Physics 427/Philosophy 427—Philosophy of Physical Science

(Co-convened with Philosophy 527)

In Fall 2016 this course will be co-taught by Professors Healey and Ismael

Quantum mechanics is perhaps the most successful theory of all time, when judged by the scope and accuracy of its predictions and its explanatory power. But what does the empirical success of quantum mechanics tell us about the world in which we live? Ever since its consolidation nearly 90 years ago there have been heated debates about how to answer this question. As we'll see, the issues raised in the classic debate between Bohr and Einstein have been sharpened, but not clearly resolved, by subsequent thinkers.

One issue is indeterminism: does quantum mechanics show that physical processes are ultimately chancy, so that exactly similar circumstances may lead to different outcomes? If it does, then what becomes of our concept of causation (not to mention free will)?

Another issue is locality: does quantum mechanics show that a distant system may be instantaneously affected by what is done to another system hereabouts? If it does, then isn't that incompatible with the theory of relativity?

In quantum mechanics, measurement seems to play a very different role than in other theories. Do our observations create, rather than merely revealing, the phenomena? If they do, what can we say about any world (or worlds!) lying behind these phenomena? Can quantum mechanics even give a consistent account of the process of measurement? We'll also take a quick look at some currently "hot" topics like quantum computation and information, quantum cryptography, and quantum teleportation.