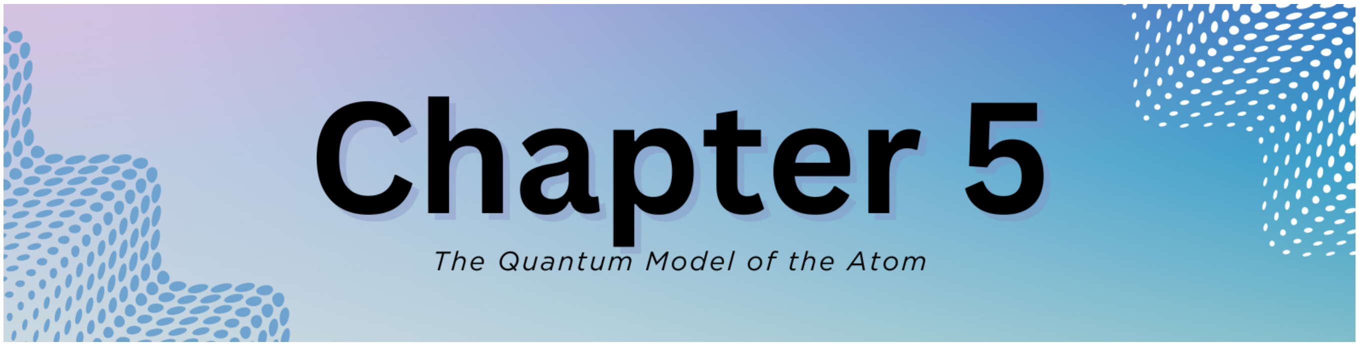
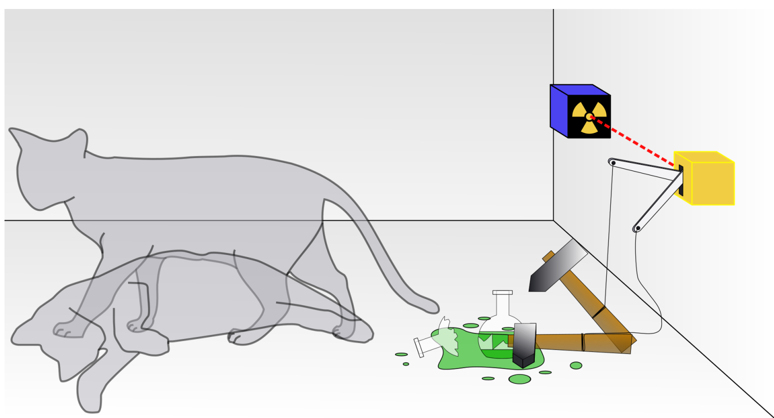
CHAPTER OVERVIEW

5: The Quantum Model of the Atom



In the early 1930's Erwin Schrödinger published a way of thinking about the circumstance of radioactive decay that is still useful. We imagine an apparatus containing just one Nitrogen-13 atom and a detector that will respond when the atom decays. Connected to the detector is a relay connected to a hammer, and when the atom decays the relay releases the hammer which then falls on a glass vial containing poison gas. We take the entire apparatus and put it in a box. We also place a cat in the box, close the lid, and wait 10 minutes.



Schrödinger's cat: a cat, a flask of poison, and a radioactive source are placed in a sealed box. If an internal monitor detects radioactivity (i.e., a single atom decaying), the flask is shattered, releasing the poison, which kills the cat. The Copenhagen interpretation of quantum mechanics implies that after a while, the cat is simultaneously alive and dead. Yet, when one looks in the box, one sees the cat either alive or dead, not both alive and dead. This poses the question of when exactly quantum superposition ends and reality collapses into one possibility or the other. (CC BY-SA 3.0; Dhatfield).

A diagram of a box which has the superposition of both states. The diagram of both the dead and alive cat are present, along with the intact and broken flask, as well as the released and unreleased hammer attached to the radioactive sensor.

We then ask: Is the cat alive or dead? The answer according to quantum mechanics is that it is 50% dead and 50% alive.

Quantum Mechanics describes the world in terms of a *wave function*. DeWitt wrote about the cat that "at the end of [one half-life] the total wave function for the system will have a form in which the living cat and dead cat are mixed in equal portions." (Reference: B.S. DeWitt and N. Graham, eds., **The Many-Worlds Interpretation of Quantum Mechanics** (Princeton, 1973), pg. 156.) When we open the box, we "collapse the wave function" or "collapse the state" and have either a live cat or a dead cat.

Of course, this is just a thought experiment. So far as I know nobody has actually every done this experiment. In a sense the cat is a "red herring" [sorry!]. The paradox is just an illuminating way of thinking about the consequences of radioactive decay being totally random. Imagine we have a friend waiting outside when we open the box. For us the wave function collapses and we have, say, a live cat. But our friend's wave function does not collapse until he comes into the room. This leads to a strong solipsism, since our friend can they say that we owe our objective existence to his kind intervention in coming into the room and collapsing our state.

As Heisenberg said, then, "The wave function represents partly a fact and partly our knowledge of a fact." Our friend needn't have come into the room to collapse his wave function: if we have a cell phone we can call him and tell him the result of the experiment. Of course, this assumes that we don't lie to him and tell him the cat is dead when it is alive. Unexplained but apparently true is the fact that when a state collapses, it collapses into the same state for everybody. If we see a live cat everybody sees a live cat (unless they or us are hallucinating).

Chapter Sections
