Weak Discernibility

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Simon Saunders argues that, although distinct objects must be discernible, they need only be weakly discernible (Saunders 2003, 2006a). I will argue that this combination of views is unmotivated: if there can be objects which differ only weakly, there can be objects which don't differ at all.

Objects are weakly discernible if they stand in some irreflexive relation (Quine 1976). Max Black's two spheres are weakly discernible: each is one mile from the other, but not one mile from itself (Black 1952). As Saunders points out, some entangled fermions seem to exhibit mere weak discernibility. Two maximally entangled fermions (electrons in the singlet state, for example) are indiscernible in some straightforward respects: same mass, same charge. They are indiscernible in less straightforward respects too: neither has a determinate location or momentum, but they are indeterminate in just the same ways. What about spin? Pick any line, say that running between your ears right now. For each electron in the pair, it is indeterminate whether it is spinning clockwise or anti-clockwise around that axis. Crucially, however, it is determinate that each is spinning in the opposite direction to the other: their collective state is *anti-symmetric*. Thus they are weakly discernible: each electron spins in the opposite direction to the other, but not in the opposite direction to itself (despite the fact that neither spins in any determinate direction at all).

Saunders also points out that entangled elementary bosons need not be even weakly discernible. (Elementary bosons are those, like photons, which are not composed of fermions.) Bosons in 'identical' states are indiscernible in straightforward ways (mass, charge), they match in their indeterminacies, and moreover it is determinate that they spin in the same direction as each other: their collective state is *symmetric*. Thus they are utterly indiscernible: each boson spins in the same direction as the other, despite the fact that neither spins in any determinate direction at all. Saunders writes 'The answer to Quine's question -- Are quantum particles objects? -- is therefore: Yes, except for the elementary bosons'. (2006a, p.60)

Saunders wants to undermine the following argument: quantum particles are indiscernible; so they are not objects (‘not individuals’); this explains their statistical behaviour. This is because Saunders has an alternative explanation of the statistical behaviour (2006b). I will not address this wider context here. Instead, I want to challenge Saunders’s conjunction of the claim that fermions are objects with the claim that suitably entangled elementary bosons are not.

According to Saunders, objects satisfy the principle of identity of indiscernibles (PII). Suppose someone claims that ‘two’ objects are indiscernible yet nonidentical. How can the advocate of PII respond? One option is to accept that the objects are nonidentical, and to argue that they are discernible; thus Saunders on fermions. A second option is to accept that they are indiscernible, and to argue that they are identical. But a third option is to argue that neither exists at all. Saunders takes this third approach both to elementary bosons and to (hypothetical) co-located indiscernible classical particles: ‘if relative distances and velocities are zero, [and] if no more refined description is available...we would do better to say that there is only a single particle present (with proportionately greater mass). This [is] a classical counterpart to elementary bosons…’ (2006a, p. 60).

In effect, Saunders is using PII to address the Inverse Special Composition Question: under which conditions does an object have proper parts? (van Inwagen 1990) PII tells us that no object can have indiscernible proper parts. So PII *forbids* us to posit elementary bosons as the proper parts of a symmetric boson system: if they existed, they would be indiscernible. And PII *permits* us to posit fermions as the proper parts of an anti-symmetric fermion system: if they exist, they are weakly discernible. But PII does not *require* us to posit such fermions.

If any principle requires us to posit the existence of distinct objects, it is not PII but Leibniz’s Law, the principle of nonidentity of discernibles: where there are instances of incompatible properties, there are, correspondingly, distinct objects. Leibniz’s Law is a fine principle, but the problem is how to recognise instances of incompatible properties. In the present context, how can we tell whether we have a simple system with a mereologically-irreducible property, or a complex system whose proper parts have incompatible properties?

The coherence of ontological monism shows that we could in principle attribute the apparent heterogeneity of the universe to different modifications of one huge, partless object. The question is whether it is at all plausible to do so. Our only hope is somehow to determine whether the properties of the whole are basic, or else mereologically reducible; perhaps considerations of simplicity and/or ontological economy will help. Is the universe just irreducibly personish-here-and-cattish-there, or is it like that because there's a person here and a cat there?

Saunders argues that an entangled-fermion system has proper parts, while an entangled-boson system does not. For him, an entangled-boson system is just irreducibly symmetric. Then why not say that an entangled-fermion system is just irreducibly anti-symmetric? Neither symmetry nor antisymmetry has a better or worse claim to ontological basicness. We know that if entangled fermions did exist, the *being-of-opposite-spin* relation between them would not supervene upon their other properties. The same goes for the *being-of-the-same-spin* relation between putative bosons. We can treat each as either an irreducible property of the system or else as a nonsupervenient relation amongst the parts (recall that none of these particles has any determinate direction of spin).

The difference between antisymmetry and symmetry doesn't give us positive grounds for recognising fermions but not bosons. The only possible motivation for making this distinction is a principle according to which we should posit distinct objects wherever these are not forbidden by PII: we'd love to have those bosons, if it weren't for their pesky indiscernibility. But there are two objections to this principle. First, it incites us to divide an object with, say, four units of mass into a three-unit part and a one-unit part. Second, it conflicts with the modest, empiricist stance which makes PII attractive in the first place. PII tells us to restrict our ontology to the minimum required by Leibniz's Law, to choose a single object over two indiscernibles any time. The present principle tells us to make work for Leibniz's Law, to choose mereological complexity over simplicity whenever we can.

If we accept PII, we should deny the existence of both bosons and fermions. Analogously, we should say that Black's 'two spheres' are a single, spatially disconnected but partless object. Of course this sounds strange: picturing the system, it seems obvious that it is spatially disconnected because *this* one is over *here*, and *that* (other) one is over *there*. But remember that absolute space isn't allowed into the picture, just 'two spheres' which are one mile apart but lack any specific location.

If we give up PII, on the other hand, we should admit entangled elementary bosons as well as entangled fermions. Bosons are not indiscernible shadows of acknowledged objects (as if each piece of furniture in my study were allegedly co-located with a distinct but indiscernible piece of furniture): some of their properties are additive, so it makes a difference how many bosons are in a given system. And, as with fermions, the states of entangled systems can in principle be collapsed so as to reveal/create independently-existing particles.

Finally, what about numbers? According to his critics, Shapiro's (1997) non-eliminative mathematical structuralism entails that some distinct numbers (*i* and –*i*, for example) are indiscernible, in violation of PII. Ladyman (2005) points out that these numbers are in fact weakly discernible, though MacBride (2006) questions the metaphysical underpinnings of mere weak discernibility. My arguments point towards a different option for structuralist advocates of PII: neither falsely identifying nor controversially distinguishing *i* and –*i*, but denying their very existence in favour of the system of which they are putative elements. This, however, is eliminativism.[1]

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