicenna scholarship.

3 | Avicenna's Natural Kind Essentialism

Let me start this section by addressing an issue that has not come up yet, but which is of some importance both from a contemporary as well as a historical perspective. This concerns the interpretation of *essence* more broadly, namely, what are essences? I favour a view according to which essences are not any kind of additional *entities*; rather, essences capture what it is to be a certain kind of entity (Tahko 2023). One way to put this idea is to say that essences are *ways of being* an entity. Thus, when we try to state or express an entity's essence, we might do so by giving a list or set of the entity's existence and identity conditions, but that expression, list or set is not itself the essence, nor is the essence to be understood as a concept. This is because sets, concepts and so on would be some kind of abstract or linguistic entities in their own right, but we are here merely using these as a way to capture, in language or thought, what the essence of a given entity is. Importantly, this view rules out the potentially tempting idea according to which natural kind essences just are the substantial kind universals and accordingly they would be instantiated in substances. Universals as well are entities, and if essences are not a type of entity, then *they* as well have an essence of their own, as discussed briefly in the previous section. So, instead, we should treat the essence of, say, *horseness*, as nothing but *horseness*; it is not something that exists in concrete horses or in an abstract fashion—it is just what it is to be a horse.[7] It should be noted here that Avicenna distinguishes between three senses of essence: (1) essences considered in conceptualisation; (2) essences in concrete particulars; and (3) essences in themselves. It is the third sense of essence that is relevant here, and perhaps closest to the contemporary essentialist view that I have been operating with.

The question that I would like to raise now is what would, or should, Avicenna say about the problem of substantial kind change, given the assumptions that we have made? While the question may not have arisen for Avicenna or indeed Aristotle in *exactly* the same format as the contemporary version presented above, it is quite clear that the historical precedent for this problem can be found in Avicenna's work as well. One area

of Avicenna's work where some of the contemporary issues are anticipated comes up in his discussion of the mutation of the elements, that is, one of the four elements mutating into another one (cf. Richardson, this volume). Another point of connection can be derived from the discussion of biological species, given their evolution over time—are there individuals that change their species? From a contemporary point of view, this is an area of obvious interest, but it is well known that Aristotle and Avicenna both regarded species to be *eternal* (e.g., Aristotle's *Physics* 3.6, 206a25–27). Aristotle also rejected the coming into existence of new (animal) species. On the face of it, both Aristotle and Avicenna could thus be expected to deny the possibility of kind change in this regard. Jon McGinnis expresses the background to this very clearly:

> A substantial form [...] is that by which a thing is what it is, namely, that which explains why some substance is a member of its species. In other words, substances are not more or less a member of a species; they either wholly and completely belong to a species or they do not. There simply are no degrees of speciesshood for its members. This point is one that Aristotle makes in *Categories* 5, and which all of those working within the Aristotelian commentary tradition accept. (McGinnis, this volume, section 3.1.)

When put like this, there seems to be a tension not only with the problem of substantial kind change understood in the sense that an individual could potentially change its kind but also in the sense that the kind *itself* could change over time. However, this is exactly what appears to happen in post-Darwinian biology. Biological species themselves may be regarded as changing over time, and indeed there must then also be 'borderline' individuals that are members of a species only to a degree, or perhaps members of one or more species at the same time. This point could be put in rather more scientific terms, but it is also reflected in the philosophical literature on natural kinds and related to issues regarding *crosscutting kinds*, that is, kinds that do not follow a neat, nested hierarchy of categories (see, e.g., Khalidi 1998).

Examples of crosscutting kinds are not difficult to find in biology even without going into the details of evolutionary theory. Consider the kind *mammal*. Humans are mammals, and so are *monotremes* such as the platypus. The platypus is also *oviparous*, meaning that it produces offspring by laying eggs, like birds. But birds and humans cannot be classified together either as mammals or as oviparous. A possible reaction to examples such as this one is to deny that crosscutting categories like *mammal* are genuine natural kinds. In fact, there may be very good reasons to do so in many cases—and I would consider the case of mammal to be one of them. Yet, the phenomenon is much too common for this to be a workable strategy, and it extends also to chemistry, which is often considered a source of some of the most reliable examples of genuine natural kinds (see Havstad 2021 for discussion).

The upshot is that any scientifically respectable version of natural kind essentialism will need to be able to accommodate phenomena like crosscutting kinds and hence at least some forms of what looks like substantial kind change. Now, McGinnis (this volume, section 5) in fact makes a bold case in favour of a possible route for Avicenna to accept something like this. The route is via material changes in the individual members of a species, which can be passed on to their offspring, enabling the possibility of evolution. McGinnis suggests that this is possible while retaining the core commitment to immutable essences:

> There is nothing in principle, which I can see, that precludes replacing Ibn Sīnā's active and passive powers passed on by the parents with genetic material contributed and passed on equally by parents. The DNA contains the information necessary for the organism to develop, which happens when DNA sequences are converted into messages that are used to produce the proteins that are the building blocks for the more complex structures of the organism. For the contemporary Avicennan, the DNA sequences would be what prepare and dispose the matter for the reception of the more complex structures, that is, higher-order forms, which are the dispositional forms of mixtures, which in turn are the matter for the essences qua species forms. (McGinnis, this volume, section 5)

While I think that this is a clever suggestion, it will need some further metaphysical analysis to work. In particular, how can we retain immutable general essences for natural kinds in the face of the broader challenge that evolution and other examples that we have considered introduce? I believe that the answer lies in how we should treat Aristotelian immanent universals more generally. To this end, it is worth noting that the underlying issue is much broader than the version of it that we encounter in the case of biological species. In fact, passages that suggest consideration of this issue in other contexts can be found in Avicenna as well. For instance, Jari Kaukua draws our attention to an interesting passage where Avicenna discusses the (im)possibility of other colours becoming white (possible *de dicto*, not *de re*):

> [I]f one supposed, say, that at some moment, there is no colour but white (or any other from among the infinite [colours]), it would then be true in an absolute sense, with respect to the absoluteness of mode, that every colour is white (or some other), whereas prior to [that moment], [the truth of the statement] would have been possible. If associated with the predicate, this possibility is not true, for it is not possible in the proper sense that every colour is white – on the contrary, there are colours here that are necessarily (*bi-l-ḍarūra*) not white. Likewise, if we supposed a moment at which there are no animals but men, it would be true then, according to the absoluteness of mode, that every animal is human, whereas prior to [that moment], [this would have been] possibly [true]. If applied to the predicate, however, the possibility would not have been valid. (Avicenna, *Ishārāt*, ed. J. Forget (Brill, 1892), 4, 40–1, as cited by Kaukua, this volume.)

As I read this passage, I take it that the thought is of course not that a non-white object couldn't become white, but rather that the colour itself, say, black, could not become white. Kaukua's interpretation is similar, emphasising that the essences of the actual colours dictate that it is not possible *de re* that a non-white colour could become white without ceasing to exist. Accordingly, in this case as well, we are trying to determine the limitations that the (general) essences of entities entail. So, we need an overarching analysis of the scope of such limitations.

Kaukua's discussion draws attention to another issue that we need to take into account, namely, the role of future contingency in this analysis. This is of course also related to the question of how a biological species might evolve over time, but Kaukua discusses the much more general problem of interpreting counterfactuals in the context of Avicenna's philosophy. Interestingly, Kaukua's proposal is that the modal content in counterfactual statements such as, say, 'Humans could evolve to become robots' (not Kaukua's example and certainly not Avicenna's!) should be understood as merely epistemic (cf. Kaukua, this volume).[8] The reasoning behind this is that such counterfactuals need to be grounded in the essence of the entities figuring in the relevant scenario. So, in this case, we are interested in the (general) essence of humans. If I understand Kaukua's proposal correctly, the epistemic possibility in question is then just related to the fallibility of our knowledge of essence—either humans will evolve to become robots or they don't and this is determined by the essence of humans, but we may not have complete knowledge of this essence and its implications for the future evolution of humans. More precisely: since we do not have infallible access to the real definition of humanity, we cannot be certain about borderline cases. I take it that one line of reasoning behind this analysis relates to the importance of the immutability of essences in Avicenna's philosophy (as well as his commitment to the PSR), and the apparent tension that this raises for our analysis of counterfactuals. Now, what makes all this even more interesting is that Kaukua's analysis of Avicenna actually fits quite well with a line of reasoning that we can find in contemporary essentialist accounts as well.

Let me now return to the hinted solution concerning Aristotelian immanent universals that I would like to propose, where the key point to consider is that if we regard natural kinds to be substantial universals, then these kinds don't exist without instances. A related example of a problem considered in contemporary essentialist philosophy which has received some attention is the analysis of cases such as yet to be synthesised transuranic elements. What should we say about the essences of non-naturally occurring transuranic elements, such as element 99, *Einsteinium*, prior to their synthesis? One might suggest that the relevant substantial kind universal came into existence when we first synthesised the element and then went out of existence when it decayed, but my preferred response is instead that such universals should not be considered to exist 'in' time, even though their instances do (see Tahko 2023, cf. also Kistler 2004 and Lowe 2004). However, this is not meant to suggest a commitment to any kind of Platonism. Rather, as long as a kind has instances at some point in the past or in the future, it may be regarded to exist. On this line of thought, we should conceive natural kinds, including biological species, as four-dimensional. But in that case, all biological species have (presumably) the same history! So, when viewing the evolutionary tree as a whole, there is no clear demarcation between one species and the other. Of course, we can still use any of the usual criteria (say, the phylogenetic species concept) to draw distinctions between species, but ultimately all species have the same origin, the same common ancestor—assuming that all life on Earth indeed has the same origin.

We could develop this line of thought even further and suggest that, at least in a manner of speaking, there is just one species of biological organism, with different temporal parts. This organism may be considered to 'evolve' over time from our limited perspective, but if considered four-dimensionally, there is no change in the kind itself. Earlier, in the second section of the paper where I introduced natural kind essentialism, I noted that we might wonder why, say, membership in the kind *animal* or *organism* would be more important to an individual cat than membership in the kind *cat*. Now we have a possible answer: the kind cat would, in this analysis, be merely a small 'slice' of the four-dimensional kind *organism*. So, it could even be considered as the narrowest kind that the individual cat is a member of. This is a metaphysical option that may be most promising in the face of phenomena like natural selection and radioactive decay. Of course, all these metaphysical details are debatable, and it is also possible to make distinctions among four-dimensional objects that share some of their temporal parts, so the evolutionary tree could be sliced up in various ways if one so wishes. But the more general upshot—and all that we need for our purposes here—is that there is no real issue in reconciling the contemporary scientific evidence with the idea of substantial kind change if kinds are conceived of four-dimensionally: any change over time is already built-in to the general essence of the kind.

This very brief and admittedly controversial account leaves many questions unanswered, but the key among them in the present context is, of course, whether this type of four-dimensionalism is, in fact, compatible with Avicenna's philosophy, and if not, would it be a greater departure from his views than accepting substantial kind change?[9] More generally, is adopting four-dimensionalism of this type a price worth paying for the ability to address the problem of substantial kind change? The latter question is of course something that we can also ask in the context of contemporary natural kind essentialism—and in that case, I think that the answer is positive. In the case of Avicenna, I will invite those who know his work best to assess the proposed strategy, but it does appear to me that the commitment to immutable essences must be at the very core of Avicenna's philosophy. So, if there is a way to retain that commitment in the face of the scientific facts, then we are hopefully on the right track. If I have done justice to McGinnis's and Kaukua's ideas, then I believe that the proposed analysis also bolsters some of their proposals.

Endnotes

[1] Perhaps it is worth noting that the notion of *essence* that we operate with is of course broadly Aristotelian in the sense that it should be

considered prior to modality. In other words, all essentialist truths about *x* are necessary truths about *x*, but not all necessary truths about *x* need be essentialist truths *about x*, even though all necessary truths are true in virtue of the essence of some entity or other. See Fine (1994) for the classic account.

[2] This third view is distinct from natural kind essentialism in the sense that it concerns the nature of the kind itself as an entity—if the kind is a further entity. Compare: we might ask what entities having a certain property are like on the one hand, and we may ask what the entity *property* is like on the other hand. The latter question might be answered by saying that property is a type of universal, instantiated in substances, and so on. Similar questions could be asked about the entity *natural kind*. Thanks to Jari Kaukua for raising this issue.

[3] See Cohen (1978) for a helpful discussion of Aristotle on individuals and essences.

[4] As Benevich (2022: 417) defines it: 'According to Avicennian conceptualist essentialism, we know whether an attribute belongs to an essence in virtue of itself, by limiting our inquiry to the concept that corresponds to that essence'. Benevich specifies the view further: '"Existence" signifies here actuality, how things actually are. Conversely, "essence" stands for how things could or must have been. Conceptualist essentialism helps us distinguish between the attributes of essence and the attributes of existence.' (Ibid.).

[5] For a much more detailed discussion of formal ontology, see Hakkarainen and Keinänen (2023).

[6] See Tahko and Lowe (2020) for further details on ontological dependence relations such as generic dependence.

[7] McGinnis (this volume) quotes a relevant passage from *Ilāhīyāt*, 5.1 [4] on *horseness* which could be read as bolstering this very point, although I won't reproduce it here.

[8] This is of course assuming that we are dealing with a genuine counterfactual to begin with, i.e., that the real definition of humans includes us being animals.

[9] Interestingly, Jari Kaukua has pointed out to me that, in posthumous work, Avicenna suggests that God knows the universe atemporally. While this does not directly address the question of substantial kind change, it certainly suggests that the four-dimensional perspective was not entirely alien to Avicenna.

References

Benevich, F. 2022. "Avicennian Essentialism." *British Journal for the History of Philosophy* 30: 244–279.

Cohen, S. M. 1978. "Individual and Essence in Aristotle's Metaphysics." In *Paideia: Special Aristotle Issue*, edited by G. C. Simmons, 75–85. State University College at Buffalo.

Fine, K. 1994. "Essence and Modality." *Philosophical Perspectives* 8: 1–16.

Hakkarainen, J., and M. Keinänen. 2023. *Formal Ontology*. Cambridge Elements in Metaphysics. Cambridge University Press.

Havstad, J. C. 2021. "Complexity Begets Crosscutting, Dooms Hierarchy (Another Paper on Natural Kinds)." *Synthese* 198: 7665–7696.

Hommen, D. 2021. "Kinds as Universals: A Neo-Aristotelian Approach." *Erkenntnis* 86: 295–323.

Keinänen, M., and J. Hakkarainen. 2017. "Kind Instantiation and Kind Change - A Problem for Four-Category Ontology." *Studia Neoaristotelica* 14, no. 2: 139–165.

Keinänen, M., and T. E. Tahko. 2019. "Bundle Theory With Kinds." *Philosophical Quarterly* 69, no. 277: 838–857.

Khalidi, M. A. 1998. "Natural Kinds and Crosscutting Categories." *Journal of Philosophy* 95, no. 1: 33–50.

Kistler, M. 2004. "Some Problems for Lowe's Four-Category Ontology." *Analysis* 64, no. 2: 146–151.

Lowe, E. J. 2004. "The Four-Category Ontology: Reply to Kistler." *Analysis* 64, no. 2: 152–157.

Lowe, E. J. 2006. *The Four-Category Ontology: A Metaphysical Foundation for Natural Science*. Clarendon Press.

Lowe, E. J. 2008. "Two Notions of Being: Entity and Essence." *Royal Institute of Philosophy Supplement* 62: 23–48.

Lowe, E. J. 2012. *Contemporary Aristotelian Metaphysics*, edited by T. E. Tahko, 229–248. Cambridge University Press.

Smith, B., and K. Mulligan. 1983. "Framework for Formal Ontology." *Topoi* 1: 73–85.

Tahko, T. E. 2015. "Natural Kind Essentialism Revisited." *Mind* 124: 795–822.

Tahko, T. E. 2022. "Natural Kinds, Mind-Independence, and Unification Principles." *Synthese* 200, no. 2: 1–23.

Tahko, T. E. 2023. "Possibility Precedes Actuality." *Erkenntnis* 88, no. 8: 3583–3603.

Tahko, T. E. 2024. "Natural Kind Essentialism." In *The Routledge Handbook of Essence in Philosophy*, edited by K. Koslicki and M. J. Raven, 156–168. Routledge.

Tahko, T. E., and E. J. Lowe. 2020. "Ontological Dependence." In *The Stanford Encyclopedia of Philosophy (Fall 2020 Edition)*, edited by E. N. Zalta. Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/archives/fall2020/entries/dependence-ontological/.