Cord Friebe

Kant's Rejection of Leibniz's Principle and the Individuality of Quantum Objects

Abstract: Kant rejects Leibniz's Principle of the Identity of Indiscernibles (PII). In quantum mechanics, Leibniz's principle is also apparently violated. However, both ways of rejecting the PII differ significantly. In particular, Kant denies that spatiotemporal objects are *unique* individuals and establishes appearances as *merely singular* ones. The distinction between 'unique' and 'singular' individuals is crucial for the role that intuition plays in cognition: it will be shown that Kant's way of rejecting the PII goes against the standard versions of conceptualism and non-conceptualism which, in turn, points out the relevance of this issue for the understanding of transcendental idealism. Finally, the systematic relevance will be checked by defending a Kantian interpretation of quantum individuality.

1 Introduction

Kant rejects Leibniz's Principle of the Identity of Indiscernibles (PII). According to Leibniz, spatiotemporal objects are *unique* individuals: every thing, such as a drop of water, is qualitatively distinguishable from every other so that, in principle, there cannot be more than one such thing. According to Kant, spatiotemporal objects are *merely singular* individuals: such-and-such water drops, e. g., are "appearances" and so can be presented to us, in intuition, several times. Correspondingly, maximal comprehensive empirical concepts such as "such-and-such water drop" are *complete*, according to Leibniz. They are individual concepts that refer to one single, unique object. For Kant, even the most comprehensive empirical concepts, in application to intuition, are *general*. They refer to one, or more than one, singular object.

This distinction between unique and singular individuals is crucial for the understanding of Kant's transcendental idealism. For, it shows that, for Kant, distinguishing (conceptually) and individuating (via intuition) are two significantly distinctive aspects of cognition. This goes against (the standard version of) *conceptualism*.[1] On the other hand, intuitions that are not determined by con-

1 Standard conceptualism (defended by McDowell, and others) denies that intuition plays a significantly distinctive role in cognition. Standard non-conceptualism (defended by Hanna, and

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cepts would present unique individuals; a merely singular object can only be presented if, counterfactually, there can be a second exemplar *of the same concept*. This goes against (the standard version of) *non-conceptualism* according to which cognition is a more developed capacity based on elementary, non-conceptual perception. So, Kant's way of rejecting the PII challenges the two extreme views and asks for further qualification.

Quantum mechanics (QM) also rejects the PII, at least according to the so-called Received View. However, the way in which QM (allegedly) violates the PII differs significantly from Kant's and leads to other, non-Kantian ontologies of quantum objects: or they are still unique individuals distinguishable by non-qualitative, *haecceistic* properties, or they are not individuals at all (see French and Krause 2006). As it seems, Kant's view of spatiotemporal objects (appearances) as being merely singular, as opposed to unique, individuals has been overlooked by philosophers of science.[2] I will check the prospects of a Kantian interpretation of quantum individuality.

The paper is structured as follows. The first Section provides a close-to-text interpretation of Kant's peculiar view. Then, the second Section explicates the relevance of Kant's rejection of the PII for the understanding of transcendental idealism, focussing on the debate about conceptualism vs. non-conceptualism. Finally, the third Section applies the foregoing results to the current debate in the philosophy of QM.

2 Kant's Rejection of the PII

Leibniz argues that numerically distinct, spatiotemporal objects such as two drops of water always differ in intrinsic, qualitative properties. Such objects are intrinsically and qualitatively distinguishable, e. g., the first is red, the second green. Accordingly, there apparently are two ways of opposing to Leibniz: (i) numerically distinct objects may be distinguishable only extrinsically, e. g. by relationally spatiotemporal characteristics such as 'being x meters apart from each other', and (ii) they may be distinguishable non-qualitatively, by so-called haecceities such as 'being identical with the object called *a*'.

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others) holds that intuition is even so distinctive that it can present objects without being determined by concepts, namely in perception. A recent summary of this debate can be found in Allais (2015, ch. 7).

2 Hermann Weyl calls a unique individual "Sonderwesen" (2000, 21), but a merely singular individual "Einzelding" (2000, 16). Unfortunately, Muller and Saunders (2008, 501) suggest as if Weyl is talking about individuals always in the same sense (namely, just in the first).

In the indicated ways, one does not really reject the PII. Rather, in both ways one merely modifies the principle by pointing to some other ways of distinguishing numerically distinct objects, namely extrinsically or non-qualitatively. Consequently, in the contemporary analytic metaphysics and in the philosophy of science, these ways are considered to be strategies of *saving* the PII.[3] By contrast, I will argue that Kant rejects the PII completely: considered as appearances, the two water drops are numerically distinct 'although' *utterly* indistinguishable. For Kant, space is a principle of individuation *sui generis*, not a Leibnizian principle in disguise. In particular, Kant does not opt for spatial *distinguishability*, as it could be done, say, on a Newtonian account of space. It is crucial that spatiotemporal objects are considered to be appearances and that things can be presented to us in intuition. Kant's understanding of spatiotemporality matters for his way of rejecting the PII, which is not the case in the two ways mentioned above.

Here is, in its entirety, Kant's relevant text on the identity and the difference of spatiotemporal objects:

> If an object is presented to us several times, but always with the same inner determinations (*qualitas et quantitas*), then it is always exactly the same if it counts as an object of pure understanding, not many but only one thing (*numerica identitas*); but if it is appearance, then the issue is not the comparison of concepts, but rather, however identical everything may be with regard to that, the difference of the places of these appearances at the same time is still an adequate ground for the **numerical difference** of the object (of the senses) itself. Thus, in the case of two drops of water one can completely abstract from all inner difference (of quality and quantity), and it is enough that they be intuited in different places at the same time in order for them to be held to be numerically different. Leibniz took the appearances for things in themselves, thus for *intelligibilia*, i. e., objects of the pure understanding (although on account of the confusion of their representations he labelled them with the name of phenomena), and there his principle of **non-discernibility** (*principium identitatis indiscernibilium*) could surely not be disputed, but since they are objects of sensibility, and the understanding with regard to them is not of pure but of empirical use, multiplicity and numerical difference are already given by space itself as the condition of outer appearances. For a part of space, even though it might be completely similar and equal to another, is nevertheless outside of it, and is on that account a different part from that which is added to it in order to constitute a larger space; and this must therefore hold of everything that exists simultaneously in the various positions in space, no matter how similar and equal they might otherwise be. (*CPR* A 263/B 319 ff.)

3 See, e. g., Black (1952): disputant A, the defender of the PII, applies the strategy of weakening the historical version.

Firstly, it should be stressed that Kant is not concerned with the merely epistemological problem of cognizing/perceiving the numerical distinctness of things: the difference of place is an adequate ground not only for the recognisability of the numerical difference of the object but for its ontological, numerical distinctness itself. Further, spatial difference does not merely *coincide* with numerical distinctness, neither contingently nor necessarily, but is the *ground* for it. Kant holds that spatiotemporal objects are numerically distinct in virtue of their difference in places.

This being said, the thesis, at first glance, seems to be that inner difference is not needed but spatial difference is sufficient. It seems as if Kant in fact weakens Leibniz's principle by including spatial locations/relations into the scope of the potentially distinguishing properties. However, Kant never explicitly says that the difference of the places *distinguishes* the drops of water; he only points out that spatial difference grounds their numerical distinctness. Kant apparently does not introduce spatial difference as a criterion of distinguishability but as a *principium individuationis*.

Kant stresses that numerically different parts of space are "completely similar and equal to another". So, even if spatial locations are considered to be properties (which is *not* obviously the case), they are completely similar properties, not able to distinguish their objects. Different places, at best, are like different property *exemplifications* which likewise do not distinguish their objects. Consider two equally red things with two numerically different exemplifications of (Platonic) Redness: they would be indistinguishable with respect to colour, as the two water drops would be with regard to spatial 'properties'.

Be this as it may, the main point is that it makes dialectically no sense to assume that spatial difference is considered to be distinguishing. For, dialectically, it is crucial to consider the drops of water, on the one hand, as "objects of pure understanding" and, on the other hand, as "appearances". Considered as objects of pure understanding, they would be one and the same thing; considered as appearances, they would be many (two). However, with the assumption that they are distinguishable by spatial properties, these two ways of considering the spatiotemporal objects implies that Kant would fairly misrepresent his opponents. Both the historical Leibniz as well as defenders of a relational PII would hold rather absurd views.

Leibniz, in Kant's view, must then somehow ignore the qualitative (spatial) difference of the concrete, empirical objects. Thus, it seems as if Leibniz (in Kant's view) takes the water drops as being non-spatial, i. e. as being located outside space (and time). In contrast, an interpretation is needed according to which taking them as "objects of pure understanding" does not dislocate them. The adequate way for Kant interpreting Leibniz is, rather, to say that the

difference of the places is *irrelevant* or *impotent* for the numerical distinctness of the spatiotemporal objects. However, this difference cannot be irrelevant or impotent (for Leibniz) if it were distinguishing.

In the other direction, Kant would believe that one can distinguish spatiotemporal objects by spatial locations/relations *only if* one considers them as appearances. Again, it sounds absurd that Kant wants to say that only a transcendental idealist is able to defend the view that spatial distinguishability grounds the numerical distinctness of things. There are many non-Kantians defending a relational PII. Why should it matter, in order to be spatially distinguishable, that the drops of water can be *intuited* in different places at the same time, i. e. that they must be considered as appearances? An interpretation is needed that explicates how the role of intuition contrasts Kant from other self-declared opponents of the historical Leibniz. I suggest that Kant's focus is not on kinds or grades of distinguishability but that spatial distinctness is numerical distinctness sui generis.

The adequate contrast is between (spatiotemporal) objects considered as unique individuals and as merely singular individuals. Taking a drop of water as an object of pure understanding neither means to take it as something located outside space and time nor as something that is unknowable for us (which would be the case if the "object of pure understanding" were the thing as it is in itself, in Kant's own sense). It, rather, means to take each single drop of water as a unique individual which excludes, in principle, a second such one. Taking it, instead, as an appearance does not mean to distinguish it otherwise but to ground its mere singularity. It is presentable more than once, because space is an a priori condition of it.

For clarity, consider firstly the standard-Aristotelian account of properties as immanent universals. *Immanent* universals – as opposed to Platonic ideas – are concrete entities, i. e. they exist in space and time. Assume that they can be presented to us. Occasionally, a given universal such as Redness exists simultaneously in various positions of space. One and the same 'thing' – the unique universal Redness – would be *multilocated* in space. Consequently, multilocation is a way in which an entity could be presented to us several times. It is *the* way in which a unique entity could be presented to us several times; it excludes, in principle, a second, numerically distinct exemplar. Undoubtedly, Kant rejects the idea of properties being immanent universals since he concludes from the numerical distinctness of different parts of space that "this must therefore hold of *everything* that exists simultaneously in the various positions in space". Nonetheless, it is reasonable to assume that Kant is aware of this philosophical possibility, and from this one gets the idea of what it could mean to take something

spatiotemporal as an object of pure understanding: namely, treating it *universal-like*.

Granted, a drop of water is not a universal but a particular/individual. However, there is a way to reduce the particular to universals, namely *Russell's Bundle Theory* of objects. According to Russell, a spatiotemporal object such as the drop of water is nothing other than a bundle of (immanent) universals. Considered in this way, the numerical distinctness of things is grounded in intrinsic, qualitative distinguishability; some element in the bundle must be different in order to get numerically distinct objects. With Russell's ontology, the historical PII is satisfied. Applied to the completely similar water drops, Russell would either say that there is only a single drop which is x meters apart from *itself* (see O'Leary-Hawthorne 1995), or that there is a such-and-such object discontinuously scattered in space. This strategy to save the PII in light of some counter-example has been called "identity-defence" (see Hawley 2011).

I suggest that, in Kant's view, Leibniz's way of taking the water drop(s) as object(s) of pure understanding is to consider it (them) as Russellian bundle(s) of universals. In this way, they surely are *spatiotemporal* objects – neither something outside space and time nor something considered apart from space and time – so that, in a reasonable way, (Russell-)Leibniz could philosophically misrepresent them. What makes 'them' objects of pure understanding (according to Kant) is that on the ontological ground-floor there only are universals, i. e. the *de facto* location in space doesn't matter ontologically. In particular, difference of place is no adequate ground for their numerical distinctness, it is rather irrelevant. According to transcendental idealism, by contrast, space and time *are*, by being transcendentally ideal, on the ontological ground-floor; they are a priori conditions of cognition and so of the objects of (our) experience. Consequently, spatial differences play a crucial role for the numerical distinctness (individuality) of such objects.

To confirm this reading, look at Kant's claim that if the drops of water are appearances, "then the issue is not the comparison of concepts, but rather, however identical everything may be with regard to that, the difference of the places of these appearances". This, in turn, implies that if they were objects of pure understanding, the issue would in fact be the comparison of concepts, namely of *empirical* concepts: "such-and-such water-drop" is the concept in question. This would obviously make no sense if with "objects of pure understanding" Kant had in mind his own things in themselves; they cannot be cognized. Also, this likely makes little sense if Kant has objects outside of space and time in mind; empirical concepts are those of concrete objects. Regarding Russellian bundles of universals, however, the issue *is* the comparison of empirical concepts: with each bundle is associated its adequate *descriptivist* proper

name. Therefore, I further suggest that concepts for which their comparison matters for the purpose of individuality must be *individual concepts*. They refer to unique individuals. Again, the issue is not allegedly different grades of distinguishability but the contrast between unique and singular: regarding objects of pure understanding, the comparison of individual concepts matters, whereas regarding appearances the comparison of concepts doesn't matter, because *they* are general. General concepts do not refer to unique individuals but to merely singular ones: that their concepts are general means that, in principle, there can be more than one such individual.

So, the first package, which Kant rejects, is *PII–Russell-bundles–individual-concepts*. The second package, which Kant affirms, includes the (complete) rejection of the PII and general concepts. However, concerning Kant's positive solution an objection immediately arises. In the *Critique*, Kant apparently favors the *substratum* ontology of objects. This apparently leads to the (rival) interpretation according to which spatiotemporal objects are numerically distinct not in virtue of difference in spatial location but because of their underlying substrata. These substrata, so the objection goes, most likely have to be considered as *bare particulars* (see, e. g., Armstrong 1978). Or these bare particulars are numerically distinct in virtue of distinguishing haecceistic properties, or their numerical distinctness is given *primitively:* in both cases, the numerical distinctness of the two water drops cannot be reduced to their difference in places but ultimately is irreducible, metaphysical identity. The role of intuition must, correspondingly, be rather epistemic than ontological: via intuition one can, e. g., grasp the haecceities of spatiotemporal objects (see Saunders 2013, 357). Further, this fits with the view according to which the empirical reality is essentially incomplete (ontologically deficient) and must be completed by grounding intrinsic natures (see, e. g., Allais 2015, ch. 10). Also in this case, the numerical distinctness is grounded in some intrinsic nature and so not in spatial difference. Spatial difference is, accordingly, merely the way in which the numerical distinctness of things can be presented to us, i. e. the way in which metaphysical identity appears.

According to this rival interpretation, Kant merely applies to spatiotemporal objects the *principle of impenetrability* which should not be confounded with the principle of individuation. Spatial difference merely coincides – even if necessarily so – with the numerical distinctness of things but is not the ground for it. However, there is no textual evidence for this reading: by contrast, Kant clearly says that, because parts of space are numerically different, "this must *therefore* hold of everything that exists simultaneously in the various positions in space". Difference of place is an adequate ground "for the **numerical difference** of the object (of the senses) itself" – and not (only) an epistemic ground for cognizing it. The only sentence which apparently sounds epistemic in fact turns out to ex-

press the rejection of bare particularity: "it is enough that they be *intuited* in different places at the same time in order for them to be held to be numerically different". Here, Kant holds that it is not enough that the two drops of water *are* in different places at the same time: for, *this* may also hold regarding bare particulars. It is crucial, rather, that they (can) be intuited therein, i.e. that they are *appearances* (in the transcendental sense): for, then, they are not individuated ontologically prior to the possibility of being intuited. Space and time, by being pure intuitions, are ontologically prior to every objective reality; they ground the numerical distinctness of objects – and so not the bare particulars.

By contrast, a Newtonian space, being already an objective reality, cannot exclude that there are also bare particulars on the ontological ground-floor, i.e. that the numerical distinctness is metaphysical identity. Only the transcendental idealist view can exclude metaphysical identity: by being appearances, spatiotemporal objects depend on transcendentally ideal space. Then, it's really space that grounds their numerical distinctness. Finally, for this purpose, to exclude metaphysical identity, spatial *distinguishability* is not required. Therefore, distinguishability is not required at all for the numerical distinctness of things.

3 Relevance for Kant's Transcendental Idealism

The role that intuition plays in cognition is crucial for the understanding of Kant's transcendental idealism. As shown, Kant's way of rejecting the PII is based on a peculiar understanding of intuition. This section is devoted to the relevance of the PII-rejection for transcendental idealism. I will focus on the debate between *conceptualists* and *non-conceptualists*.[4] In short, conceptualists argue that intuition does not play a significantly distinctive role, whereas non-conceptualists hold that intuition is autonomous, at least in perception which underlies cognition. Both standard-views are false, in my view: the significantly distinctive role of intuition is *individuation*, but an autonomous intuition (i.e. without concepts) would present unique individuals. Spatiotemporal objects,

4 Responding to one Reviewer's objection, it should be stressed that the paper is concerned with (the lessons of) Kant's argument against Leibniz's PII, i.e. with defending transcendental idealism against a rival view. The slogan that thoughts are empty without intuition, while intuitions without concepts are blind (see *CPR* A 51/B 75), by contrast, is for internal use (among Kantians) and so out of place here. Still, I agree that without intuitions *general* concepts would lack objective reality, i.e. reference to one (or, more than one) merely singular object, while in abstraction from such concepts nothing would be distinguishable.

as argued, are merely singular individuals which, thus, can only be cognized by distinguishing concepts applied to individuating intuitions.

With the foregoing results in mind, it turns out that both (standard-)conceptualists and their extreme opponents misrepresent the singularity of intuition. Correspondingly, they likewise misrepresent the generality of (empirical) concepts. As I see it, they both believe that, for Kant, intuitions in principle, i.e. in abstraction from concepts, are singular. Likewise, again for Kant, (empirical) concepts in principle, i.e. in abstraction from intuition, are general. By contrast, the rejection of the PII shows that, for Kant, an empirical concept in abstraction from intuition would be an individual concept. The reasoning is that one needs intuition in order to explain the generality of concepts; empirical concepts are general in virtue of their application to intuitions. Correspondingly, one needs concepts in order to explain the singularity of intuitions. Intuitions are singular in virtue of their determination by concepts, otherwise they would be unique.

Pars pro toto, Lucy Allais (a non-conceptualist) gives the following characterization of intuitions as singular:

> The idea that intuitions are singular means that there is a particular thing the intuition presents; *pace* the representationalist, this would not be guaranteed by images or mental intermediaries, which could represent more than one (qualitatively identical) thing. (Allais 2015, 154)

Here, the contrast of "singular" is "more than one", i.e. many or plural. Intuition, however, presents or grounds *numerical distinctness* which implies both: the singularity of each single water drop as well as the multiplicity of two (or, more) water drops. Numerical distinctness (i.e. individuality) is, by Kant, opposed to uniqueness which, indeed, would rightly be contrasted to "more than one".

Allais proceeds as follows:

> The generality of concepts (for Kant) means that concepts always apply, in principle, to more than one object; this entails that concepts do not uniquely pick out their objects – descriptive criteria do not uniquely individuate. This contrast loses its point if intuitions are not presenting us with individuals. (Allais 2015, 157)

This sounds as if non-descriptive criteria "uniquely individuate", namely via intuition. It seems as if, in accordance with Leibniz, descriptive criteria (uniquely) individuate, whereas, according to Kant, non-descriptive criteria do the same job. However, this can only be true if intuition grasps haecceities – i.e. non-qualitative properties uniquely possessed by bare particulars –, which is not Kant's view. For, to repeat, in this case the individuality of each drop of water would

be metaphysical identity, i. e. it would precisely not be grounded in spatial differences. Consequently, intuition does not do a Leibnizian job but works in a distinctively different way. In Leibniz's sense, there is *never* individuation in Kant's view. So, the right contrast, which loses its point without intuition, is rather the contrast between numerical distinctness (singularity; multiplicity) and uniqueness.

Regarding the generality of concepts, Allais, *pars pro toto*, expresses the idea that, for Kant, empirical concepts *always* (in the sense of: in principle) apply to more than one object which entails that such concepts do not uniquely pick out their objects. Kant says the contrary: in principle, (say) if Leibniz were right, empirical concepts could uniquely pick out their objects. Considered as a logical possibility (i. e. in principle), empirical concepts might be individual concepts; logically (i. e. in principle), spatiotemporal objects such as a drop of water might be a unique Leibniz/Russell-individual. However, according to transcendental idealism, this is actually (for philosophical reasons) not the case and so empirical concepts are actually general, namely in application to intuition. Transcendental idealism says that, *in application to intuition*, empirical concepts are general. In abstraction *from* intuition, empirical concepts would be individual ones that would refer to unique Leibniz-individuals. Again, the contrast is not 'more than one' vs. 'exactly one' but rather: 'a singular one' vs. 'a unique one'.

Conceptualists, in contrast, deny that intuition plays a significantly distinctive role in cognition. Firstly, they may believe that spatial differences *distinguish*, e. g. the two drops of water. Then, intuition works conceptually. However, Kant presents space as a principle of individuation *sui generis* so that the cognizing subject distinguishes objects *only* by concepts.[5] Rejecting the PII means, for Kant, that *distinguishing* and *individuating* are distinctively different activities. Objects can be distinguished only with concept(s); objects can be individuated only with intuition. Only with intuition, Kant believes, individuation has nothing

5 One may object that regarding incongruent counterparts the cognizing subject distinguishes by intuition. I would respond that concerning incongruent counterparts Kant argues *ontologically* that their distinguishability is grounded in intrinsic, rather than relational, properties (shapes). *Epistemologically*, Kant argues that their (inner) difference can only be cognized in comparison, rather than in isolation. All this can be said without denying that one distinguishes only conceptually.

to do with distinguishability.[6] This, in turn, suggests that intuition must play a characteristically different role than concepts.

Secondly, the conceptualists may believe that the role of intuition is merely causal.[7] The reasoning goes as follows: since (empirical) concepts are general, one needs a causal contact with the single particular. General concepts are (generally) connected with more than one object; in order to be able to refer to one single particular, e. g. the particular water drop in front of us, one needs some additional feature which Kant calls "intuition". In this way, cognition is essentially conceptual. However, intuition does not (merely) play this causal role. The problem to be solved is not (only) to pick out one of many individuals that are represented by general concepts. Rather, the foregoing problem is to explain how general concepts can represent individuals at all. For, these individuals must be merely singular, since unique individuals can only be represented by individual concepts. So, the individuating role of intuition must already be in play.

In my view, one cannot explain the generality of (empirical) concepts before or independently of the reference to one single object. Take the concept "such-and-such water drop": it would be an individual concept and would refer to a unique Leibniz/Russell-individual if considered in abstraction from intuition. (No causal contact is required, since unique reference is guaranteed.) Only in application to intuition, can this concept be a general one. Now, take a single drop of water presented by intuition. (The causal contact, if there is any, has to be presupposed.) What makes the concept general is the individuating power of intuition: *counterfactually*, there might be a second, qualitatively indistinguishable drop of water which would be determined by the *same* concept. This is so, Kant argues, because intuition a priori carries space which, under that concept, allows for a second exemplar. This is quite a different story from what the conceptualist has in mind: there is no general concept already connected with many individuals just before intuition enters in order to provide the causal contact to one of them. Rather, the concept *becomes* general when applied to intuition. Therefore, intuition plays a significantly distinctive role in cognition.

At this point, it seems as if the non-conceptualists were right: for Kant, there must be basic perception involving intuition alone. Conceptual cognition allegedly is a more developed capacity that presupposes elementary, non-conceptual

6 This holds both in its ontological and epistemological sense: the numerical distinctness of objects is ontologically grounded in intuition, and one can grasp the numerical distinctness of things only via intuition.

7 In this way, Allais (2015, ch. 7) characterizes conceptualism. She argues at length – in a different way, of course – why intuition does not (only) play the causal role.

perception. However, (standard) non-conceptualism doesn't fit with Kant's rejection of the PII either. Consider an intuition that presents a single water drop *in abstraction from concepts:* it would be a unique individual. This water drop can only be merely singular if, counterfactually, there can be a second, qualitatively indistinguishable exemplar. And this can only be the case if intuition is conceptually determined; otherwise there would be no way to establish the qualitative indistinguishability of both water drops. The second one must be a second exemplar *of the same concept*. Space (carried by intuition) is, for Kant, an adequate ground for the numerical distinctness of things *only when* conceptually determined; otherwise Kant would need a further argument to rule out the possibility of Russellian bundles of universal.

In abstraction from intuition, empirical concepts would be individual; in abstraction from concepts, intuition would be unique. Only in application to intuition, are concepts general; only conceptually determined, is intuition singular. (The standard version of) non-conceptualism, therefore, is inconsistent: in basic perception, intuition would present unique individuals, whereas in cognition, singular individuals are represented. Whether the spatiotemporal world contains Leibniz/Russell-individuals or possible indiscernibles would depend on the human/animal access to them: Leibniz/Russell when perceived, otherwise when cognized. In contrast, Kant generally strikes against the PII. Thus, merely singular spatiotemporal objects can only be cognized.

4 Quantum Individuality: the Kantian View

In this final Section, I will apply the Kantian view of individuality to the current debate in the philosophy of science about quantum (non-)individuality. QM rejects the PII as well, at least according to the standard-view. However, the way in which the PII allegedly fails in QM differs crucially from Kant's way of rejecting Leibniz/Russell-individuals. Nonetheless, I will sketch a Kantian solution of the quantum puzzle.

Consider, firstly, a quantum state that mimics Kant's example of the two drops of water. Instead of water, one takes two "similar" particles, e. g. two electrons, which share all "state-independent" properties such as charge and mass. The further similarity of the two water drops will be captured by the spin projection property: both electrons share the property of spin-up along z-axis. Intuitively, there are two particles at different spatial locations that share every intrinsic

property – apparently, in perfect accordance with Kant's example. Here is the state:[8]

$$|\Psi\rangle = \frac{1}{\sqrt{2}}[|R\rangle_1|\uparrow_z\rangle_1 \otimes |L\rangle_2|\uparrow_z\rangle_2 - \ |L\rangle_1|\uparrow_z\rangle_1 \otimes |R\rangle_2|\uparrow_z\rangle_2]$$

According to the standard-view, the PII is violated. This is so, however, *not* because the particle located in region R shares all properties with the particle located in region L, as Kant would believe. The state is *permutation invariant* – i.e. (anti-)symmetric with respect to the indices "1" and "2" – which leads, according to the standard-reading, to the counterintuitive view that both particles somehow participate at both locations. The PII is violated, according to this non-Kantian way of rejecting Leibniz-individuality, because both particles share the same so-called mixed state:

$$\widehat{\rho}_{1;2} = |\uparrow_z\rangle\left[\frac{1}{2}|R\rangle\langle R| + \frac{1}{2}|L\rangle\langle L|\right]$$

The particles called "1" and "2" are indistinguishable (the PII is violated) – which is not what Kant says, because neither 1 nor 2 must be identified with something located exclusively at R (or, L).

More than one non-Kantian way of dealing with such quantum objects can be found in the literature.[9] Since my purpose is only to show that there is also a consistent Kantian interpretation, it suffices to discuss one of the rival views. Closest to the foregoing discussion is the following: The indices "1" and "2" are *non-descriptivist* proper names that directly refer to bare particulars distinguished non-qualitatively by haecceities. So, quantum individuality is metaphysical identity; quantum objects are qualitatively indistinguishable but numerically distinct in virtue of these non-qualitative properties.

The Kantian view must give up the view that the (mathematical) indices "1" and "2" are the labels of the (physical) particles. This step has been done by physicists:

8 In the following, all states are fermionic, but the reasoning goes analogously in the boson case. According to the Kantian view, there is only a physical but not an ontological difference between fermions and bosons.

9 According to, e.g. French and Krause, an alternative view is to say that quantum particles are *non-individuals*, violating any classical understanding of individuality. Saunders, and others, argue that the PII can be saved in a weakened way ("weak discernibility").

> [T]here is a particle with spin up along z-axis and located in region R and [...] there is a particle with spin [up] along z-axis and located in region L. (Ghirardi et al. 2003, 384)[10]

As said, neither the particle called "1" nor the particle called "2" can be "a particle with spin up along z-axis and located in region R [or, L]", because *those* particles are in the given mixed state. Hence, the physicists are willing to talk about physical particles that are *not* labelled by the mathematical indices "1" and "2".

However, this is not enough to do justice to Kant. The physicists' talk can be interpreted in a Leibnizian way (see Friebe 2014, sec. 4), namely in the way that both particles are qualitatively distinguishable by having different properties: [spin-up; R] vs. [spin-up; L]. According to Kant, by contrast, spatial locations are *not* properties, but difference in space is a principle of individuation sui generis. Accordingly, spatial coordinates are mere labels, non-descriptivist ones of indistinguishable parts of space. Further, spatiotemporal objects, if one intends to label them adequately (for Kant), must be labeled via their spatial locations – in the case at hand: "*R*" and "*L*". So, the Kantian reading of the given state is: *R* shows spin-up along z-axis, and *L* shows spin-up along z-axis.

Plausibly, the Kantian view goes through with regard to the given state. However, in QM there are several other situations that, at first glance, are counter-examples to Kantian individuality. There is physical entanglement *and* there are many states in which, apparently, numerically different particles share spatial location. Here is an entangled state:

$$|\Psi\rangle = \frac{1}{\sqrt{2}}[(|\downarrow\rangle_1 \otimes |\uparrow\rangle_2 - |\uparrow\rangle_1 \otimes |\downarrow\rangle_2)(|R\rangle_1 \otimes |L\rangle_2 + |L\rangle_1 \otimes |R\rangle_2)]$$

The spin property is no longer coupled with the spatial location, but both 'properties' are mixed. According to Ghirardi et al., in such a state

> it is not possible, for example, to attribute any definite spin property to the particle located in R and equivalently no definite spatial property can be attributed to the particle with spin up. (Ghirardi et al. 2003, 384)

In case of entanglement, a Leibnizian discerning defense apparently fails; entanglement is, hence, a challenge not only for the Kantian view, but for the Leibnizian as well. A Kantian must argue, firstly, that it is not "equivalent" to pick out the individual via spin property or via spatial location. Instead, one must insist

10 I have slightly changed their example.

that the two particles are *R* and *L*; that they are numerically different in virtue of difference in spatial location.

Secondly, the Kantian must respond, somehow, to the challenge that *R* and *L* do not have any definite spin property. They (definitely) are in the same *mixed* state with respect to spin:

$$\widehat{\rho}_{R;L} = \frac{1}{2}|\uparrow\rangle\langle\uparrow| + \frac{1}{2}|\downarrow\rangle\langle\downarrow|$$

An objector may argue that Kant requires *definiteness* of property attribution, and that the Kantian ontology of substances requires *locality* which is, in some sense, violated here. I disagree with this objection: such requirements don't follow from Kant's way of rejecting the PII. Kant's concept of a merely singular individual doesn't strike against indefiniteness or non-locality (in some sense); it strikes (only) against the uniqueness of individuals, i.e. against Leibniz-individuality and against haecceitism. In the case at hand, one has one singular object at R and one other singular object at L: this is sufficient, regardless of other properties either objects may have, definitely or not.

More strikingly, a counter-example to the Kantian view might be the following state:

$$|\Psi\rangle = \frac{1}{\sqrt{2}}|R\rangle[|\downarrow\rangle_1 \otimes |\uparrow\rangle_2 - |\uparrow\rangle_1 \otimes |\downarrow\rangle_2]$$

Both (alleged) particles, 1 and 2, are located in the *same* region R. Explicitly, they are numerically different independently of their spatial location, which clearly goes against Kant's view of space as the principle of individuation. To defend the Kantian view in this case, one must apply the *summing defense*. The summing defense is a well-known strategy to defend the PII against provided counter-examples (see Hawley 2011; applied to QM see Friebe 2014, sec. 5). Here, I will apply this strategy in a Kantian way. Accordingly, quantum objects can be *unified* into an undivided, i.e. spatially structureless, whole. In the case at hand, there would only be one single individual, with proportionally greater mass and charge, located at R and with spin-value equal to zero.

Kant must, hence, allow for temporal variation that changes the number of objects. Unification turns more than one individual into one single one. Some spatial structure *disappears* without being substituted by other structure. In accordance with Kant's rejection of the PII, this implies that numerical distinctness reduces, i.e. the number of objects reduces (but, of course, not the quantity of mass). Correspondingly, the reversed direction – division – increases the number

of objects. New spatial structure can appear so that numerically distinct parts of the whole emerge. The given whole can be *divided* – i. e. transformed into a state such as the entangled one presented above – so that the formerly undivided whole turns into a composed whole. Then, it is composed by (new) numerically distinct, spatially individuated individuals.

Finally, there are many states in QM without any reference to spatial location. In standard-QM, the position basis is not privileged and so one can alternatively chose a different one. Even the state closest to Kant's water drops can be written in a different basis. With $|\Gamma\rangle = \frac{1}{\sqrt{2}}|\uparrow_z\rangle[|R\rangle + |L\rangle]$ and $|\Lambda\rangle = \frac{1}{\sqrt{2}}|\uparrow_z\rangle[|R\rangle - |L\rangle]$ the given non-entangled, permutation invariant state is equivalent to:

$$|\Psi\rangle = \frac{1}{\sqrt{2}}[|\Gamma\rangle \otimes |\Lambda\rangle - |\Lambda\rangle \otimes |\Gamma\rangle]$$

If there are two particles in the original state – as must be the case according to the Kantian view –, there must also be two particles in this state. For, mere basis transformation leads only to a different formulation of the very same state without any physical or metaphysical change. However, with this alternative formulation in mind, the numerical distinctness of the particles cannot be established by difference of place, and since nothing privileges the original formulation, space apparently cannot be the principle of individuation.

Therefore, the Kantian view needs an argument to *privilege* the position basis. Probably, this can be done with the program of decoherence. Also, (real) collapse interpretations such as the GRW approach are working on a privileged position basis, i. e. space is ontologically fundamental. Thus, one may conclude that the Kantian view is still a live option.

5 Conclusion

For Kant, space – being on the ontological ground-floor (it's transcendentally ideal) – provides a principle of individuation sui generis. In this way, Kant rejects Leibniz-individuality completely and establishes spatiotemporal objects (appearances) as merely singular individuals. Individuation has nothing to do with distinguishability, which implies that intuition, the individuating faculty, plays a role significantly distinctive from concepts, the distinguishing faculty. However,

Kantian individuation does not uniquely individuate so that intuition can play its distinctive role only when conceptually determined. Challenged by quantum (non-)individuality, the Kantian view still turns out to be of systematic relevance.

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