# Unravelling the random fluctuations of nothing

**The dream of theoretical physics is to unite behind a common theory that explains everything, but that goal has remained highly elusive. String theory emerged 40 years ago as one of the most promising candidates for such a theory, and has since slipped in and out of favour as new innovations have occurred.**

Now Europe is fortunate to have one of the world's leading experts in string theory working on an ambitious project that could make significant progress towards a unified theory, and at least help resolve two mysteries. One is how the universe emerged in the beginning as a random fluctuation of a vacuum state, and the other is a common explanation for all sub-atomic particles.

Czech physicist Dr. Martin Schnabl has been selected to receive a EURYI Award by the European science Foundation (ESF) and the European Heads of Research Councils (EuroHORCS) to help him pursue his project and build on five years of hard work culminating in the solution of an equation in string field theory that had gone unsolved for 20 years.

The elegance and beauty of the solution have been widely praised in a field that is highly regarded for its aesthetic appeal, drawing together many important concepts in mathematics and physics. The EURYI Awards scheme, entering its fourth and final year, aims to attract outstanding young researchers from anywhere in the world to work in Europe for the further development of European science, contributing to building up the next generation of leading European researchers.

String theory was developed in an attempt to bring together the physics of the big and the small, represented respectively by general relativity and quantum mechanics. It replaces the idea of elementary particles occupying a single zero point with a one dimensional string joining two points.

In this sense a string, like a particle, is a model designed to represent or predict particular fundamental properties of the physical universe. But while the number of particles continued to grow, the string was an attempt to join them all together, leading to the idea of a string field. This field represents all particles as vibrations of a string at given frequencies. The string field is then the sum total of all vibrations, elegantly bringing all particles together into one, so that physicists no longer need to be embarrassed by the discovery of yet another particle type.

"It's a sort of field theory for the infinite tower of oscillatory modes of a string, each of them representing different particle species," Schnabl said. As Schnabl observed, string field theory, by explaining also how quantum mechanics is compatible with general relativity, is essential for understanding what goes on in situations where both of these are playing together.

"It is important in the regimes where quantum gravity is important, such as black holes and the beginning of the universe," added Schnabl. In both cases, dimensions can be small, requiring quantum mechanics, but energies and mass are enormous, creating huge gravitational fields that currently can only be dealt with by general relativity. One of the problems of string field theory lies in conducting experiments that test predictions or help inspire new theoretical developments. The theory predicts that the universe has 10 dimensions, of which four are the ones we observe in spacetime. Yet in 40 years no better candidate has emerged to explain the properties of the universe, or all universes, at all scales of time and distance. Furthermore the string field has a habit of feeding the rest of physics and mathematics by virtue of lying at the cutting edge of analytical reason. This is why it should interest lay people as well, insisted Schnabl.

“The very general public can be interested if they enjoy watching mankind's advances in understanding some of the deepest questions about the nature of our universe.”

Schnabl, a 34 year-old Czech scientist, is a member of Princeton’s Institute for Advanced Study. He took his PhD in theoretical physics at the International School for Advanced Studies in Trieste, Italy, then went on to become research associate at the Massachusetts Institute of Technology and CERN fellow at the European Laboratory for Particle Physics. He has established himself as one of the world experts on string field theory, a particularly promising approach to string theory. He will be conducting his research at the Institute of Physics Academy of Sciences of the Czech Republic after receiving his award in Helsinki, Finland on 27 September 2007 with other 19 young researchers.

EURYI is designed to attract outstanding young scientists from around the world to create their own research teams at European research centres and launch potential world-leading research careers. Most awards are between €1,000,000 and €1,250,000, comparable in size to the Nobel Prize.

Source: European Science Foundation