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Point–Counterpoint: Can Anything Be Learned from Surveys on the Interpretations of Quantum Mechanics?

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POINT–COUNTERPOINT

Can anything be learned from surveys on the interpretations of quantum mechanics?

In what follows, **Matt Leifer** and **Nathan Harshman** present opposing views on the value of surveys on foundational attitudes towards quantum mechanics. Three such surveys were recently published and their results are summarized in Table 1. Matt takes the `point,' arguing that such surveys are *not* useful, while Nathan takes the `counterpoint.' A complete set of references for both is given at the end.

POINT MATT LEIFER

Q1. Which of the following questions is best resolved by taking a straw poll of physicists attending a conference?

A. How long ago did the big bang happen?
B. What is the correct approach to quantum gravity?
C. Is nature supersymmetric?
D. What is the correct way to understand quantum theory?
E. None of the above.

By definition, a scientific question is one that is best resolved by rational argument and appeal to empirical evidence. It does not matter if definitive evidence is lacking, so long as it is conceivable that evidence may become available in the future, possibly via experiments that we have not conceived of yet. A poll is not a valid method of resolving a scientific question. If you answered anything other than E to the above question then you must think that at least one of A-D is not a scientific question, and the most likely culprit is D. If so, I disagree with you.

It is possible to legitimately disagree on whether a question is scientific. Our imaginations cannot conceive of all possible ways, however indirect, that a question might get resolved. The lesson from history is that we are often wrong in declaring questions beyond the reach of science. For example, when big bang cosmology was first introduced, many viewed it as unscientific because it was difficult to conceive of how its predictions might be verified from our lowly position here on Earth. We have since gone from a situation in which many people thought that the steady state model could not be definitively refuted, to a big bang consensus with wildly fluctuating estimates of the age of the universe, and finally to a precision value of 13.77 +/- 0.059 billion years from the WMAP data.

Traditionally many physicists separated quantum theory into its "practical part" and its "interpretation," with the latter viewed as more a matter of philosophy than physics. John Bell refuted this by showing that conceptual issues have experimental consequences. The more recent development of quantum information and computation also shows the practical value of foundational thinking. Despite these developments, the view that "interpretation" is a separate unscientific subject persists. Partly this is because we have a tendency to redraw the boundaries. "Interpretation" is then a catch-all term for the issues we cannot resolve, such as whether Copenhagen, Bohmian mechanics, many-worlds, or something else is the best way of looking at quantum theory. However, the lesson of big bang cosmology cautions against labeling these issues as unscientific. Although interpretations of quantum theory are constructed to yield the same or similar enough predictions to standard quantum theory, this need not be the case when we move beyond the experimental regime that is now accessible. Each interpretation is based on a different explanatory framework, and each suggests different ways of modifying or generalizing the theory. If we think that quantum theory is not our final theory then interpretations are relevant in constructing its successor. This may happen in quantum gravity, but it may equally happen at lower energies, since we do not yet have an experimentally confirmed theory that unifies the other three forces. The need to change quantum theory may happen sooner than you expect, and whichever explanatory framework yields the next theory will then be proven correct. It is for this reason that I think question D is scientific.

Regardless of the status of question D, straw polls, such as the three that recently appeared on the arXiv [1-3], cannot help us to resolve it, and I find it puzzling that we choose to conduct them for this question, but not for other controversial issues in physics. Even during the decades in which the status of big bang cosmology was controversial, I know of no attempts to poll cosmologists' views on it. Such a poll would have been viewed as meaningless by those who thought cosmology was unscientific, and as the wrong way to resolve the question by

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those who did think it was scientific. The same is true of question D, and the fact that we do nevertheless conduct polls suggests that the question is not being treated with the same respect as the others on the list.

Admittedly, polls about controversial scientific questions are relevant to the sociology of science, and they might be useful to the beginning graduate student who is more concerned with their career prospects than following their own rational instincts. From this perspective, it would be just as interesting to know what percentage of physicists think that supersymmetry is on the right track as it is to know about their views on quantum theory. However, to answer such questions, polls need careful design and statistical analysis. None of the three polls claims to be scientific and none of them contain any error analysis. What then is the point of them?

The three recent polls are based on a set of questions designed by Schlosshauer, Kofler and Zeilinger (SKZ), who conducted the first poll at a conference organized by Zeilinger [1]. The questions go beyond just asking for a preferred interpretation of quantum theory, but in the interests of brevity I will focus on this aspect alone. In the Schlosshauer et al. poll, Copenhagen comes out on top, closely followed by "information-based/information-theoretical" interpretations.

The second poll comes from a conference called "The Philosophy of Quantum Mechanics" [2]. There was a larger proportion of self-identified philosophers amongst those surveyed and "I have no preferred interpretation" came out as the clear winner, not-so-closely followed by de Broglie-Bohm theory, which had obtained zero votes in the SKZ poll. Copenhagen is jointly in third place along with objective collapse theories. The third poll comes from "Quantum theory without observers III" [3] at which de Broglie-Bohm got a whopping 63% of the votes, not-so-closely followed by objective collapse.

Table 1. The collected responses to the three published sets of survey results [1-3] for the question "What is your favorite interpretation of quantum mechanics?" is shown below. Note that respondents were allowed to check more than one box and that Sommer [2] included "Shut up and calculate" as a separate interpretation, whereas Schlosshauer, Kofler, and Zeilinger [1] and Norsen and Nelson [3] do not.

Survey	SKZ [1]	Som. [2]	NN [3]
Number of Respondents	33	18	67
A. Consistent histories	0%	0%	1%
B. Copenhagen	42%	11%	4%
C. De Broglie-Bohm	0%	17%	63%
D. Everett (many worlds and/or minds)	18%	0%	0%
E. Information based/information theoretical	24%	6%	5%
F. Modal Interpretation	0%	0%	0%
G. Objective collapse (e.g., GRW Penrose)	9%	11%	16%
H. Quantum Bayesianism	6%	6%	3%
I. Relational quantum mechanics	6%	6%	0%
J. Statistical (ensemble) interpretation	0%	6%	4%
K. Transactional interpretation	0%	0%	0%
L. Other	12%	0%	8%
M. I have no preferred interpretation	12%	44%	11%
N. "Shut up and calculate"	NA	17%	NA

What we can conclude from this is that people who went to a meeting organized by Zeilinger are likely to have views similar to Zeilinger. People who went to a philosophy conference are less likely to be committed, but are much more likely to pick a realist interpretation than those who hang out with Zeilinger. Finally, people who went to a meeting that is mainly about de Broglie-Bohm theory, organized by the world's most prominent Bohmians, are likely to be Bohmians. What have we learned from this that we did not know already?

One thing I find especially amusing about these polls is how easy it would have been to obtain a more representative sample of physicists' views. It is straightforward to post a survey on the internet for free. Then all you have to do is write a letter to *Physics Today* asking people to complete the survey and send the URL to a bunch of mailing lists. The sample so obtained would still be self-selecting to some degree, but much less so than at a conference dedicated to some particular approach to quantum theory. The sample would also be larger by at least an

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order of magnitude. The ease with which this could be done only illustrates the extent to which these surveys should not even be taken semi-seriously.

I could go on about the bad design of the survey questions and about how the error bars would be huge if you actually bothered to calculate them. It is amusing how willing scientists are to abandon the scientific method when they address questions outside their own field. However, I think I have taken up enough of your time already. It is time we recognized these surveys for the nonsense that they are.

NATHAN HARSHMAN COUNTER-POINT

Let us first dispense with three easy criticisms of the Schlosshauer, Kofler, Zeilinger (SKZ) survey [1] and its other applications [2,3]:

1) **Quantum interpretation is a waste of time.** Even in the "Point" to my "Counterpoint" Matt Leifer grants that recent developments (i.e. over the last fifty years) have made quantum interpretation a subject for polite scientific company. Questioning quantum interpretation probes the murky border between physics and metaphysics, but that has been demonstrably productive in all the traditional senses of scientific progress: description, prediction, explanation and control. We now can, with a straight face, say "quantum teleportation" and "cat-like entanglement" even to funding agencies and even in the United States.
2) **This survey cannot reveal the Truth About Quantum Mechanics.** This criticism is entirely valid. I have colleagues that self-identify as social scientists and even they know that the primary purpose of surveys is to reveal information about the respondents. I remember watching the television game show The Family Feud as a child. The survey question was "Name a big fish" and a randomized sample voted "whale" by a landslide. That uncovers a gap in the science education of the respondents but should not be taken as taxonomical truth. The SKZ survey, and those who have repeated it, never imagined that it would reveal "Yes, in fact, Quantum Bayesianism is the Truth About Quantum Mechanics." Abusing terminology slightly, the intention of this survey is not to determine the ontic state of quantum mechanics as a theory, but to explore the epistemic state of quantum mechanics as a people.
3) **This survey is imperfect.** This criticism is also valid. And, if the survey were a scientific instrument, it would be our solemn duty to observe, hypothesize, experiment, and revise it until we have sharpened its resolution to the quantum limit, so to speak. However, since this survey is not a scientific instrument, we should feel no such compulsion. Optimizing the quantification of a potentially metaphysical stance is, to my mind, missing the point. I concede that larger sample sizes, more representative samples and research-based question revision could provide more meaningful results, even if the survey is acknowledged as a qualitative, subjective tool. But such seemingly scientific steps will not lead us to a quantitative, objective Truth Discovering Instrument. But again, that is not what this survey is attempting to do.

So then, is using an imperfect, non-scientific, possibly metaphysical tool a waste of time and nonsense, as claimed by the "Point"? I believe not, for at least the following reasons.

1) **The survey is an active-learning experience for quantum physicists.** Depending on the version of the survey, there are thirteen or fourteen item choices for "Question 12: What is your favorite interpretation of quantum mechanics?" The mind reels at the multiplicity, and puzzling through the implied comparisons is a satisfying mental work-out. I hereby assign the survey as homework for every member of the Topical Group, and it should be taken open-book, with trusty Google close at hand. For example, after a little sleuthing [4] in the on-line Stanford Encyclopedia of Philosophy, I have discovered a new, and according to the survey results uncommon, pleasure: the Modal Interpretation. (However, I admit it may only be my favorite interpretation until the next interpretation sweeps me off my feet. As an undergrad, I had a torrid affair with Everett, and although in grad school I pledged troth to Copenhagen, I secretly dallied with the Ensemble Interpretation.)

   Like all good active-learning educational tools, the survey authors intentionally built ambiguity into the survey. The survey authors seem to delight in the discomfort elicited by the vagueness of the survey items. For example, they begin the commentary after "Question 9: What interpretation of quantum states do you prefer?" with the statement "This is a perfect example of a question where the options are not well

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defined." Again, if this were intended to be a scientific instrument this would be an admission of gross misconduct, but here it signals that this survey is an attempt to activate the survey-taker and to encourage discussion. Since, as the "Point" admits and history has shown that discussing quantum interpretations is scientifically productive, perhaps we should be encouraging other subdisciplines like string theory and cosmology to engage in similar ambiguous and vague exercises. The process of surveying opinions on our field can enable positive change through conversation, consideration and possible conversion and convergence.

2) **The survey reminds quantum researchers that science is a social endeavor.** Please don't mistake this for my support of some controversial hypothesis like "scientific truth is socially constructed" or some other intellectually-flabby pseudo-relative appropriation from a misunderstanding of modern physics. I merely mean that science is an activity done by people, spread through space and time. As an intellectual community, scientists in general and physicists in particular consider themselves on-guard against group-think, personal bias, dogma and other Baconian "Idols of the Mind." Yet, when some report from a funding agency or other peer review undervalues a colleague's work (this happened to my friend once), one often hears the complaint that the work isn't being evaluated on merit, but instead on fashion, reputation or some other social influence. Acknowledging this, our community should welcome any activity that throws light on personal and social processes that can cloud logic and observation. As Norsen and Nelson [3] elucidate, and the "Point" also notes, it is not surprising that at a conference organized by Anton Zeilinger that 76% of respondents averred "Quantum information is a breath of fresh air for quantum foundations," while this selection was preferred by only 15% of respondents at the Bohmian-heavy conference Quantum Theory Without Observers. And I can imagine that if anyone had shown up at these conferences with a predilection for the Transactional Interpretation, she or he may have become so dispirited as to not even complete the survey, explaining that particular null result. Perhaps the biggest concern is that this survey and its sectional analyses could, like one's choice of cable news channel, encourage intellectual tribalism and partisan sniping.

3) **The survey is a vehicle for the celebration and popularization of quantum physics.** The proof is in the raisin pudding. The media found the story charming and gave it attention (see references in [3], also Google). It was discussed in academic corridors, laboratory cafeterias, blog posts, and even APS Topical Group newsletters. Instead of shaking our heads that this is a waste of time, we should rejoice. A few more people heard about quantum physics! Our cultural impact grew! Headlines like "Experts still split on what quantum theory means" and "Why quantum mechanics is an 'embarrassment' to science" may cause a few physicists to roll their eyes, especially among those most confident in their own interpretations, but I still believe the old saw: any press is good press. So let's put this survey in the same category as operas about Oppenheimer and Einstein, plays about Bohr and Heisenberg, sitcoms about Sheldon and Leonard, and lamps made to look like atomic orbitals. Category: Good Things. Subcategory: Non-Science but Pro-Quantum.

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References

[1] M. Schlosshauer, J. Kofler and A. Zeilinger, A Snapshot of Foundational Attitudes Toward Quantum Mechanics, arXiv:1301.1069 (2013).

[2] C. Sommer, Another Survey of Foundational Attitudes Towards Quantum Mechanics, arXiv:1303.2719 (2013).

[3] T. Norsen and S. Nelson, Yet Another Snapshot of Foundational Attitudes Toward Quantum Mechanics, arXiv:1306.4646 (2013).

[4] O. Lombardi and D. Dieks, Modal Interpretations of Quantum Mechanics, *The Stanford Encyclopedia of Philosophy* (Fall 2013 Edition), Edward N. Zalta (ed.), forthcoming URL = <http://plato.stanford.edu/archives/fall2013/entries/qm-modal/>.