The Observer Effect[1]

The observer effect is that to observe anything we must interact with it, which changes it. Now according to quantum theory, when a quantum wave interacts in a physical event, it immediately acts just like a point particle, giving the measurement paradox that:

"*The full quantum wave function of an electron itself is not directly observable…*" (Lederman & Hill, 2004) p240

We can't in principle see a quantum wave, as any attempt to do so collapses it to a point event. How then can a science based on observation study quantum waves that by definition can't be observed? This issue wasn't resolved last century, and so far this century is no different:

"*The history of the quantum measurement paradox is fascinating. There is still no general agreement on the matter even after eighty years of heated debate*." (Laughlin, 2005) p49.

On the one hand, well known scientists hold that only "*…what impinges on us directly is real*." (Mermin, 2009) p9, but on the other hand a theory of unobservable quantum states is the most successful theory in the history of science. The paradox is:

1. Quantum theory is part of science,
2. Science is about the physical world we see,
3. We can't see quantum waves, so science can't study them. Yet it does.

Either quantum theory isn't part of science or the currently accepted definition of science is wrong. Indeed the second assumption above is based on *logical positivism*, a nineteenth century ideology that only what is directly observable is real, i.e. only the physical is real. It is distinct from the *empiricism* of Locke and Hume, that theories be *tested* by physical observables. In this confusion, its masquerades as an axiom of science, but it failed every field of science that adopted it, e.g. behaviorism is now discredited in psychology. The last holdout is physics, but quantum theory attests that a scientific theory that does *not* describe the physical world can succeed. Science has to *predict* the physical world (empiricism) not *describe* it (positivism). Quantum theory is science because it predicts physical states, whether its quantum states are physical or not.

We don't see the world from above like a bird, but from the ground like a frog. Our *frogs-eye view* makes us embedded observers, unable to see for example relativistic changes of time or space as they change us too. If we were above it all like a bird surveying an objective world, quantum theory would be impossible, but as frogs always participating in reality, it is possible that we create it by our acts. If the act of observing quantum reality creates a physical view, then quantum waves can't be viewed for the same reason that a camera can't take a picture of itself. Nature's *information firewall* censors what we can and can't know. As the great philosopher Kant observed, what we see a view or *phenomenon*, not the "thing in itself" or *noumenon*. Modern physics tells us that the latter is a quantum reality. Note that in physics all interactions are symmetric, so as we observe a photon it also "observes" us. In quantum realism, *everything is observing everything else*, and we aren't special observers in any way.

Laughlin, R. B. (2005). *A Different Universe: Reinventing physics from the bottom down*. New York: Basic Books.

Lederman, L. M., & Hill, C. T. (2004). *Symmetry and the beautiful universe*. New York: Prometheus Books.

Mermin, N. D. (2009). Whats bad about this habit? *Physics Today, May*.

[1] This is section 3.7.2 from Chapter 3 The Light of Existence, of the book Quantum Realism by Brian Whitworth, currently under development. The link gives a free early access to the whole chapter.