Our Team

Shigeki Matsumoto

Research Area: Cosmology

IPMU Associate Professor

The dark matter problem of the universe is very important not only for particle physics but also astrophysics and cosmology. Thanks to recent cosmological observations, the existence of dark matter has been established, however, its nature has not been revealed yet. I have researched the nature of dark matter from the viewpoint of new physics at the TeV scale. To be more precisely, I have studied how dark matter can be detected in collider experiments (LHC and ILC) and detection measurements based on several new physics models such as the supersymmetric model, the little higgs model with T-parity, and the universal extra-dimension model. As an advanced topic of these studies, I would like to establish a method to clarify the nature of dark matter in a model-independent fashion. In addition to the topic related to dark matter, I am also planning to study the first order phase transition and the non-equilibrium dynamics of elementary particles in the early universe.

Yuji Tachikawa

Research Area: Theoretical Physics

IPMU Assistant Professor

The effort to reconcile quantum mechanics, which governs microscopic phenomena, and general relativity, which governs strong gravitation, led to the emergence of the superstring theory. It is the leading candidate to give a unified description of Nature at its most microscopic level, but frankly what interests me most about superstring theory is its exceptionally rich internal structure.

The theory is so rich that it not only necessitates the use of cutting-edge mathematics, but it has also occasionally given a new area of mathematics, which later received rigorous and vigorous study by mathematicians. For example, the study of supersymmetric states of string theory is now known to be related closely with algebraic geometry and representation theory.

My hope as a physicist in this Institute is to unearth more ideas from string theory, to be polished into perfection by mathematicians in the same building, thus connecting the P (physics) and the M (mathematics) of the IPMU.

Researchers gathered at the "amphitheater" of the IPMU building on the occasion of the IPMU's third anniversary in October 2010.

Melina Bersten

Research Area: Astronomy

Postdoc

My main research interests involve computational and theoretical astrophysics. Specifically, I work in the field of supernovae. These are very relevant astrophysical objects because of their connection with the final stages of stellar evolution and the energetic and chemical evolution of galaxies. They are also important in Cosmology as distance indicators. Through the computation of hydrodynamic models of core-collapse supernovae and comparison with observations, I aim at gaining a better knowledge of the physical properties of the progenitor stars.

Gaston Folatelli

Research Area: Astrophysics

Postdoc

I am an observational astrophysicist working in the field of supernovae. I first got interested in this subject through the use of Type Ia supernovae as powerful distance indicators in the study of the expansion history of the Universe. I focused on the use of spectroscopy and multi-band photometry as a means to improve the precision of distance measurements. In the past few years, I also became interested in understanding supernovae as astrophysical objects in connection with stellar evolution, the mechanism of explosion, and the interaction with the interstellar medium. For that purpose I have been involved in the monitoring of all types of supernovae very soon after explosion.

Ahmet Emir Gumrukcuoglu

Research Area: Cosmology

Postdoc

My interests primarily revolve around cosmological inflation. One focus of my research is the study of inflationary scenarios with new observable signatures, such as broken statistical isotropy and/or substantial non-Gaussianity, which provide additional criteria for discriminating among different models. I am also interested in the effect of supersymmetric flat directions on the post-inflationary evolution of the universe. An ongoing project involves a nonlinear study of the preheating of flat direction condensates - the explosive decay may give rise to gravitational waves in the frequency range of upcoming observations.

Johannes Schmude

Research Area: Theoretical Physics

Postdoc

I am interested in relationships between geometry, gauge- and string theories. In the past, I have mainly worked on problems regarding gauge/string duality, specifically the case of gauge theories with additional fundamental matter fields. On the string theory side of the duality, these are represented by D-brane sources, which can be conveniently described by the mathematics of generalized calibrations. Just as calibrations capture the physics of D-branes, G-structures provide a very natural language to address issues regarding the involved supergravity backgrounds themselves.

Simon Wood

Research Area: Theoretical Physics

Postdoc

The primary focus of my research is logarithmic conformal field theory. Conformal field theories are quantum field theories that are invariant with respect to transformations that preserve angles but not lengths. These theories are encountered in string theory and statistical mechanics and have a very rich mathematical structure that can be described by vertex operator algebras. Logarithmic conformal field theory is a generalization of standard conformal field theory, which admits logarithmic divergences in correlation functions. The vertex operator algebras of logarithmic conformal field theories are still quite poorly understood. Here at the IPMU I hope to get a better understanding of these vertex operator algebras of logarithmic conformal field theories as well as the categorical structures underlying their representation theory.