MSRI Special Lectures

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Professor Dijkgraaf is a member of the Royal Netherlands Academy of Arts and Sciences and recipient of the Spinoza Prize, the highest scientific award in the Netherlands.

Tuesday, April 25th

4:30 p.m. Simons Auditorium, MSRI (preceded by a reception at 3:30 p.m. in the Lobby)

The Quantum Geometry of String Theory

Since Einstein's theory of relativity we know that the geometry of space and time play a crucial role in our understanding of the fundamental laws of the universe. However, modern physics is now confronted with the limits of this framework. Remarkable discoveries, such as the existence of black holes, the accelerating universe and the Big Bang itself, force us to rethink our familiar concepts. String theory is a leading candidate for a theory of quantum gravity and gives insights in how the geomery of space and time could be changed on the smallest scales, where the laws of quantum physics rule. Space-time seems to be no longer a fundamental object, but becomes an emergent phenomenon that only appears as an approximate concept in the semi-classical limit. Mathematical physics can provide interesting thought experiments that illustrate this phenomenon. Exact computations in matrix models and gauge theories illustrate that we are starting to discover the mathematical structure of quantum geometry.

Thursday, April 27th

4:10 p.m. 60 Evans Hall

The Unreasonable Effectiveness of Quantum Physics in Modern Mathematics

Mathematics has proven to be "unreasonably effective" in understanding a large variety of phenomena in nature. Although we have no prior reasons to expect this, it has turned out that the fundamental laws of science are best formulated in terms of mathematical formalism. In this lecture I want to argue for the reverse effect: Nature is an important source of inspiration for mathematics, even of the purest kind. This phenomenon goes back a long time – analytic geometry and calculus grew out of classical mechanics. In recent years it has been the world of quantum field theory and elementary particles that has greatly stimulated mathematical thinking. It has led to surprising breakthroughs in our understanding of for example topology, as in understanding knots and curved manifolds. Quantum physics has also revolutionized algebraic geometry. These are all classical subjects in pure mathematics, that have their origin in the 19th century, but had to wait for their solution till the development of quantum physics with all its counterintuitive notions, such as the uncertainty principle, virtual particles, and the sum over histories. At this moment these interactions between mathematics and physics are one of the most intellectually fruitful areas in science.

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