QSIT 2009 - Questions 1

24. September 2009

1. **State Space in Quantum Mechanics**

   Figure out the relevant Hilbert space for Schrödinger's famous cat, whose fate is described as follows:

   > One can even set up quite ridiculous cases. A cat is penned up in a steel chamber, along with the following device (which must be secured against direct interference by the cat): in a Geiger counter there is a tiny bit of radioactive substance, so small, that perhaps in the course of the hour one of the atoms decays, but also, with equal probability, perhaps none; if it happens, the counter tube discharges and through a relay releases a hammer which shatters a small flask of hydrocyanic acid. If one has left this entire system to itself for an hour, one would say that the cat still lives if meanwhile no atom has decayed. The psi-function of the entire system would express this by having in it the living and dead cat (pardon the expression) mixed or smeared out in equal parts.

   [English translation of E. Schrödingers *"Die gegenwärtige Situation der Quantenmechanik"*, Naturwissenschaften 23 (1935), which appeared in the Proceedings of the American Philosophical Society (1935).]

2. **Unitary evolution of a quantum system**

   Based on the previous question, write down into which state the system evolves, when initially the cat is alive and the substance is undecayed. Discuss, whether the evolution is unitary.

3. **Measurement process**

   Look into the steel chamber, i. e. measure the state of the cat. How does the formal measurement operator look like and what's the probability to find the cat alive?