Determining When Schrödinger's Cats Die

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Abstract

Calibration to a non-local standard is required to precisely measure the time when Schrödinger's cats die.

Determining When Schrödinger's Cats Die[i]

In 1935, Schrödinger proposed this thought experiment:[ii]

> *"One can even set up quite ridiculous cases. A cat is penned up in a steel chamber, along with the following diabolical 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 one 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 first atomic decay would have poisoned it. The ψ 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."*

The operation of Schrödinger's thought experiment includes many experimental runs, destroying one cat in each run. After each run the diabolical device is reset and another unfortunate cat is penned in for the next run. Schrödinger stated the mean probability of one atom's decay is one hour.

In fact, the diabolical device causes each cat's death a short (assumed fixed in the figures) time after an atom's decay. The two hat shaped (^) curves in the figures represent one ψ (wave function) relationship. Any two curves where the mean atom's probability of decay was 0.5 at 1 hr would fit Schrödinger's description.

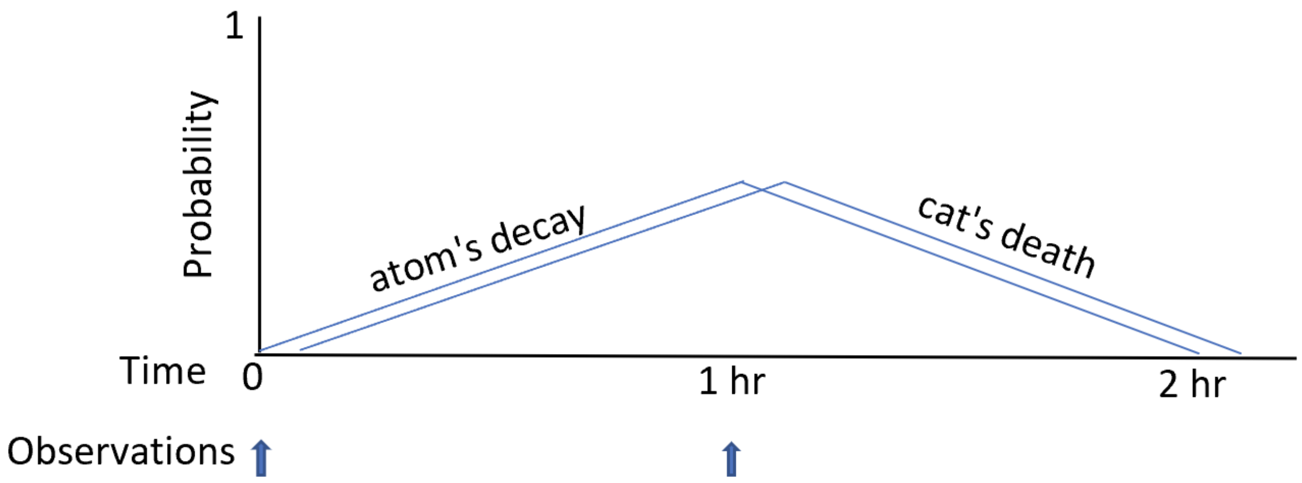

Fig. 1. When Schrödinger's cats die.

Each experimental run identifies a point on a curve representing one atom's decay time and a point representing one cat's death time on the respective hat shaped curves in Fig. 1. Many experimental runs produce the two parallel, offset and hat shaped curves shown in Fig. 1. At the bottom of Fig. 1 the upward bold arrows indicate the two times when a human observes the cat's state in each run.

An atom in each run has a 0.5 probability of decaying at one hour from the start. The figures assume the maximum distribution of each atom's decay and each cat's death is roughly 2 hours.

Schrödinger indicates there are two human observations of each cat's state, the first when a cat is penned into the diabolical device (time 0) and the second time at 1 hour, near the middle of the approximate 2 hour range. These two observations identify a time measuring apparatus with a one hour interval (e.g., a timer which sounds at one hour). At these two times each cat's actual state is observed. Each cat's actual time of death occurs sometime over the 2 hour range but is only determined with a precision of +/- one hour

In each run of the experiment, an alive cat is penned in at time 0 and a second human observation of the cat occurs one hour after time 0. The actual time of death of each cat is rarely at 1 hour. But probabilistically, in half the runs the cat is still alive when observed at 1 hour, and in half the runs the cat is already dead at 1 hour.

A distribution of the cat's states includes both alive and dead cats during this two hour range because the +/- one hour precision of the time of a cat's death overlaps the approximately two hour range of the atom's decay.

In Fig. 2, the time unit between observations is changed to 10 minutes. Now the human's observations occur every 10 minutes (10 minutes = 1/6 of one hour time unit) which is a more precise calibration given the approximately two hour total atom decay time. Then the observed time of a cat's death is within +/-10 minutes of the actual time of death. As the time units become smaller, the precision of the measurement result of each cat's death time increases.

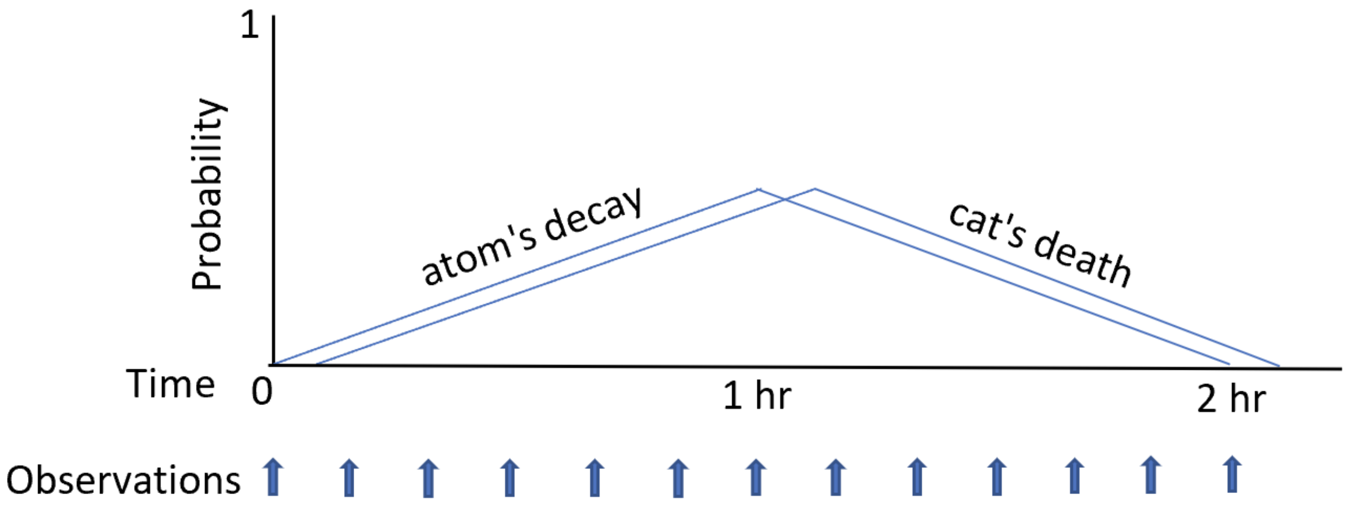

Fig. 2. After recalibration, when Schrödinger's cats die.

Fig. 2 recognizes that in Schrödinger's thought experiment, the measurement result precision is determined by the time interval between human observations. In all physical measurements the precision of a measuring apparatus interval (MAI) is determined by calibration of the MAI to a standard. Where calibration divides each interval into equal value segments and compares each segment to a standard segment (i.e., 10 minutes time) or factor thereof.

Thus, Schrödinger's experiment actually identifies that when calibration is imprecise in his thought experiment, a precise measurement result is not practical. Calibration must be included in a measurement theory whenever the calibration precision is not considered infinitesimal.

Currently, calibration in all physics is treated only as an experimental process which adjusts a physical measuring instrument. [iii] This is only valid for classic measurement results where the calibration precision may be considered infinitesimal.

Any precise measurement, in theory or practice, is produced by a measuring apparatus calibrated to a unit standard.[iv] The first calibration process actually identifies the property (mass, length, time, spin, etc.) of a measuring apparatus as well as determines the precision of all measurement results in theory or practice.

Schrödinger's view that the atom's decay and a cat's state have one ψ function is correct, but does not recognize how the calibration of the observations changes precision. When calibration to a non-local standard is included in measurement theory, each measurement result is not one certain state, but has a precision, even the life of a cat.

Notes

[i] An earlier version of this paper (without the figures) appeared on the blog ScienceX June 17, 2020. https://sciencex.com/news/2020-06-schrdinger-cat.html?utm_source=nwletter&utm_medium=email&utm_campaign=daily-nwletter

[ii] E. Schrödinger, "The Present Situation in Quantum Mechanics". First published in German in Naturwissenschaften 23, 1935. This translation (J. D. Trimmer) first appeared in the *Proceedings of the American Philosophical Society*, 124, 323–38 (1980).

[iii] D. H. Krantz, R. D. Luce, P. Suppes, A. Tversky, *Foundations of Measurement*, Academic Press, New York, 1971, Vol. 1, page 32. “The construction and calibration of measuring devices is a major activity, but it lies rather far from the sorts of qualitative theories we examine here”.

[iv] K. Krechmer, Relative measurement theory (RMT), Measurement, 116, 2018, pp. 77-82.