Novelty Journals

ISSN 2394-9651

International Journal of Novel Research in Physics Chemistry & Mathematics
Vol. 10, Issue 3, pp: (87-92), Month: September - December 2023, Available at: www.noveltyjournals.com

Studying the Accuracy Curve and Simulating It in Virtual Laboratories

[1]Ali Riyadh Abdulridha, [2]Faeq A. AL-Temimei, [3]shaymaa awad kadhim, [4]Nameer haider imran, [5]Ihab Alfadhel

[1]Physics Department / Faculty of Science/ University of Kufa/ Iraq

[2]Physics Department / Faculty of Science/ University of Kufa/ Iraq

[3]Physics Department / Faculty of Science/ University of Kufa/ Iraq

[4]Physics Department / Faculty of Engineering / University of Kufa/ Iraq

[5]Department of Geology / Faculty of Science/ University of Kufa/ Iraq

DOI: https://doi.org/10.5281/zenodo.10057560

Published Date: 28-October-2023

Abstract: **The theory of quantum entanglement has been tested realistically in international laboratories for the past six decades, and the probability function was the main element in determining the final result of the experiment, as well as the percentage of inaccuracy in the experiment was measured to obtain the best performance of the experiment with the theory developed by raising the level of particles**

Either in our virtual laboratory (VIQEL) we are facing a bigger problem in creating a probability function that is very close to reality and also gives the same percentages of inaccuracy for real experiments to achieve the best results.

To enhance the probabilistic results to become closer to the mathematical theory of the probability function, we also attached some graphs for the error curve or the inaccuracy curve and to indicate the permissible global level of error in the experiment, which we relied on in our virtual laboratory.

We also proved, through the results provided by the virtual laboratories, the ability to rely on these laboratories to closely converge the results and is able to simulate reality even in the percentage of error and at the level of thousands of particles used in the experiment and for the highest possible accuracy results.

Keywords: **virtual laboratory Accuracy, Simulating, Probability.**

I. INTRODUCTION

Things around us are not as they seem, nor are they as the theory of quantum mechanics says they are. Scientists, including the scientist Niels Bohr, argued that the microscopic world is ruled by random probability, and that the states a given system will experience cannot be accurately predicted, but probabilistic methods can be used. Einstein, on the other hand, rejected all these beliefs, arguing that the universe is deterministic and that if enough information is gathered, everything can be predicted. Newton and other scientists also believed in Einstein, who concluded that "God does not play dice"[1].

The theory of quantum entanglement is perhaps the most controversial topic. Einstein's nightmare is what he called the remote ghost effect, which destroys everything stipulated by the theory of relativity, which stipulates that there must be direct contact between subatomic particles. This connection must be billions of times faster than light, even if the two particles are far apart [2].

This sparked interest among scientists in studying quantum entanglement and laying the groundwork for it. This was demonstrated at the Copenhagen Conference. German scientist Heisenberg is one of the people who researched in this field [3,4].

The debate continued until Irish scientist John Stuart Bell came along and developed his theory, which was supposed to reveal the reality of quantum entanglement, as it demonstrated the existence of hidden influences on experimental results. The polarization properties of Bell and light are used as the main properties to study photon pairs and their behavior, and four polarization angles are used to give the maximum variance of the results [5].

Scientists are still experimenting with quantum entanglement, trying to integrate it into quantum computing applications and high-speed communications by 2022. Nobel Prize awarded to quantum entanglement scientists [6,7].

Here we explain, we will try to study the probability and the wave function, and focus on the error rate in the hypothetical experiment.

II. UNCERTAINTY PRINCIPLE

The inexact principle was proposed by Werner Heisenberg, one of the modern physicists and one of the founders of quantum theory, and concluded that the inexact principle is one of the two formulas of the original quantum theory [8].

which is different from the Austrian school's Wave mechanics physicist Irwin performed calculations based on the basis of Schrödinger's matrix mechanics, which represents the quantum version of quantum theory, combined with the transformation theory of British physicist Paul Dirac [9].

In quantum theory, a partial formulation of the inaccuracy principle applies to electrons, stating that the less accurate an electron's position can be determined, the more accurate its momentum can be determined. The lower the momentum of the electron is determined, the lower the momentum of the electron. determine the accuracy of its location [10].

The inaccuracy principle has become a general formula applicable to all physical phenomena explained by quantum theory. It has become one of the most important foundations and principles of modern physics and has been adopted by many scientific fields outside of physics, but at different speeds. The greater the precision with which certain cases can be defined, the less precise others can be [11].

Some people want to apply the principle of imprecision philosophically and guarantee it as one of the foundations of modern logic. This principle has been developed since Heisenberg in 1927 in Since the closed formula was proposed in mathematics and physics, the closed formula has become an important formula, replacing the principle of inevitability with physics[12].

III. SIMULATION OF THE UNCERTAINTY PRINCIPLE IN A VIRTUAL LABORATORY

There is a great difficulty facing the researcher when he wants to apply the principle of uncertainty in virtual reality to simulate reality, as this principle talks about semi-random data and is far from prediction [13].

Therefore, we used the results of previous experiments, and through the results presented in those experiments, and by studying the uncertainty curve, we obtained a mathematical equation An approximation that shows the mechanism by which this principle works, albeit in an approximate manner, but with excellent accuracy [14].

We also applied software codes that give random values and at the same time can be calculated theoretically to be close to the practical results [15].

IV. MEASUREMENT OF UNCERTAINTY FROM A VIRTUAL LABORATORY FOR CHSH EXPERIMENT

Now, according to Bell's theory, we will put a set of variables in the form of four sums of photons' polarization angles, and this means that we will perform Bell's experiment four times and each time we will get a set of data that we discuss in detail. And these four angles will be (0, 45, 22.5, and 67.5).

Now we start running the laser in the virtual lab and start recording the results for the four cases, as shown in the figure below.

Novelty Journals

ISSN 2394-9651

International Journal of Novel Research in Physics Chemistry & Mathematics
Vol. 10, Issue 3, pp: (87-92), Month: September - December 2023, Available at: www.noveltyjournals.com

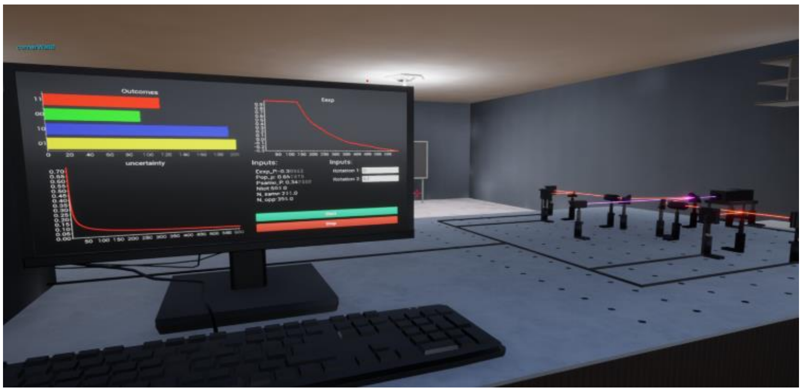

Fig. 1 -Conducting Bell Cases experiment inside the virtual laboratory

When conducting the experiment and turning on the laser device, the computer started recording the results, which are considered highly random at first, as shown in Table-1- for the first 30 readings:

Table 1-Uncertainty in the CHSH experiment for the first readings

N	States				Expectation value	Uncertainty
	,01	,00	10	11		
1	0	1	0	0	1.000	**No Data**
2	1	0	0	0	0.000	**0.522**
3	0	0	0	1	0.333	**0.426**
4	0	0	0	1	0.500	**0.369**
5	0	0	0	1	0.600	**0.330**
6	0	1	0	0	0.667	**0.301**
7	1	0	0	0	0.429	**0.279**
8	0	0	0	1	0.500	**0.261**
9	0	1	0	0	0.556	**0.246**
10	1	0	0	0	0.400	**0.233**
11	0	0	0	1	0.455	**0.223**
12	0	1	0	0	0.500	**0.213**
13	1	0	0	0	0.385	**0.205**
14	0	1	0	0	0.429	**0.197**
15	0	0	1	0	0.333	**0.191**
16	0	0	0	1	0.375	**0.185**
17	0	0	0	1	0.412	**0.179**
18	0	1	0	0	0.444	**0.174**
19	0	0	0	1	0.474	**0.169**
20	0	0	0	1	0.500	**0.165**
21	0	0	0	1	0.524	**0.161**
22	0	0	0	1	0.545	**0.157**
23	0	1	0	0	0.565	**0.154**
24	0	0	0	1	0.583	**0.151**
25	0	1	0	0	0.600	**0.148**
26	0	0	0	1	0.615	**0.145**
27	0	0	0	1	0.630	**0.142**
28	0	0	0	1	0.643	**0.140**
29	0	1	0	0	0.655	**0.137**
30	0	0	0	1	0.667	**0.135**

In general, we know that the uncertainty curve shows us the randomness in the quantum world, where we will notice from the diagram that the uncertainty value will be large at the beginning of the experiment, and when the number of photon pairs is few and approximately in the first 30 photons, we will notice a large difference in the continuous change of the curve and then start reducing the difference This means that the randomness in the initial values will be large and then begin to decrease gradually [16]

International Journal of Novel Research in Physics Chemistry & Mathematics
Vol. 10, Issue 3, pp: (87-92), Month: September - December 2023, Available at: www.noveltyjournals.com

It should be noted that the four cases shown in the table represent the options or locations that photons are allowed to enter, as they are represented by numbers, so the photon has two places, either 1 or 0, and the other photon also has either 1 or 0, which results in four options or four cases for the photon pair as we see in the table [16,17].

At the end of the experiment, when we pass more than 5,000 readings, the uncertainty values become close to one percent, which is the permissible value, with which we can rely on the quantitative results and compare them with the theoretical results, as shown in the second table here:

Table 2- Uncertainty in the CHSH experiment for the last readings

N	**States**				**Expectation value**	**Uncertainty**
	,01	,00	10	11		
5204	0	1	0	0	0.7022	**0.01023**
5205	1	0	0	0	0.7018	**0.01023**
5206	0	1	0	0	0.7019	**0.01023**
5207	0	1	0	0	0.7019	**0.01023**
5208	0	0	0	1	0.7020	**0.01023**
5209	0	0	0	1	0.7021	**0.01023**
5210	0	1	0	0	0.7021	**0.01023**
5211	0	1	0	0	0.7022	**0.01023**
5212	0	0	0	1	0.7022	**0.01023**
5213	0	1	0	0	0.7023	**0.01023**
5214	1	0	0	0	0.7020	**0.01023**
5215	0	0	0	1	0.7020	**0.01022**
5216	0	1	0	0	0.7021	**0.01022**
5217	0	0	0	1	0.7021	**0.01022**
5218	0	0	0	1	0.7022	**0.01022**
5219	0	0	0	1	0.7022	**0.01022**
5220	0	0	0	1	0.7023	**0.01022**
5221	0	0	0	1	0.7024	**0.01022**
5222	0	0	0	1	0.7024	**0.01022**
5223	0	1	0	0	0.7025	**0.01022**
5224	0	1	0	0	0.7025	**0.01022**
5225	0	1	0	0	0.7026	**0.01021**
5226	0	0	1	0	0.7023	**0.01021**
5227	0	1	0	0	0.7023	**0.01021**
5228	0	0	0	1	0.7024	**0.01021**
5229	0	1	0	0	0.7024	**0.01021**
5230	0	1	0	0	0.7025	**0.01021**
5231	0	0	0	1	0.7025	**0.01021**
5232	0	1	0	0	0.7026	**0.01021**
5233	0	0	0	1	0.7027	**0.01021**

fact that photons are represented by numbers, the four cases represented in the table correspond to the options or locations that photons are permitted to enter. Since each photon has two possible locations—either 1 or 0—and the other photon has the same possibility, the photon pair has four possible options or cases, as shown in the table.

To better study the change in the inaccuracy value for all the readings, we draw a graph of all the values between the inaccuracy in the measurement on the vertical axis and the number of readings in the horizontal axis, which numbered more than 5000 readings (photonic pair) to look like the following:

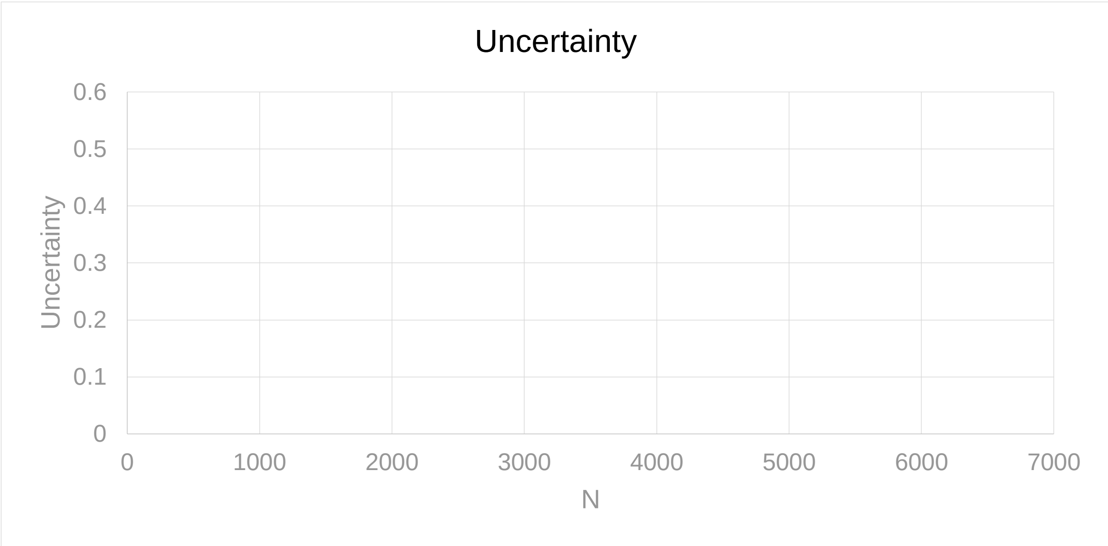

Fig. 2 -Uncertainty curve for the CHSH experiment

The curve above represents the results of uncertainty, and through it we can compare the results from international experiments, especially those conducted in the last quarter of the last century by the scientists Alan and John Clauser.

V. COMPARISON

Through the research published in IOP Science journal in 1978 on the experience of Bell's cases, we can compare the results in practice, as we will notice that the values that were tested in the practical experiment gave an uncertainty curve that is very similar to the curve presented by the experiment in the virtual laboratory and decreasing results, which indicates that the experiment gives Excellent results that can be compared to reality [17].

VI. CONCLUSIONS

We conclude from the aforementioned values, which were drawn in the form of a graph, that the uncertainty principle that was simulated is very accurate and excellently close to the real values of the global experiments of quantum mechanics, where we achieved a correct distribution of the first random values in the experimental to be unknown data and at the same time give a clear pattern when Increasing the number of readings [18], so that the result becomes identical to the theory and can be relied upon in conducting more experiments, and this leads us to two important points:

1- It is possible to take advantage of the VIQEL virtual laboratory in conducting many experiments of another type, with the possibility of relying on its results, as it gives results close to reality and a very close uncertainty rate.

2- Our ability to simulate realistic randomness on computers will give us a greater understanding of the mechanism by which the universe works from the smallest particles and allow us to better interpret reality and develop stronger theories that can explain everything.

ACKNOWLEDGEMENTS

We would like to extend our sincere gratitude and admiration to the University of Kufa/Iraq for the assistance and resources it offers researchers. Particularly, the physics department laboratory at the scientific college to support them.

Ethical Approval: The study protocol was approved by local ethics committee.

Disclaimer: None

Conflict of interest: There are no conflicts of interest to declare.

Funding disclosure: support by ourselves

REFERENCES

[1] Natarajan, Vasant. "What Einstein meant when he said "God does not play dice…"." Resonance 13.7 (2008): 655-661.

[2] Alford, Mark G. "Ghostly action at a distance: A non-technical explanation of the Bell inequality." American Journal of Physics 84.6 (2016): 448-457.

[3] Espagnat, Bernard. Conceptual foundations of quantum mechanics. CRC Press, 2018.

[4] Cassidy, David C. Beyond uncertainty: Heisenberg, quantum physics, and the bomb. Bellevue Literary Press, 2010.

[5] Whitaker, Andrew. "John Bell and the most profound discovery of science." Physics world 11.12 (1998): 29.

[6] Acín, Antonio, et al. "The quantum technologies roadmap: a European community view." New Journal of Physics 20.8 (2018): 080201.

[7] Kumar, Adarsh, et al. "Futuristic view of the internet of quantum drones: review, challenges and research agenda." Vehicular Communications (2022): 100487.

[8] Heisenberg, Werner. The physical principles of the quantum theory. Courier Corporation, 1949.

[9] Mehra, Jagdish. "Niels Bohr's discussions with Albert Einstein, Werner Heisenberg, and Erwin Schrödinger: The origins of the principles of uncertainty and complementarity." Foundations of physics 17 (1987): 461-506.

[10] Engelhardt, A. G., A. V. Phelps, and C. G. Risk. "Determination of momentum transfer and inelastic collision cross sections for electrons in nitrogen using transport coefficients." Physical Review 135.6A (1964): A1566.

[11] Binnig, Gerd, and Heinrich Rohrer. "Scanning tunneling microscopy—from birth to adolescence." reviews of modern physics 59.3 (1987): 615.

[12] Demopoulos, William, and Michael Friedman. "Critical notice: Bertrand Russell's The Analysis of Matter: Its historical context and contemporary interest." Philosophy of science 52.4 (1985): 621-639.

[13] Zidaru, Teodor, Elizabeth M. Morrow, and Rich Stockley. "Ensuring patient and public involvement in the transition to AI-assisted mental health care: A systematic scoping review and agenda for design justice." Health Expectations 24.4 (2021): 1072-1124.

[14] Pumplin, Jonathan, et al. "New generation of parton distributions with uncertainties from global QCD analysis." Journal of High Energy Physics 2002.07 (2002): 012.

[15] Katti, Sachin, Shyamnath Gollakota, and Dina Katabi. "Embracing wireless interference: Analog network coding." ACM SIGCOMM Computer Communication Review 37.4 (2007): 397-408.

[16] Kovachy, Tim, et al. "Quantum superposition at the half-metre scale." Nature 528.7583 (2015): 530-533.

[17] Clauser, John F., and Abner Shimony. "Bell's theorem. Experimental tests and implications." Reports on Progress in Physics 41.12 (1978): 1881.

[18] Heisenberg, Werner. The physical principles of the quantum theory. Courier Corporation, 1949.