I. THE (EXTENDED) MEASUREMENT PROBLEM

Classical mechanics allows for a transparent picture of the world: If the physical states were its furniture, then the thing-in-itself would be immediately accessible: Momentum and position of massive objects were, in principle, not barred from immediate and simultaneous perceptual access. Physics provided a powerful language: There were seemingly no boundaries to what it could describe—and with that: tame. Since the wake of quantum mechanics, the idea of an immediately accessible underlying reality described by physical theories has gotten cracks. One of the problems besides non-locality and contextuality: The quantum-mechanical formalism cannot simply be extended to an exhaustive description of the observer—if it were extended, then what would we make of an observer in a superposition state?

The problem is commonly exemplified with the Wigner’s-friend experiment: Wigner performs a measurement on a joint isolated system \( S \otimes F \) containing his friend \( F \) who, in turn, measures a system emitted by a source \( S \). If the measurement bases of Wigner and his friend are chosen appropriately with respect to the emitted source state, then the probability distribution of Wigner’s measurement of \( S \otimes F \) is ambiguous: It depends on whether the friend’s measurement is considered to be a quantum-mechanical evolution with a corresponding unitary operator on the joint system or it is taken to induce a “collapse” associated with a definite measurement result.

But what is the actual problem here? Is there a contradiction at the heart of the quantum-mechanical description? Is quantum mechanics in this sense fundamentally broken? Is something wrong with quantum mechanics rather than with the expectation of a physical theory describing the real thing-in-itself? The Fruaigher/Remmer article seems to provide an affirmative answer. The measurement problem is not just a peculiarity of quantum mechanics being probabilistic; the problem can be exemplified with a single-shot Gedankenexperiment—in an extended Wigner’s-friend experiment. The authors concluded in an earlier version that, therefore, “single-world interpretations are inconsistent.” The conclusion relies on carrying over the inconsistency of a formalism to one possible interpretation.

Just as conclusions from an extended Wigner’s-friend experiment to interpretations are in doubt, so are claims that, because of the Gedankenexperiment, quantum mechanics is more troubled than it has been before. If quantum mechanics is regarded as a probabilistic theory over a non-distributive lattice, then it is not the probabilistic trait that is problematic: The joint system \( F \otimes S \) is in a superposition, not a statistical mixture, as it might have also been the case in a probabilistic theory over a Boolean lattice. If it were in a statistical mixture, there would not be a problem; it is the contextual character of a non-distributive lattice that is essential to the measurement problem. In this regard, it is secondary whether the problem becomes apparent in one or merely in a limit of multiple runs. So after the extended Wigner’s friend experiment, quantum mechanics is just as broken as it has been before—or not: If the terms “isolated system,” “interaction,” and “measurement” are used carefully, there is less of a problem.

Contextuality can be regarded as a consequence of subjecting interactions themselves to experience, and, thus, rendering them meaningful. Then, the measurement problem is not a mere insufficiency of quantum mechanics but rather inherent to particular requirements for physical theories—inherent to a specific way of picturing the world. The measurement problem, thus,
begs to reflect on the basic assumption and aspirations of doing physics.

II. THE “MEASUREMENT” PROBLEM

Maudlin’s reading of the measurement problem [15] is the inconsistency of the following triad: (a) The time evolution of isolated systems in quantum mechanics is unitary; (b) measurement results are exclusively one of several possible values; (c) quantum mechanics is complete. Statements [a] and [b] are fairly undebated: The first is a matter of definition, and the latter a necessary requirement for falsifying theories [17]. The last statement [c], however, is a relic of the hegemonic aspirations of physics rooted in a traditional understanding insinuating a correspondence of a theory’s symbols with reality: A “measurement” does here not only mean an interaction between two systems, but is the exhaustive description of an observation—the account of experience that yields the normative empirical evidence for the validity of physical theories, including, paradoxically, quantum mechanics itself. If, however, there is no privileged language, e.g., for reasons rooted in the nature of meaning and reference [13, 18–21], then quantum mechanics does not have such a privileged status either: The reduction of an observation (a meaningful account of experience) to symbols of a formal language is in doubt. A measurement as an interaction between two systems is, in this regard, not equivalent to an observation as an account of experience constitutive to meaning [10]: The measurement is not so much of a problem, after all.

III. CHANGING PERSPECTIVE

Whether or not there is an actual problem that needs to be solved, one may ask: What are the characteristics of theories that are troubled by the measurement problem? Under which circumstances are we to expect a measurement problem? What is so peculiar about quantum mechanics that it gives rise to the “measurement problem”? What is so peculiar about classical mechanics that it does not? If we cannot make sense of the measurement problem, then what is a perspective in which we can?

If one requires (a) physical theories to account for interactions so that they are empirically significant, and (b) that an observation necessarily goes with such an interaction, one can develop a language game that leads to probabilistic and contextual theories [11]. A “Born rule” that assigns probability weights to ordered sets of measurements as well as the measurement problem naturally accompany such theories. Then, in fact, classical mechanics seems strange as it is a theory without the ability to empirically trace the interaction—the causal link—necessary for sensory perceptions: In classical mechanics, a system has determinate position and momentum if it is sufficiently characterized. It is assumed that “reading off” the value of position and momentum does not rely on an interaction—and potentially disturbance of the system—in a way that is captured by classical mechanics itself. In fact, if it were, then the system’s behavior would be indeterminate. Thus, classical mechanics does not provide the ability to detect measurements. In other words: There is no key-agreement protocol like “BB84” [2].

IV. KNOWLEDGE — POWER

Why is it appealing to embrace the last of Maudlin’s statements, i.e., the assumption that quantum mechanics—or any other physical theory, for that matter—is complete? What tempts to believe that quantum mechanics can provide an exhaustive description of an observer’s account of experience—that quantum mechanics can excavate the “ultimate real truth”? If physics, and in particular quantum mechanics, is attributed a privileged access to reality, then physics attains a special and powerful role. The unwillingness to even raise doubts about the exhaustive completeness of physical theories can be considered from a perspective of power and influence: Such doubts might undermine this special authority. The link between discursive authority and a scientific language becomes apparent in Foucault’s discourse analysis. For instance, the focus of a “science of the subject” has been narrowed down on sexuality—“[n]ot, however, by reason of some natural property inherent in sex itself, but by virtue of the tactics of power immanent in this discourse” [23, p. 70]. The result: “We have placed ourselves under the sign of sex, but in the form of a Logic of Sex, rather than a Physics. [...] Whenever it is a question of knowing who we are, it is this logic that henceforth serves as our master key.” [23, p. 78] Sexuality could become the all-ruling

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3 The corresponding statement in [15] refers to linear time evolution following from the Schrödinger equation. The inconsistency arises merely if Wigner’s friend, measuring a system, is isolated, and, thus, the evolution modeled by a unitary operator.

4 Collapse theories, such as GRW [16], give rise to different statements and can, thus, be considered as formally different theories.

5 Dewey remarks that the quest for absolute and unchangeable truth drives towards a “spector theory”: “The common essence of all these theories, in short, is that what is known is antecedent to the mental act of observation and inquiry, and it totally unaffected by these acts; otherwise it would not be fixed and unchangeable. [...] The object refracts light to the eye and is seen; it makes a difference to the eye and to the person having an optical apparatus, but none to the thing seen. The real object is the object so fixed in its regal aloofness that it is a king to any beholding mind that may gaze upon it. A spectator theory of knowledge is the inevitable outcome.” [23, §1, p.26] The interaction assumption might not be perspective easily embraced by physicists if it limits the ability to attain absolute knowledge.
language because it attained the status of a science, with a “logic” of its own, and the ability to produce real and exhaustive knowledge. This iterates the myth of a privileged access to reality and a derived privileged discursive status of science—a political extension to the myth of the given. But it reveals at the same time that there is not one scientific language we are inevitably converging to: Instead, it is a question of power tactics what to put into the scientific focus—in this case, how to choose a perspective onto the subject.

Does “putting ourselves under the sign of a Physics” liberate us from the struggle for semantic authority? Feynman [26] and Kuhn [27] debunk the idea of physics being somewhat “better” than other scientific disciplines. And why should it be?

It seems perfectly clear, at least since Wittgenstein and Sellars, that the ‘meaning’ of typographical inscription is not an extra ‘immaterial’ property they have, but just their place in a context of surrounding events in a language-game, in a form of life. This goes for brain-inscriptions as well. [10, §1.12]

What are the consequences of embracing a linguistic “master key” to knowledge and truth about the subject? A new master key is game theory with its fundamental paradigm of the rational and egoistic player—the homo economicus. To conclusively “understand the subject,” we merely have to know his objective function. The view appeals also to physicists [28]. Schirrmacher [4] investigates [24, 30] how modelling the subject as an egoist agent pursuing the maximum of his quantifiable objective is a discourse that produces egoists—a discourse that unconditionally equates “sensible” with “egoistic.” If we replace that key by artificial intelligence [31]: The problem remains. The way we look at things or subjects shapes what and how we see it. [2]

The search for absolute truth has normalising, ordering, and narrowing effects.

We have been referring to subjects, complex human beings. The described effects may not apply to the world of physical objects governed by the physical laws discovered by physics. [11] On a fundamental level, we may still “be” quantum systems. So are we then quantum brains-in-a-vat, connected by quantum channels? Is all we ever refer to—all we mean if we talk about things—eventually not an external thing, but a quantum state [20]? This undermines what we essentially consider “doing physics:”

1. Doing physics establishes meaning. It adds something to our language that is not inherent to it in the first place.

2. The process of learning, understanding, and discovering continues. Quantum mechanics—and its current understanding—is not the end of physics. We may expect—and search for—paradigm shifts as they happened before.

Instead of trying to save quantum mechanics as the one privileged access to reality, or taking the measurement problem as an indicator that there must be another such privileged access, we advocate a pragmatic—in a philosophical sense—search for perspectives onto and descriptions of the world out there. Any theory must have the modesty to allow for something in our experience that it cannot grasp. No theory can claim for itself to have exhaustively captured an observer’s account of experience, while it draws legitimacy from experimental findings.

Quantum mechanics is not the master key, but it is not broken either.

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6 If what we mean is not an immaterial property—as observed by Rorty—, then we can also not conclude from some theory alone on the conclusions of an observer, as demanded by “consistent reasoning” in [5].

7 The epigraph of [24] is, not surprisingly, a quote from Foucault: “We should not try to discover who we are, but instead who we refuse to be.” [own translation]

8 “Das Problem ist, dass die Theorie nicht nur Handeln beschreibt, sondern Handeln erzwingt, sie ist nicht nur deskriptiv sondern normativ. Sie postuliert nicht nur Egoisten, sie produziert sie. Die Rationalität, die sie sich auf die Fähnen schreibt, kommt nicht von selbst. […] Vernünftiges Verhalten des Gegners entsteht nicht durch vernünftige Argumente, sondern durch Drohung und Angst vor Vernichtung.” [23, §6] In short: Fear-mongering aligns the agents with his game-theoretic model. With the application of game theory to economics the agents have shifted from states to persons—and so have the targets of the alignment process.

9 Schirrmacher sees close links between the game-theoretic mod-
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