Mathematical Sciences 2011

"A large part of doing research is to be stuck and to be confused and to feel like one doesn't make progress. But then, every once in a while you make progress. Then something comes out, a light turns on and that insight or feeling of discovery, of finding something new, carries with it such joy that you go back and are willing to be frustrated yet again."

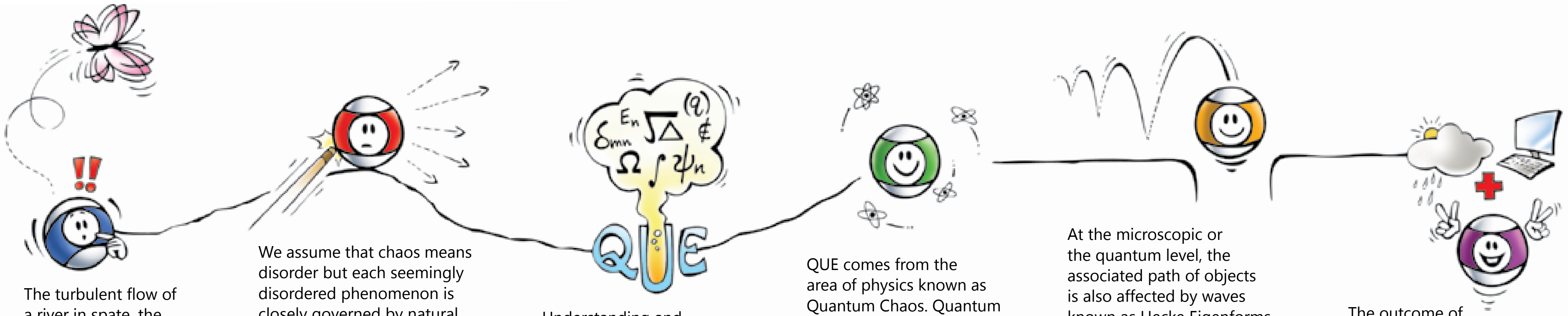
Kannan Soundararajan

Professor of Mathematics, and Director, Mathematics Research Center, Stanford University

- B.S. in Mathematics from the University of Michigan
- Ph.D. in Mathematics from Princeton University

Prof. Kannan Soundararajan has made fundamental contributions to analytic number theory. His recent development of new unexpected techniques to study the critical values of general zeta functions has led to the proof of the Quantum Unique Ergodicity Conjecture for classical holomorphic modular forms.

Finding order in chaos with number theory



The turbulent flow of a river in spate, the flapping of a butterfly's wings, and the trajectory of a falling object are phenomena that seem to have unpredictable outcomes. The chaos theory in physics attempts to explain these seemingly random outcomes.

We assume that chaos means disorder but each seemingly disordered phenomenon is closely governed by natural laws that determine the initial conditions. These initial conditions in turn determine multiple paths and patterns which taken together seem chaotic.

Understanding and interpreting chaos helps us understand our environment and ourselves better. Prof. Soundararajan's research has helped us understand the physics of chaos in a mathematical framework. He has made headway in solving a long standing problem in number theory called Quantum Unique Ergodicity Conjecture or QUE.

QUE comes from the area of physics known as Quantum Chaos. Quantum Chaos tries to understand the relationship between the chaotic motion of macroscopic objects like people and planets to the rules that govern the microscopic world or the quantum world.

At the microscopic or the quantum level, the associated path of objects is also affected by waves known as Hecke Eigenforms. This complicates matters. Prof. Soundararajan uses the example of a billiard ball on a frictionless table to explain this phenomenon. If a ball is hit in a certain direction, it will move along on one path around the billiards table. Hitting it in other directions, however, will cause the ball to bounce in a more chaotic manner, covering paths around the table.

The outcome of Prof. Soundararajan's research can potentially be used in disciplines as diverse as computer science, medicine and meteorology. Trying to work out the seemingly chaotic workings of the human brain or heart or atmospheric disturbances could potentially help predict medical conditions or weather changes.