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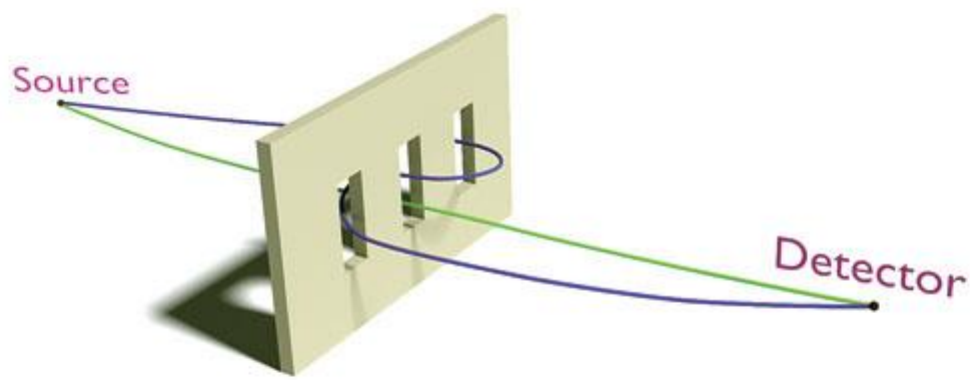
Indians attempt quantum clean-up - Experiment to right old error

G.S. MUDUR



Indian physicists propose a tabletop experiment that will provide scientists their first opportunity to measure the probability that particles can move through slits in a twisted path (depicted by the purple

New Delhi, Aug. 24: A team of Indian physicists has proposed a tabletop experiment to clear a key misconception in a fundamental scientific theory that has led to errors that are blocking efforts to understand nature better.

Urbasi Sinha at the Raman Research Institute, Bangalore, and her collaborators have proposed an experiment to quantify and cancel the errors that emerge in certain experiments in quantum mechanics, a bedrock theory of physics developed in the early 20th century.

While quantum mechanics faithfully describes the subatomic world, it is also critical for an understanding of the universe at its largest scales. But since the 1930s, physicists have largely ignored a set of errors that creep into applications of what they call the superposition principle, a mathematical tool used, among other things, to predict the behaviour of subatomic particles passing through two thin slits on a screen.

The experiment proposed by the Bangalore physicists involves sending either light or subatomic particles through three fine slits on a screen and will provide scientists their first opportunity to measure and correct the errors.

“Something brushed under the carpet for a long time may now be pulled out and cleaned up,” said Sinha, a Jadavpur University graduate who got a PhD from the University of Cambridge and was a post-doctoral scientist at the University of Waterloo, Canada, before she joined the Raman Institute.

A paper proposing the experiment will appear in the journal *Physical Review Letters* this week. It has been authored by Sinha; her physicist husband Aninda Sinha who works at the Indian Institute of Science, Bangalore; another physicist couple, Joseph Samuel and Supurna Sinha, at the Raman Institute; and research scholar Rahul Sawant, also at the Raman Institute.

“The experiment will test certain laws of nature beyond what has been done so far,” Ashoke Sen, professor of physics at the Harish Chandra Research Institute, Allahabad, who was not associated with the work, told **The Telegraph**. “This is the way science progresses.”

Using theoretical principles, the Bangalore physicists have shown that one of the earliest pieces of a jigsaw puzzle that describes quantum mechanics was incorrectly positioned — like a piece of a picture puzzle placed upside down.

“We’ve been able to put together many of the pieces, but we can’t put the rest in place unless we go back to that piece and fix it,” said Barry Sanders, a senior physicist at the University of Calgary, Canada, and director of the Institute of Quantum Science and Technology.

The errors the Indian team is trying to correct emerge in wave interference experiments that some physicists say symbolise the core of quantum mechanics — a scientific theory with bizarre consequences in the subatomic realm.

In cricket, a ball hurled by the bowler flies in the direction of the throw towards the wicket. A ball tiny enough to follow quantum rules could fly around the wicket or around even the bowler’s head before flying towards the wicket. Such weird paths in quantum mechanics are called “non-classical paths”.

Physicists, while studying the behaviour of subatomic particles, have until now chosen to ignore the probability of non-classical paths in experiments such as the standard two-slit experiment. While this is fine for cricket balls and rockets, it compromises accuracy in the subatomic world.

The three-slit experiment proposed by the Raman Institute-IISc team will allow physicists to measure the contribution of non-classical paths.

In a classical path, a particle would go right through a single slit. In a non-classical path, a particle could pass through one slit, return through the second and turn again to pass through the third slit. (**See graphic**)

Quantum mechanics predicts that even such a twisted path has a non-zero probability of occurrence. But in calculations until now, this probability has been assumed as zero.

“Not a single standard textbook of quantum mechanics takes into account such non-classical paths in the two-slit experiment,” said Aninda Sinha.

“While the importance of non-classical paths has been pointed out earlier, this paper is perhaps the first where their contribution is quantified and a concrete experiment has been proposed to measure it,” said Sumathi Rao, a physicist at the Harish Chandra Research Institute.

Sinha and her colleagues have just set up the three-slit experiment at the Raman Institute, using a combination of lasers, microwaves and single photons