Can condensed matter physics inform the metaphysics of substance?

INTRODUCTION

Substance theory states that any object-like thing is constituted by a metaphysically independent substance and the properties borne of that substance (Robinson, 2020). There are some potential counterexamples to substance theory that physics might provide; for example, condensed matter physics offers the quasiparticle (QP). QPs like electron holes and phonons cannot exist independently of other objects, which might imply that, according to substance theory, they are un-object-like; however, they are often imagined as objects by condensed matter physicists. To investigate how physicists, philosophers, and laymen understand problems at the physics-substance theory intersection, a survey posing several open-ended problems was distributed. It was hypothesised that entities like QPs may require their own metaphysical category, such as 'quasiobject' or 'quasisubstance'.

METHOD

The study employed a mixed-methods approach, aiming to gather both qualitative and quantitative insights into intuitive perspectives on problems regarding the nature of substance and objecthood. Eight questions were presented to participants, the analysis for three of which can be seen below. Invitations to participate were extended through university email channels and both a physics and a philosophy page on Reddit.

Responses were first analysed qualitatively on a case-by-case basis to extract the key themes across the responses to each question. The questions were intentionally open-ended and original so as to encourage participants to rely on their intuition when answering. After qualitatively deriving the key themes, all responses were categorised according to which key theme they fell into, and a dataset was created for statistical analysis. Participants were asked for their subject field so they could be categorised into three groups: physicists, philosophers, and laymen, enabling trends in how responses correlated with academic fields to be analysed.

RESULTS

Participant field	Number of Participants
Physicists	67
Philosophers	23
Laymen	51
Combined	141

Table 1: Table displaying number of participants for each field of education, as well a combined total in bold.

Philosophers make up a relatively small proportion (16%) of all participants; hence, statistics associated with philosophers may be less reliable.

QUESTION 1A

Responses dichotomised between an essentialist and a nominalist position. Essentialists stated that the electron was more than the sum of its properties and had an essence, or form, that it was imperfectly embodying. Nominalists argued that electrons are the sum of their properties, although it was frequently posited that some properties were unknowable.

Field	Essentialist position	Nominalist position
Physicist	19.5%	80.5%
Philosopher	59%	41%
Laymen	36%	64%
Combined	31.5%	68.5%

Table 2: Quantitative analysis of the responses to Question 1a.

26 participants (18.5%) were unsure or did not answer.

QUESTION 1B

Responses dichotomised into a holistic and a reductionist position. The holistic position was that an electron's external relations are necessary for a full definition, with one response stating, "*Externalities are important in quantum physics and field interactions.*" The reductionist position often referenced identity; one participant stated, "*You can identify an electron from its intrinsic properties alone.*"

Field	Holist position	Reductionist position
Physicist	64.5%	35.5%
Philosopher	43%	57%
Laymen	69%	31%
Combined	64%	36%

Table 3: Quantitative analysis of the responses to Question 1b.

60 participants (42.5%) were unsure or did not answer.

QUESTION 2

Question 2 responses split between arguing that light either is or is not an object. Some participants argued light is an object because it is causally active, while others argued light's wave nature makes it a non-object.

Field	Light is an object	Light is not an object
Physicist	70%	30%
Philosopher	82%	18%
Laymen	50%	50%
Combined	64.5%	35.5%

Table 4: Quantitative analysis of the responses to Question 2.

34 participants (24%) were unsure or did not answer.

QUESTION 3

Responses split between arguing that colour either is or is not an object. While the overwhelming majority argued the latter, there was variability in how this was done. Many argued that colour is a property of photons rather than an object. One participant said, "*Since colour is mind independent, it cannot be an object. It is qualia.*" On the contrary, one participant adopted a pragmatist position, stating, "*They can be objects when we need them to be.*"

Field	Colour is an object	Colour is not an object
Physicist	6%	94%
Philosopher	0%	100%
Laymen	16%	84%
Combined	8.5%	91.5%

Table 5: Quantitative analysis of the responses to Question 3.

14 participants (10%) were unsure or did not answer.

QUESTION 4

Responses suggested QPs were either objects, properties, or something in between ('quasiobjects'). In favour of QPs being objects, one participant reasoned, "*Organs can't function without the body, but are objects.*" Many argued QPs are not objects because they cannot exist by themselves. Some argued in favour of the concept of 'quasiobjects', with one participant stating, "*[QPs] don't meet the criteria to be an object, but they're more than not-an-object*", and another simply stating, "*Quasi-objects?*"

Field	QPs are objects	QPs are not objects	QPs are 'quasiobjects'
Physicist	25%	55.5%	19.5%
Philosopher	20%	73.5%	6.5%
Laymen	37.5%	37.5%	25%
Combined	29%	51%	19%

Table 6: Quantitative analysis of the responses to Question 4.

31 participants (22%) were unsure or did not answer.

It should be noted that all statistics discount blank or unsure responses (unless explitiely stated) and are rounded to the nearest half decimal place.

DISCUSSION

Substance theory is arguably more in line with the nominalist position since the existence of non-spatiotemporal acausal abstracta like idealised forms or essences, often implied within the essentialist position, adds complications to the theory; hence, the physicist and layman responses to Question 1a can be said to support substance theory. Substance theory is plausibly more aligned with the reductionist position since it states object-like things are metaphysically independent, which arguably discounts extrinsic properties; thus, the physicist and layman responses to Question 1b do not support substance theory.

Question 3 revealed that colour was overwhelmingly seen as un-object-like, which can be said to support substance theory's property-substance distinction. Regarding Question 4, while some responses suggested QPs are 'quasiobjects', these were in the minority. The majority of responses suggested QPs are emergent properties, which arguably supports substance theory. More work utilising modal logic is intended to be done to understand the validity of the concept of quasiobjects.

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Reference: Robinson, H. (2020b). Substance. Spring 2020 ed. [Online] Stanford Encyclopedia of Philosophy. Available at: https://plato.stanford.edu/entries/substance [Accessed 20 July 2023].

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