Quantum Question Theory

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The following definitions and schematic diagram have been copied out of the opening pages of ***On well-formed logical and psychological questions; Roy Lisker, 1996*** **:**

Definitions

In Logical Question Theory, a ***WFQ*** **(well-formed question) is a syntactically proper question. Statements in the form of a question with incorrect syntax are called "ill-formed questions" or** ***IFQ*** **. Improper syntax may create a semantic puzzle, sometimes considered a "paradox". These are often humorous.**

Example: ***"Do you consider this question a waste of your valuable time?"***

The question interrogates itself as subject, so that in fact it has no subject. That one's time is being wasted in consenting to listen to it could be restated as:

"Do you consider the time spent in figuring out why statements such as 'do you consider this question a waste of your valuable time?' better spent doing something else?"

Syntax and grammar are not the same. A question such as "Is you happy?" is a WFQ stated in bad grammar.

An IFQ (ill-formed question) is one whose syntactic elements are not in proper arrangement. Thus " What is the color

of a Platonic idea?" is an IFQ because the domain of inquiry ought to correspond to the question, therefore the "answer" doesn't correspond to the question, but rather explains why the question is misstated . We call this an "explication" rather than an answer. The explication of the above question is "Platonic ideas don't have colors." (Not even the absence of color, or black. The *observable* , color, is not present in a Platonic idea.)

One can debate the issue of whether the absence of the required observable in the subject (or domain of inquiry) of a question should constitute an IFQ. However there is no debate about an IFQ which of the following form:

" Does this question have an answer?"

Explication : The question itself is treated as being inside the domain of inquiry, which is improper. The distinction between the semantic and the syntactic question is very important. We notate them as follows:

*** " Q " will stand for the *semantic content* of the question statement. This is what the question *means* , and can be identified with "the question" itself as a entity in thought.

*** " $[Q]_U$ " stands for the verbal or semiotic actualization of Q in some specific instance. U is the context from which the actualization of the question draws its components or diacritical vocabulary. In Quantum Question Theory it also includes the experimental apparatus or instrument, designated "I".

$[Q]_U$ is the syntactic question. *Confusion between Q and $[Q]_U$ in the application of the word 'question' is the source of many pseudo-paradoxes.*

Example: "Does this question have 10 letters?" If the word "question" refers to the syntactic question, the statement is a WFQ, with answer "No". If "question" refers to the semantic question, the statement is meaningless, hence an IFQ.

There is also the *grammatical* question. Its structure is represented in the "logical question theory" (LQT) schema shown below. The grammatical question differs from the declarative statement by having the form of a question. An IFQ is a *grammatical* question which is *syntactically* incorrect, or ill-formed.

What we mean by this is that there is a set of rules governing proper syntax which a grammatical question must fulfill to qualify as a WFQ. These are presented below, immediately after the schema.

Q and $[Q]_U$ are combine in *Phase I*, the *inquiry*, *request*, or *initiation phase* of the interrogation process.

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*****"Γ " is the *interrogator*, the person or agency asking the question. In Logical Question Theory (LQT), the interrogator is completely impersonal, a mode of inquiry , such as one refers to when speaking of the "Interrogative Case" of Latin.**

In Psychological Question Theory (PQT), the "person" of the interrogator enters into the discourse through his *need to know* the answer. This is discussed at length in the original paper.

The status of the interrogator in Quantum Question Theory (QQT) is one of the concerns of this article.

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***" D " is the *domain of inquiry*, also known as *the topic* or *the subject* .D, its observables , and the states of those observables, define the matter being investigated in the posing of the question.

*** " X " is the *collection of observables* of D. These are qualities or attributes which ,the interrogator believes, exist in the subject : color, size, joy, weight, truth, loyalty ......

*** "C "is the *choice set* . In Quantum Theory C is the *set of states* of the members of X. For example, if D is a warm, visible object, so that X includes temperature and color, then C include all the numerical values of the colors and temperatures that D may assume. If D is a traffic light, X may include "color" and "intensity" (including black or " 0 intensity" for the case when the light is turned off. Unlike the "color of a Platonic idea" example, an observable "color" is still present when the light is turned off). The choice set for color then includes the 4 options 'red', 'green', 'yellow' and 'black'.

The question *"What is the color of that traffic light now?"* refers to a world in which traffic lights have colors. The answer chooses an elements from the set C = {red, green, yellow, black}.

The list of observables belonging to the domain of inquiry may change, in which case a well-formed question at one period in scientific history may be ill-formed at a later date, and become well-formed again at a still later date. When the observable in question is inappropriate, one may call these null questions.

Null question statements play an important role in the sciences. For example, the question: " *How much phlogiston is*

***consumed in the burning of a pound of tallow?"* was well-formed until it was demonstrated that there is no phlogiston. The explication for this statement in the modern world is: *"Phlogiston doesn't exist. "*   Null questions in fact are in a borderline area between WFQ and IFQ statements.**

An even better example is : "*What is the speed of a galaxy relative to the ether?* "

Before Einstein's theory of special relativity, it was believed that this was a proper question, although no one knew the answer. Owing to the failure of the Michelson-Morley experiment Einstein developed a theory in which the ether was eliminated. Thus, the explication from 1905 to the latter part of the 20th century, was "the ether doesn't exist."

However, the discovery of the background microwave radiation restored an ether concept. If the word 'ether' is defined to mean, "The universal fixed reference frame", then the above question once again becomes meaningful.

This debate over the status of null questions has considerable reverberations in Quantum Question Theory. We defer treatment of these to the next paper.

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***** " Ω " is the *respondent* : the person or entity to whom the question is addressed. In the logical theory Ω is of minor importance. All logical questions are , in some sense, being addressed to the universe at large, some abstract domain of Truth where all the answers are.**

***** " Σ " is the *answer*, the subset of members of the state collection C, of all observables in X at the moment of inquiry.**

*****" E " is *the explication*. The full response to an IFQ has to include, in addition to the simple statement , *"That is an IFQ"* , the classification of all the false relationships between the components of the question schema. The explication E of an IFQ is the correlative of the answer, Σ , of a WFQ.**

Obviously the explication of any WFQ , θ is simply : " θ is a WFQ " One does not have to explain why it is well formed. However, an IFQ can be ill-formed in many different ways. To use an analogy: middle C is but a single note on the piano, but there are many ways in which a note isn't middle C. If a piano teacher asks a student to play middle C, and she does so, the teacher need only say "That's right"; but if she plays another note, the teacher may say , " No, that's C#", or " That's c , but it's in the wrong octave." , and so on. *The full response* to an IFQ is its explication.

The distinction between "answer" and "explication" can be illustrated with a few examples:

The statement: *"Does this question have an answer? "* is an IFQ. The *explication* is that the question statement itself is the domain of inquiry, which is improper.

However the question : *" Does this question have an explication? " does* have an answer, and is therefore a WFQ ! Answer: "Yes". Explication: "The statement is a WFQ that asks an IFQ, a question about itself."

Consider next: *"How many answers does this question have? "*

If one replies "None" ,then it would seem to have at least one answer. However if the respondent says "One", the interrogator is led to ask : "What is it?" and so forth.

The correct procedure is the following: this statement doesn't have any answers because it is an IFQ. *The reply "None." is not an answer, it is part of the explication.* **To call "None" an answer , is like saying that:**

"Does the question ' The moon is bright.' have an answer ? " **has an answer . Since "The moon is bright" is a statement, not a question, the "answer" might be taken to be "No". However, since this statement is not in the domain of inquiry (the class of all questions), the statement "No" is an explication, not an answer.**

All of these components are arranged below in the *schema of the logical question* **:**

Schema of the Logical Question:

Phase I : The Inquiry

$$\Gamma: \begin{bmatrix} Q \\ \downarrow \\ D \\ \downarrow \\ X \\ \downarrow \\ C \end{bmatrix} \rightarrow Q_{[U]} \longrightarrow \Omega$$

The semantic content , Q, is translated by the interrogator , Γ , into the question statement, Q[U] . consisting of domain of inquiry D, observables X and choice set of states, C. This is sent to the respondent Ω .

Phase II: The Response

$$\boxed{\begin{array}{l} \Omega: Q_{[U]} \rightarrow \begin{bmatrix} \begin{bmatrix} WFQ \\ \downarrow \\ D \\ \downarrow \\ X \\ \downarrow \\ \Sigma \in C \end{bmatrix} \xrightarrow{\Phi} \Gamma \end{bmatrix}, or \\ \\ \ldots\ldots\ldots\ldots \rightarrow \begin{bmatrix} \begin{bmatrix} IFQ \\ \downarrow \\ E \in Q_{[U]} \end{bmatrix} \xrightarrow{\Phi} \Gamma \end{bmatrix} \end{array}}$$

If Q[U] is a WFQ, Ω specifies the states of the choice set in the answer , Σ , transmitted (Φ) back to Γ . If Q[U] is an IFQ, Ω specifies the states of the choice set in the Explication , E transmitted (Φ) back to Γ .

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The original paper "*On well-formed logical and psychological questions*" devotes a considerable amount of space to the syntactical priorities of a WFQ. For the purposes of the present article, this abbreviated description will suffice:

" A well-formed question Q includes a domain of inquiry , D , possessing a set of attributes ,or observables X , with a choice set of states C from which the respondent is being directed to make a selection, Σ .

(a) The answer does not contain the choice set.

(b) The choice set should not include the observables.

(c) The observables should not include the domain of inquiry.

(d) The domain of inquiry should not include the question itself.

(e) The question doesn't interrogate its syntactic components."

Here are examples of ill-formed questions arising from each of these errors:

(a) *Question:* Which is larger, 1 or 2 ?

***Answer:* Either 1 is larger than 2 or 2 is larger than 1**

(b) Can you list all the elements one finds in gas? (reversal of primary and secondary characteristics, of observables with states.) Is that liquid in a hydrogen state?

(c) How big is a large city? Why are bad people evil? Is the rain wet?

(d) Is this a question?

(e) What is the choice set of this question?

The objective of this paper is to apply the ideas in my original paper on Question Theory to the kinds of questions that arise in Quantum Theory. Even as an IFQ in the Logical Theory may be a WFQ in the psychological theory, so there are syntactically improper questions in LQT that may function as proper questions or WFQ in Quantum Question Theory (QQT) .

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The components listed and described above have been labeled:

$$Q,\ Q[_U].\ \Gamma\ ,\ D,\ X,\ \ C,\ \Sigma\ ,\ E,\ \ \Omega$$

A systematic examination of them will uncover what modifications need to be made of the LQT schema for the purposes of QQT.

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(1) Q is the semantic content of a question, its meaning. A Quantum Question however requires more structure than what one finds in LQT. In Quantum Theory, (also in Relativity) it is not sufficient to ask the question, one must also describe the process by which it will be answered, that is to say, the experimental set-up. The complex of interrogator, question, formal question, and recipient can be assigned the letter I for "instrument"

$$I = F\ (Q,\ Q[_U]\ ,\ \Gamma,\ \Omega.\}$$

Our motivation in formalizing QQT is to establish a framework for the representation of quantum experiments. This excludes whole classes of questions that are quite proper in the logical theory: For example, "What does one find at the center of the moon?" does not specify anything about the technology used in probing the center of the moon. A question more in line with QQT would be "What does a shock wave sent through the moon's center tell us about the minerals located there?"

Example : Let e designates a electron detected on March 15, 2005 at 8:30 AM on the northwest corner of 57th and 7th Avenue in New York City.

Q^1: "Where is the path its taken from then to now?"

An interesting way of restating this question is:

Q^2: "Does e have a locale 5 minutes after its position is measured?" This question embodies the paradoxical character of quantum measurement. For if its location has been precisely measured, the uncertainly in momentum will be so large that its direction and velocity 5 minutes later is virtually unknowable.

On the other hand, if one wishes to limit its velocity and direction, the position measurement must be so vague as to be useless.

The semantic content of Q^1 depends on a decision made by the interrogator to the effect that it does or doesn't mean anything. (The *reality* of the path of e is in fact a *decision* not a controversy.) Although the question can't be answered, it can be considered meaningful. *Hence in QQT there exist meaningful questions without answers , that is to say, question schemas in which it is impossible to extract the set Σ from the set of states C .*

The choice set includes the methodologies used in finding an answer, while the "answers" to these questions must therefore include the explanations given as to why all methodologies fail.

Thus the notion of "explication" discussed above is extended to cover meaningful questions without answers. The explication of Q^1 is:

" The statement '*e followed a unique path after detection*' is true but the nature of the question is such that it is impossible to make a decision between all theoretically possible paths. "

Quantum Theory affords many examples of situations in which an answer is known to exist but cannot be calculated. Among these one includes the Schrödinger Cat questions: the cat must be either alive or dead, but one can't choose between them.

Some legitimate quantum "experiments" have the property that the interrogator's search (Γ , Q, I . $Q_{[U]}$) for the answer Σ brings about the destruction of the domain of inquiry, D! Spin measurements do this. Here are some extra-quantal examples:

(A) Orpheus looks at Euridice to find out of she's really there. Because he's looked she disappears. If he doesn't look he can say truthfully, "Euridice is there in back of me." because Pluto told him that she would be. So its true but untestable.

(B) A Black Hole can't be seen. If it could be seen it wouldn't be a Black Hole. Here we are talking about indirect evidence, which always has some probability coefficient associated with it: "X is probably a Black Hole because of its gravitation effects on surrounding matter".

(C) A farmer decides to experiment with a scheme for curing his horse of the need for food. He systematically reduces the amount of hay the horse is fed each day by a single wisp. After a

few months of this the horse dies of starvation. Concludes the farmer: *" The horse ruined the experiment."*

(D) The *Cosmic Censorship Hypothesis*: **the chaos inside a Black Hole cannot be detected, because detection is a causal process and nothing acausal can escape from the interior of a Black Hole.**

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(2) The syntactic question $Q_{[U]}$: In QQT this is enlarged to cover the "experiment". It is very important because it embodies Bohr's Principle of Complementarity : *The form of the question shapes, even determines, the domain of inquiry* **.**

Example : **the** *two-slit experiment* **, the form of which determines whether one is studying the properties of waves, particles, or something in between.**

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(3) *The interrogator* Γ **:**

Postulate: **In Quantum Theory, the interrogator is identified with the Absolute Frame of the experiment, which is assumed given. See the discussion below.**

Corollary: **The question "Where am I ?" is meaningless in Quantum Question Theory.**

Proof: **Because of the Uncertainty Principle, the investigation of any observable of the Interrogator sets up an infinite regress. The result is an infinite chain: "The uncertainty of the uncertainty of the uncertainty ....". In the limit this goes to infinite uncertainty, or complete absence of knowledge.**

"Where am I?", a thoroughly reasonable question in LQT, becomes an IFQ in QQT! That is because " quantum questions" are "answered" by experiments and measurements, not by logic. Therefore one is obliged to postulate that there is no uncertainty associated with the interrogator's information about himself.

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(3) *The domain of inquiry D* : It is in the very nature of the Uncertainty Principle that the search for the answer to the question alters the domain of inquiry. In QQT therefore, not only is the domain of inquiry determined by the form of the question (Complementarity) , the process of conducting the inquiry must alter the choice set C of this domain (Uncertainty) :

$Q_{[U]} = I(Q)$: Complementarity

$D^* = Q_{[U]}(D)$: Uncertainty

As in LQT, D contains the set X of "observables". These come in non-commuting *sets of adjoints* :

Position/Momentum

Time/Energy

Angular Momentum J^x , J^y, J^z . These do not commute with each other, but all of them commute with J^2 .

Spin σ_x , σ_y, σ_z ...

The experiment implicit in the question will have the effect of altering the relationship between the eigenvalues of these pairs, hence the collection of potential states given in the choice set, C .

Sometimes the investigation will actually alter the set of observables X ! Consider the situations posed by Bell's Theorems. Let p_r, p_l be streams of electrons released in spontaneous pairparticle creation. We measure the spin of the electrons p_r in a fixed direction. This means that the spins measured in any other direction will have been altered by this measurement and are unreliable.

By the Bell correlation, the spins of p_l will be correlated to those of p_r . Hence the spins of p_r measured in any direction other than the fixed direction will also be unreliable. Hence the experiment has rendered unmeasurable the spins of p_l in other directions.

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Cross-Examination

We now imagine the following thought experiment:

It has been stated that QQT does not allow the interrogator to interrogate himself. Imagine however that we have two interrogators Γ_1 , Γ_2 who are investigating each other. This means that the domain of inquiry D_1 of Γ_1 includes Γ_2 or some aspect of him (or her) , while the domain of inquiry D_2 of Γ_2 includes some aspect of Γ_1 . The results are quite interesting.

Γ_1 and Γ_2 are working in the same laboratory at rest in the same reference frame. Each is measuring the location of the heel on the left shoe of the other. Thus D_1 = left heel of Γ_2 ; D_2 = left heel of Γ_1 .The acceptable error to the position measurements is a small number ε .

Γ_1 goes first. By his determination, Γ_2 's left heel is at a location ($x_2 \pm\varepsilon$, $y_2 \pm\varepsilon$). However, this measurement induces an uncertainty into the momentum, and therefore the velocity u_2 , of

Γ_2. If his mass is M_2 then this uncertainty in velocity is of the order of

$$u_2 = h/(2\pi M_2 \varepsilon)$$

Assuming a Galilean reference frame both velocity and position are relative. Therefore, with the displacement of his left heel the *entire body* of Γ_2 is displaced by the "collapse of the wave packet" of Γ_1's ruler in the act of making the measurement.

After Γ_1 has finished Γ_2 sets about to measure the location of the left heel of Γ_1. Yet as seen by Γ_1, Γ_2 will appear to be oscillating with an uncertainty $\geq u_2$. However Γ_2, or more precisely his left heel, is the domain of inquiry D_1 of Γ_1, which has now become unstable.

There are two ways to interpret this situation.

Interpretation 1: Let's assume that there is no laboratory to supply a fixed reference frame, but that Γ_1 and Γ_2, are, by mutual agreement standing on the same plane.

In this case Γ_2 will interpret the uncertainty induced by Γ_1 entirely in terms of a vagueness *in the location of* Γ_1. Symbolically, the uncertainty induced in Γ_2 by Γ_1 *has been thrown onto the domain of inquiry D_2. Γ_2 detects no uncertainty in his own location, since the question "Where am I?" (in QQT) is improper if stated by the interrogator* . Symbolically:

$$Q_1 (\Gamma_2) = \Gamma_2^*$$
$$Q_2^*(\Gamma_1) = Q_2 (\Gamma_1^*) = \Gamma_1^{**}$$

The shifting of uncertainty onto the domain of inquiry is indicated in the second line. otherwise stated, the uncertainty of the interrogator *vis-a-vis* the domain of inquiry commutes.

Interpretation 2 **:** Suppose now that Γ_1 and Γ_2 are in a laboratory which, by common consent, can be taken as a fixed reference frame (space *and* time !) unalterable by any acts of measurement.

In this case Γ_2 will acknowledge that Γ_1's act of measuring the location of his left heel has set up a velocity oscillation *within himself* of uncertainty u_2 .

The problem with this is that it contradicts Newtonian mechanics, by which every action engenders an equal and opposite reaction. The only way of getting around this is to assume that the signal returned to Γ_1 giving him the information about the location of Γ_2 has upset *his* equilibrium as well, inducing a self-uncertainty of velocity of Γ_1 in the amount $-u_2$!

The reason that one doesn't assume this to be the case in classical QT is because it is taken for granted that the domain of inquiry is infinitesimal relative to the interrogator. Experiments are assumed not to produce a backlash onto the interrogator himself. In the situation under discussion , D_1, D_2 ,Γ_1 and Γ_2 are assumed to be of the same order of magnitude. Under this assumption both situations reduce to Interpretation 1, and one reaches the

Conclusion **:** *In classical Quantum Mechanics the Interrogator is identified with the Absolute Frame* .

This is the principal reason why Quantum Theory and Relativity are irreconcilable at the present moment. Strictly speaking, the quantum experiment, or quantum question, violates

the conservation of momentum but the effect is so minute as to be negligible.

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(5) Ω is the "respondent" . In Logical Question Theory, (as opposed to Psychological Question Theory), the "response" is outside of time, in some absolute realm of truth and falsehood. One might say that the response is in "history". The logical question, "On what day of the year do the French celebrate Bastille Day?" does not depend on the willingness of the French to answer the question, or any other temporal consideration. Its answer is "July 14th" irrespective of local circumstances.

However, look at this question in QQT:

" Is an electron a wave or a particle ? "

Since quantum questions are always about the experiments used to answer them, one has to invoke Bohr's Principle of Complementarity, and say that "The answer to that question depends upon the experimental apparatus (1- or 2- slit) used in finding the answer."

The response, the domain of inquiry, the choice collection, and even the set of observables are determined by the form $Q_{[U]}$ of the question !

As Bohr himself observed, a question such as "Does the electron 'exist' before one looks for it?" no longer qualifies as a legitimate quantum question.

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QQT modifications of the LQT schema

(1) By the Uncertainty Principle the question, (or experiment) alters the domain of inquiry. Thus the response must include this information $\Omega = \Omega\ (Q; D^*)$

(2) If the interrogator is not identified with the Absolute Frame, the question will also alter the state of the interrogator. Hence, the total response must be of the form: $\Omega = \Omega\ (Q, D^*, \Gamma^*)$

(3) The form of the question, (the experimental apparatus) , shapes the domain of inquiry D , the collection of states C, the response and sometimes the observables X . (Complementarity)

The QQT schema is modified from LQT as follows:

$$\boxed{\Gamma : \begin{bmatrix} Q \\ \downarrow \\ Q_{[U]} \\ \downarrow \\ I \\ \downarrow \\ D \\ \downarrow \\ X \\ \downarrow \\ C \end{bmatrix} \longrightarrow \Omega(Q, D^*, \Gamma^*)}$$

The semantic intention, Q, of the question is translated by the interrogator , Γ , into the experiment description Q[U] which includes the experimental apparatus I. This shapes the domain of inquiry, the observables, the choice set and the answer. The formation of the answer has altered the choice set, though normally it does not affect the set of observables. The instrument I is also not normally thought to be affected, but this is because the domain is customarily treated as infinitesimal relative to the interrogator. However, if they are of the same order of magnitude, the interrogator himself will be altered.

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