(This document was created 2003-Dec-31-09:36 in Vail, Colorado, and it was most recently altered (until this note was added) on 2004-Feb-01. It was submitted to Nature on 2004-Nov-14. The word count was 2203, while the word count for "The mental Universe" is 1016.)

A Clearer Light
Richard Conn Henry

Human folk have historically looked to our intellectual leadership—our religious leaders—to understand the meaning of our lives, and the nature of our world. Many among us still do today. But, with Galileo Galilei, a new element arrived. Galileo succeeded in believing the *unbelievable*, regarding the physical world: "were it not for the existence of a superior and better sense than natural and common sense to join forces with reason, I much question whether I, too, should not have been much more recalcitrant toward the Copernican system than I have been since a clearer light than usual has illuminated me." [1] But Galileo did much *more* than simply *himself* succeeding in believing this impossibility: he succeeded in having *you too* believe (and indeed nowadays *effortlessly* believe) that the Earth goes around the Sun. This was, and remains, a stunning accomplishment in physics outreach.

So, with Galileo and then with Newton, religion was joined by physics in teaching us our place in the universe and the nature of that universe. With the explosive growth of physics over subsequent years it is hardly surprising that premature and very wrong conclusions were reached concerning what physics actually teaches us. It can be argued that those incorrect mechanistic conclusions about the nature of the universe did immense damage to humankind, perhaps propelling both the communists and the Nazis.

Yet a *correct* understanding of what physics *does* teach us was accessible even to Pythagoras: "number is all things," and numbers are nothing but *mental*. Galileo's only mention of Kepler, in his greatest book, is to hold Kepler up to contempt: "But among all the great men who have philosophized about this remarkable effect [tides], I am more astonished at Kepler than at any other. Despite his open and acute mind, and though he has at his fingertips the motions attributed to the earth, he has nevertheless lent his ear and his assent to the moon's dominion over the waters, to occult properties, and to such puerilities." Newton, too, was baffled at the occult nature of gravitation. Yet while Newton extended the (false) notion of "particle" to include light, he was nonetheless deeply insightful that this whole concept is but an effective theory, profoundly useful but hardly *true*. Newton's biographer Westfall says, "The ultimate cause of atheism, Newton asserted, is 'this notion of bodies having, as it were, a complete, absolute and independent reality in themselves…' " [2] This depth of Newton's insight explains how, despite Newton's Rings, he could still talk of light as particle; Newton did not have the trouble so many people do today regarding what is still sometimes, and shallowly, called "wave/particle duality."

With the discovery of quantum mechanics in 1925, the whole problem was solved. The brighter physicists were led, just as Galileo had been, to "believe the unbelievable," in this case that the universe is *mental*. Arthur Koestler, [3] after leading his readers brilliantly through the Galilean achievement, ends by noting this next (and final) frontier: " … the stream of knowledge is heading towards a non-mechanical reality; the universe begins to look more like a great thought than like a great machine. Mind no longer appears to be an accidental intruder into the realm of matter; we are beginning to suspect that we ought rather hail it as the creator and governor of the realm of matter [quoting Sir James Jeans]." Koestler also quotes Eddington,

"The stuff of the world is mind-stuff. The mind-stuff is not spread in space and time; these are part of the cyclic scheme ultimately derived out of it. But we must presume that in some other way or aspect it can be differentiated into parts. Only here and there does it rise to the level of consciousness…"

And yet, the second and *greater* half of the equivalent of Galileo's achievement in his own time, namely the implanting of the new understanding into the minds of the broad mass of humanity, has not been achieved to this day. This is the shame of physics. The leadership of physics has failed to implement the outreach to humanity of the profound understanding that we have gained regarding the nature of humanity, and the nature of the universe, arising from the discovery of quantum mechanics. Humankind, despite all the reading of popular books about time and superstrings, has been left with a quite incorrect idea of a "universe of things."

It is easy enough to understand why we have failed. Galileos are much, much, rarer than are, for example, Nobel-quality physicists. Eddington's understatement explains it all: "It is difficult for the matter of fact physicist to accept the view that the substratum of everything is of mental character." [4]

What does our leadership in physics today actually tell the people? On 2002 March 2 John H. Marburger III, President G. W. Bush's science advisor, addressed a broad audience on the subject of the Copenhagen interpretation of quantum mechanics. [5] The event was an all-day symposium at the Baird Auditorium of the Smithsonian Institution, occasioned by the presentation of Michael Frayn's play "Copenhagen" at the Kennedy Center in Washington, DC. Marburger in his presentation said some wonderful and true things that are rarely said, in public or in private, by physicists, e.g. "In the Copenhagen Interpretation of microscopic Nature, there are *neither* waves *nor* particles." Unfortunately Marburger's otherwise excellent remarks are framed in terms of a non-existent "underlying stuff." "It is not true that the underlying stuff sometimes behaves like a wave and sometimes like a particle." "*The wave is not in the underlying stuff, it is in the spatial pattern of detector clicks*." And, best of all, "We cannot help but think of the clicks as caused by little localized pieces of stuff that we might as well call particles. This is where the particle language comes from. It does not come from the underlying stuff, but from our psychological predisposition to associate localized phenomena with particles." Marburger's is the clearest statement that I have seen, from today's leadership of physics, that there are no particles (as we think of such).

The "Galileo" of quantum mechanics was, unfortunately, Albert Einstein. Unlike Galileo, Einstein jumped the *wrong* way. We all live today with the sad consequences of this fundamental mistake by our greatest recent leader. And no one has emerged to set things right.

The truth, as Eddington indicated, is difficult to believe, and it is not surprising that alternatives have been presented that purport to preserve a material world. But these alternatives are all sham, productive of no new physics and having as *purpose* only the preservation of illusions. "The so-called interpretations of quantum theory introduce new concepts, such as an infinity of parallel worlds, without any experimental support nor any benefit to the theorist …. These gratuitous additions to quantum theory are the true analogs to Ptolemy's epicycles…" [6] Scientists have, sadly, left it to the non-physicist, playwright Michael Frayn, [7] to point out the Emperor's lack of clothes: "I hesitate to express any reservations about something I understand so little, particularly when it comes from such an authority, but it seems to me that the view which Gell-Mann favours, and which involves what he calls alternative 'histories' or 'narratives', is precisely as anthropocentric as Bohr's, since histories and narratives are not freestanding elements of the universe, but human constructs as subjective and as restricted in

their viewpoint as the act of observation." A Nobel prize in physics is no guarantee of understanding of quantum mechanics: witness the criticism of Lamb's [8] recent effort by Luzuriaga; [9] witness the criticism of Weinberg's [10] by Polchinski. [11] But in agreeing ultimately that quantum mechanics cannot be tampered with, Weinberg [12] points out the amazing fact that quantum mechanics despite its successes does not supply the Hamiltonian! I wonder if we have looked hard enough at where quantum mechanics comes from? [13]

Physicists shy away from the truth because the truth is so alien to our everyday physics. Marburger quotes Frayn (who is speaking as Bohr), "we discover that there is no precisely determinable objective universe. That the universe exists only as a series of approximations. Only within the limits determined by our relationship with it. Only through the understanding lodged inside the human head," but instead of continuing the quotation, Marburger says "I would demur only on the final sentence. It is not through our understanding that the universe exists, but through countless mousetrapping events…" Had Marburger continued, he would have had to quote Bohr's wife Margrethe, "So this man you've put at the center of the universe—is it you, or is it Heisenberg?" *This* is what sticks in the craw of the physicist, although we did see, above, that Eddington felt that *he* could cope with the problem.

"… we were not led to reject a freestanding reality in the quantum world out of a predilection for positivism. We were led there because this is the overwhelming message quantum theory is trying to tell us." [14] The most common evasion today of this reality (or rather non-reality) is called decoherence. We have seen that Marburger in his talk never actually expounds the Copenhagen interpretation, but instead breaks into advocacy of decoherence with its mousetrapping events. Yet the idea that an irreversible act of amplification ("mousetrap") is necessary to collapse the wave function has long been known, and by *experiment*, to be simply wrong. In what is known as a "Renninger type experiment," the wave function is collapsed simply by a human mind seeing *nothing*. No irreversible act of amplification involving the photon has taken place—yet the decision is irreversibly made. The universe is *entirely* mental.

In 10th century, Ibn al-Haytham [15] initiated the view that light proceeds from a source, perhaps reflects from something, and then enters the eye, where it is perceived. This picture is wrong—not true—but it is still what most people think occurs, including, unless pressed, most physicists. If humanity is to come to terms with the universe, we must abandon such incorrect views. The world is genuinely quantum mechanical, and we must learn to perceive it as such.

The experiment has not yet been done (and it may not be worth doing, because the result is certain), but appropriately delayed beams from two gravitationally-lensed images of a single quasar show interference fringes, establishing unequivocally that there can be no light "out there" that is "on its way." There is not *anything* "out there." But please—we already knew that in 1925.

There is absolutely no reason we cannot switch humanity to a correct perception of the world—and there are profound benefits in doing so. The first benefit does not affect physicists (*as* physicists), and that is the spreading of the philosophical joy of discovering the mental nature of the universe. We have no idea what this means; and we seem to have no hope of ever *learning* what it means; but—the great thing is—it is *true*. *Physics* cannot help anyone from this point onwards. You may, if you wish, descend into solipsism (but do be careful not to blush); or, you can expand to the Deism of George Washington and Benjamin Franklin and Thomas Adams and Thomas Jefferson and the other non-Christian founders of America; or … something else, if you can justify it—just don't ask physics for help!

But the second benefit does indeed affect physicists as physicists. Anyone who has learned to fully accept that nothing exists except the observations themselves, is light years ahead of peers who stumble through physics ever hoping to find out what things are. If we can "pull a Galileo," and get people *believing* the truth, they will find physics a breeze from that point on. And … perhaps some bright graduate student will find that Hamiltonian!

Richard Conn Henry is Professor of Physics and Astronomy at The Johns Hopkins University in Baltimore.

References

1. Galileo Galilei, *Dialog Concerning the Two Chief World Systems*, trans. S. Drake, U. of California Press, Berkeley & Los Angeles (1953), p. 328.
2. Westfall, R. S., *Never at Rest*, Cambridge University Press, Cambridge (1980), p. 302.
3. Koestler, A. *The Sleepwalkers*, Penguin Books (1959), p. 542.
4. Eddington, *The Nature of the Physical World*, Cambridge University Press, Cambridge (1948), p. 281.
5. Marburger, J. *On The Copenhagen Interpretation of Quantum Mechanics*, http://www.ostp.gov/html/Copenhagentalk.pdf
6. Fuchs, C. A. & Peres, A., PHYSICS TODAY, September 2002, page 14.
7. Frayn, M. Copenhagen, Anchor Books, New York (2000), p. 101.
8. Lamb, W. E., Am. J. Phys. **69**, 413 (2001).
9. Luzuriaga, J., Amer. J. Physics **70**, 10 (2002).
10. Weinberg, S., Phys. Rev. Lett. **62**, 485 (1989).
11. Polchinski, J., Phys. Rev. Lett. **66**, 397 (1991).
12. Weinberg, S., *Dreams of a Final Theory*, Pantheon Books, New York (1992), p.237.
13. Henry, R. C., in *Bell's Theorem, Quantum Theory and Conceptions of the Universe*, ed. M. Kafotas, Kluwer, Dordrecht (1989), p. 175; Henry, R. C., Amer. J. Phys **58**, 1087 (1990); Steiner, M., *The Applicability of Mathematics as a Philosophical Problem,* Harvard University Press, Cambridge, MA (1998), Appendix A.
14. Fuchs, C. A. & Peres, A., PHYSICS TODAY, September 2002, page 90.
15. Rashed, R., Science **297**, 773 (2002).