Quantum Mechanics: Physics AP C
Introductory Reading

Standard Deviation/ σ : When data is gathered in an experiment without a bias, it falls within a random range of values that we represent by a normal distribution, that is, a bell-shaped curve based on the mean value. The standard deviation represents how much variation there is from the mean, and the number of data points in an area decreases as the number σ value goes up. 68% of data will be within one σ, 95% within two, and 99.7 % within three, and 99.994% within four. Only 1 data point in 3,500,000 willfall at five σ by chance alone. The more standard deviations away you are from the mean, the more likely it is that what you’re observing is not due to random chance. But likelihood ≠ certainty.

Null Hypothesis: When a positive claim is made, we attach a burden of proof to it. This burden of proof is called the null hypothesis. The null hypothesis is the negation of any claim that’s made (e.g. in a pharmaceutical study, the null hypothesis is that a new drug acts no differently than a placebo). Once a claim has carried the burden of proof and falsified the null hypothesis, any counter claims will then have the burden of proof applied to them. If the null hypothesis is not falsified, that does not mean that it is true, simply that a claim has not been able to prove it false. As such, the null stands as a provisional, default negation, unless and until it’s falsified.

Extraordinary Claims, Extraordinary Evidence: For any individual experiment, the burden of proof required to confirm the presence of a known quanta, is 3 σ. For an unknown/undiscovered/unproven quanta, the standard is 5 σ. But just like failing to falsify the null hypothesis did not mean that the claim was false, falsifying it does not mean that the claim is true. The null hypothesis for the Higgs was that the signals observed were nothing more than random noise. And there’s still a 1/3.5 million chance that that’s the case.

Negative Energy: Gravitation is what is known as a ‘conservative force’. That is, the only way you get any gravitational potential energy in the macroscopic world, is to expend kinetic energy in equivalent exchange.

Quantum Tunneling: Tunneling is a process by which quanta move through a barrier which is, under classical mechanics, impenetrable. Tunneling is responsible for nuclear fission as quanta tunnel out of the nucleus , and allows temporary violation of conservation of energy. Coupled with the mathematics of inflation, this has been hypothesized to be the mechanism behind the creation of universes. From physicist Alan Guth, “Putting [general relativity and quantum mechanics] together, one can imagine that the universe started in the total empty geometry – absolute nothingness – and then made a quantum tunneling transition to a nonempty state. Calculations show that a universe created this way would typically be subatomic in size, but that is no problem . . . Vilenkin was able to invoke inflation to enlarge the universe to its current size.”

State Vector: The SV describes how the quantum states of a system are changing. It is represented by a mathematical wave function in which different possible states, known as eigenstates, exist in superposition before the wave function is ‘collapsed’ by measurement/observation.