Our Team

Kentaro Hori

Research Area: Theoretical Physics

IPMU Professor

My research is motivated by two questions: What is the fundamental law of Nature? Which mathematics is used to describe it? The right theoretical framework must unify general relativity and quantum mechanics. It must be described, I think, by a language which unifies mathematical areas that were born and grew up individually with these two physics developments. String theory is a leading candidate for such a framework.

"Mirror symmetry" is an example that suggests "unification of mathematics." It is a phenomenon that strings moving in two different spaces lead to exactly the same physics, in a surprising way in which symplectic geometry and algebraic geometry of the two spaces are exchanged. We have shown that it can be understood using duality in two-dimensional quantum gauge theory. This work led to further development such as correspondence between D-branes.

Currently, I am studying string compactifications using various techniques including mirror symmetry. One big goal is to obtain a picture of totality of theories with minimal supersymmetry in four-dimensions. At the same time, I aim to develop the best language to describe the theory, in collaboration with mathematicians.

On October 3rd, 2008, IPMU full-time members gathered to celebrate the institute's first anniversary. By contrast, when IPMU launched on October 1st, last year, there was no full-time members. IPMU is ramping up very quickly.

Kai Martens

Research Area: Experimental Physics

IPMU Associate Professor

"Physics or philosophy?" was the question that got answered when, in 1994, I received my Ph.D. in physics from Heidelberg University in Germany. It was earned during five exciting years on a hyperon beam experiment at CERN.

In 1995 I came to the University of Tokyo to build the Super-Kamiokande detector. Five wonderful years of doing neutrino physics in Kamioka and preparing for K2K at KEK ended when in 2000 I joined the faculty at the University of Utah. Results from our HiRes experiment in Utah changed the paradigm in cosmic ray physics. The next generation Telescope Array experiment is now taking data, and I had a major role in bringing that about.

The biggest problem in particle astrophysics today is Dark Matter. I am really excited that at IPMU I have the opportunity to work on the XMASS experiment in Kamioka. What will this new and challenging Dark Matter experiment teach us? Are there WIMPs out there? Working towards answers to these questions I also watch for Supernovae again with Super-Kamiokande and ultra high energy cosmic rays with Telescope Array. Experimental data are the foundation of knowledge, and at IPMU we seek knowledge - of the Universe.

Yen-Ting Lin

Research Area: Astrophysics

Postdoc

I work on galaxy formation and clusters of galaxies. In the cold dark matter paradigm, the formation and evolution of galaxies are strongly coupled to that of the dark matter, and therefore a detailed knowledge of galaxy formation processes may serve as a fundamental check of the underlying cosmological model.

At IPMU, I plan to study ①the role of mergers and feedback from supermassive black holes in the formation of massive galaxies, ②the evolutionary connection between the present-day galaxies and those at z=1, using data from the HyperSuprimeCam, and ③the constraining power on cosmology from galaxy clusters.

Domenico Orlando

Research Area: Theoretical Physics

Postdoc

One of the greatest strengths of string theory is the web of connections among seemingly unrelated areas of physics and mathematics. To this date, I have concentrated my research activity in two main directions: the study of exact conformal field theory (CFT) solutions in string theory and the study of topological strings. Regarding CFT, I am interested in how the world-sheet and target-space descriptions interact and how methods from conformal field theory can solve problems in supergravity and vice versa. My interest in topological strings is mainly related to the exploration of the correspondence between crystal melting and the topological A-model.

Seong-Chan Park

Research Area: Theoretical Physics

Postdoc

I am looking for the physics beyond the standard model. The best chance will come from the Large Hadron Collider and from cosmological/astrophysical observations which show us the true nature of our mother universe.

Currently I am working on the higher dimensional models which might be responsible for the deep mystery of electroweak scale physics and the quantum nature of space-time. The higher dimensional black hole is one of my favorite topics.

Mikael Pichot

Research Area: Mathematics

Postdoc

I work on geometry, dynamical systems, and operator algebras. In other words, the study of spaces and the influence their geometry has on symmetry groups and operator algebras associated with them. Specifically, my recent achievements are concerned with geometric group theory (e.g. L2 cohomology, intermediate rank), nonpositively curved spaces (e.g. Bruhat-Tits buildings, polyhedral complexes of friezes), foliation theory (e.g. concentration of transverse measures), and noncommutative geometry (e.g. property RD, Baum-Connes).

Susanne Reffert

Research Area: Theoretical Physics

Postdoc

I am trained as a string theorist, but my research has also taken me into the subjects of algebraic geometry, quantum algebra, knot theory, combinatorics, and various facets of statistical physics. Therefore, I have come to consider myself more generally a mathematical physicist. My primary interest is directed towards the interface between mathematics and physics, as well as the connections between several different subfields. Examples of such connections are the relations between string theory and geometry or string theory and aspects of statistical physics, such as dimer models and integrable spin chains.

Jan Schuemann

Research Area: Experimental Physics

Postdoc

I am working to upgrade the Super-Kamiokande (Super-K) detector by introducing Gadolinium (Gd) to the water. This enhancement will enable the experiment to observe neutrons produced in neutrino (and other) interactions, which in turn will allow Super-K to observe relic supernova neutrinos and reactor neutrinos.

Currently, I am developing a device to precisely measure the transparency of liquid solutions, such as the pure water of Super-K and a 0.1% (by mass) Gd solution. Additionally, I am performing studies of data quality and background estimates for the Gd upgrade.

Kenneth Shackleton

Postdoc

Research Area: Mathematics

In low-dimensional topology and geometric group theory, an exciting strategy is to associate to a compact manifold or a finitely generated group a connected graph: Witness Gromov's programme to study the large-scale geometry of groups (via their Cayley graphs), or Minsky et al's solution to Thurston's ELC, or Hatcher-Thurston's algorithm giving finite presentations of surface mapping class groups. The aim always is to elicit an underlying principal. These objects then take on a life of their own...

Jing Shu

Postdoc

Research Area: Theoretical Physics

Our current description of microscopic structure in Nature is the Standard Model (SM) of particle physics, where all elementary particles gain their masses through electroweak symmetry breaking (EWSB). Theorists have come up with many new models to address the origin of EWSB with different predictions at the TeV energy scale to confront the experimental data from the Large Hadron Collider (LHC). The origin of dark matter and the existence of baryon asymmetries in our universe also require new physics beyond the SM.

My research has been focused on model building to interpret EWSB, deciphering collider signals at the LHC, and understanding general aspects of weak scale cosmology such as dark matter and baryon asymmetries.

Jiayu Tang

Postdoc

Research Area: Cosmology

Great progress has been made in observational cosmology, which has led to more astounding discoveries in cosmology than we ever expected, i.e., the existence of so-called dark matter and dark energy. To explore the nature of the dark universe has become the common task of observational and theoretical cosmology. My current research interest is to investigate the dark universe with cosmology experiments.