Definition of Uncertainty

by Hamid – May 2008

It is obvious that there are a lot of definitions for the word "***uncertainty***" in different branches of human knowledge. But a scientific approach to the subject requires a rational method especially for the purpose of quantifying the "***doubt***". Meanwhile, "*uncertainty*" is a parameter associated only with the result of a measurement. On the other hand, a perfect definition of uncertainty, as the foundation stone of quantum mechanics, is the starting point for understanding the theory of everything. Consequently, this definition must have an entirely mathematical structure without dimensions in order to be applicable to measurement results related to all natural phenomena.

Some physicists, disappointed with so called ***Heisenberg uncertainty principle***, believe that uncertainty is that very standard deviation (σ). Usually they don't say anything about scientific basis of their opinion because that is an unrealistic idea and a belief only. After a long period of time I found the most important origin of this misunderstanding.

Apparently, old definition and meaning of uncertainty which has been stated by **NIST** (**N**ational **I**nstitute of **S**tandards and **T**echnology) is a source of this mistake. You will find below what has been said by NIST:

Standard Uncertainty and Relative Standard Uncertainty

Definitions

The **standard uncertainty** $u(y)$ of a measurement result y is the estimated standard deviation of y.

The **relative standard uncertainty** $u_r(y)$ of a measurement result y is defined by $u_r(y) = u(y)/|y|$, where y is not equal to 0.

Meaning of uncertainty

If the probability distribution characterized by the measurement result *y* and its standard uncertainty *u*(*y*) is approximately normal (Gaussian), and *u*(*y*) is a reliable estimate of the standard deviation of *y*, then the interval *y* - *u*(*y*) to *y* + *u*(*y*) is expected to encompass approximately 68 % of the distribution of values that could reasonably be attributed to the value of the quantity *Y* of which *y* is an estimate. This implies that it is believed with an approximate level of confidence of 68 % that *Y* is greater than or equal to *y* - *u*(*y*), and is less than or equal to *y* + *u*(*y*), which is commonly written as *Y*= *y* ± *u*(*y*).

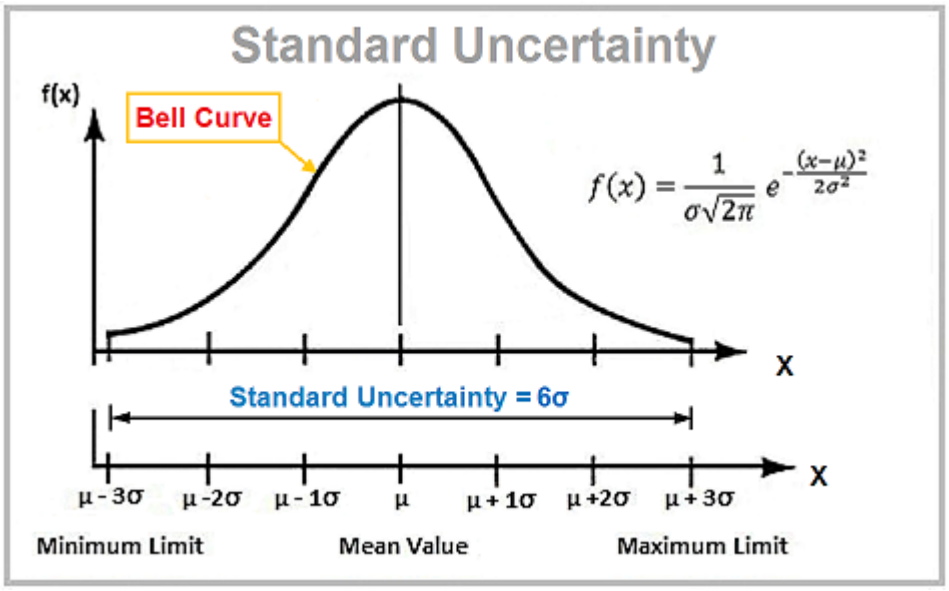
http://physics.nist.gov/cgi-bin/cuu/Info/Constants/definitions.html

It is worthy of mention that there are important similarities between what has been stated by NIST and my explanation of uncertainty (see references), of course there are considerable discrepancies as well.

In my opinion, definition of standard uncertainty mentioned by NIST is not scientific and normal because there isn't any fact, observation or experimentation to verify it.

Based on my knowledge and experience, standard uncertainty can be defined as follows:

The standard uncertainty u_x of a measurement result X is equal to six standard deviation of X, i.e. $u_x = 6\sigma_x$.



If x would be the mean value of the measurement result, then **$X = x \pm 3\sigma_x$.**

Standard Uncertainty or Natural Tolerance $= X_{max} - X_{min} = 6\sigma_x$

I am confident that this definition of uncertainty is the fundamental common concept applicable to the micro world and also to the macro world. This concept enables us to generate a probability wave function with direct physical interpretation.

References

1- How Can the Photons Tolerate Each Other?, October 2004, toequest.com
2- Double Slit Experiment and Quantum Mechanics, December 2005 toequest.com
3- Planck Length and Quantum Geometry, January 2007, toequest.com

Notes

- The German version of this article can be found at:
  Definition der Unsicherheit
- The Persian version of this article can be found at:
  تعریف عدم قطعیّت
- For more details about this "*definition of uncertainty*" and its capabilities for generating the new probability wave function and also its application concerning *the* ***Theory of Everything*** *(**TOE**)* refer to:

  Wave Function, Developed Gaussian Distribution **,** and
  Exact Planck Length Unveils Quantum Gravity