Our Team

Naoki Yasuda

Research Area: Astronomy

Professor

As part of my study of the universe, I am observing type Ia supernovae (SNe Ia). An SNe Ia type surpernovae is thought to be the thermonuclear explosion of a white dwarf that has exceeded 1.4 solar masses as a result of accreting mass from its companion star in a binary system. SNe Ia have similar luminosity and spectrum characteristics, as well as a maximum luminosity comparable to that of an entire galaxy. Assuming that SNe Ia have a constant absolute luminosity, we can determine their distance up to 9 billion light-years, which gives us information about the expansion history of the universe and the content of its dark matter and dark energy. I have searched for distant SNe Ia using the NAOJ's Subaru telescope in collaboration with the Supernova Cosmology Project and found this method to be more effective than the Hubble Space Telescope for detecting distant SNe Ia. The data has been used to measure the SNe Ia rate and constrain the progenitor system for SN Ia. I also joined the SDSS-II Supernova Survey and have obtained about 500 multi-band light curves from SNe Ia. This data has been used to examine the relationship between SNe Ia and their host galaxies.

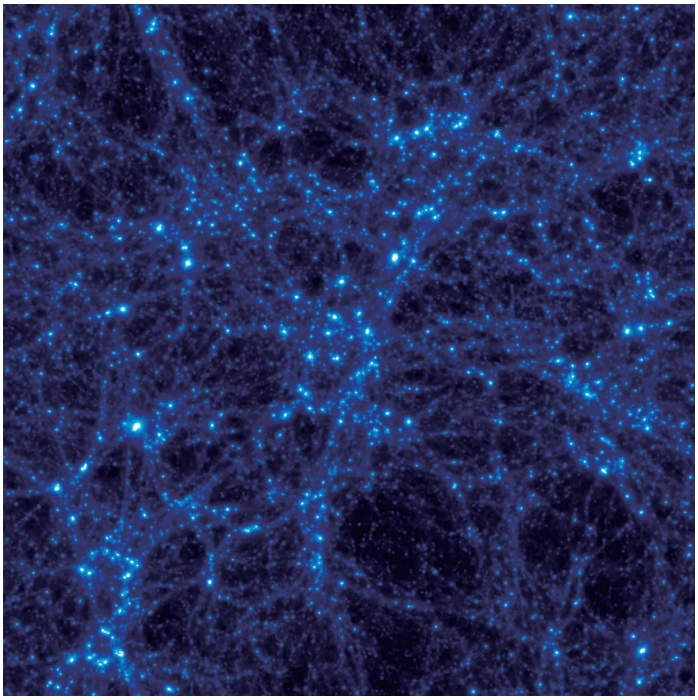
Taizan Watari

Research Area: Theoretical Physics

IPMU Associate Professor

In the 1960's, scientists discovered that the variety in the types of light mesons and their interactions derives from an underlying symmetry and its spontaneous breaking. Applying this idea to the variety in the types of elementary particles in the Standard Model and their Yukawa interactions, my collaborator and I pointed out in 2006 that an E_n type Lie algebra and its symmetry breaking may be at work behind the Standard Model.

In string theory compactification, the algebra arises from topology of a geometry. In order to know more about the detailed pattern of Yukawa couplings, however, non-topological aspects of the geometry are also involved. Neutrino oscillation experiments have revealed that the leptons have large mixing angles, which contrasts sharply with small-angle quark mixing. This contrast has been the biggest theoretical puzzle associated with the Yukawa couplings. Can this puzzle be solved in terms of geometry? I am looking for the answer to that and other questions.



The distribution of galaxies in the universe shows a characteristic pattern called "the large scale structure." The structure may be as large as one billion light years in size. It is thought that the structure developed through gravitational amplification of the tiny matter density fluctuations generated in the early universe. The picture shows a computer simulation of the cosmic structure formation (see page 20). The bright regions are dense concentrations of galaxies, whereas the dark regions are empty spaces called "cosmic voids."

Guillaume Lambard

Research Area: Experimental Physics

Distinguished Postdoc

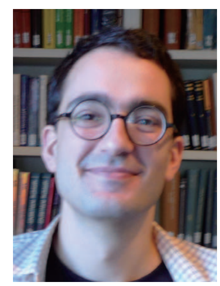
My Ph.D. allowed me to investigate one of the greatest mysteries of the Universe, dark matter, and to constrain its potential characteristics through the framework of 4+n dimensions. Using the ANTARES neutrino telescope in France, I studied neutrino fluxes from possible sources of dark matter and developed a strategy for neutrino reconstruction, including the fine details of the ANTARES telescope.

At the IPMU, I continue to probe the deep nature of dark matter, either indirectly via the Sun and similar objects (Super-Kamiokande observatory), or directly by means of the XMASS experiment (Kamioka). I'm also very excited to help enhance the efficiency of hybrid photo-multipliers.

Simon Dedeo

Research Area: Astrophysics

Postdoc

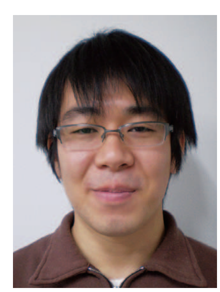


I work on the interface between fundamental theories and the observations. I ask questions, for example, about how symmetries underlying gravitational theories might leave signatures in cosmological and astrophysical phenomena. Or, I ask under what conditions can various coarse-graining techniques allow one to make and test predictions while remaining agnostic about microphysics. Finally, I ask about complexity in physical and biological systems, using tools from condensed matter and information theories. Sometimes, I answer these questions!

Keisuke Izumi

Research Area: Theoretical Physics

Postdoc



The present-day acceleration of the universe's expansion is one of cosmology's most interesting phenomena. Although most investigations take a scalar approach, this phenomenon may indicate large-scale modification of general relativity. Ghost excitation, which has negative energy, is problematic for a modified gravity theory that takes into account this acceleration. However, I've shown that ghost excitation causes negligible instability.

Ikko Shimizu

Research Area: Astrophysics

Postdoc

The universe contains much hydrogen from which Lyman α photons radiate. Recently, many objects with a strong Lyman α line (LAE) were discovered at a very high redshift. Although the spatial distribution of LAEs is very important, it has not been described theoretically. Therefore, I am attempting to build up a picture of LAEs that is concordant with CDM cosmology. Moreover, to comprehensively understand galaxy evolution, I'm exploring how LAEs are related to galaxies observed with other methods.

Hajime Takami

Research Area: Astrophysics

Postdoc

I study cosmic rays of the highest energy level. Although cosmic rays with energies 1000 times greater than the maximum energy of the largest artificial collider (LHC) have been detected, the sources of these cosmic rays are unknown. I am investigating the propagation process of these cosmic rays and their sources using data from observations. I would like to expand my research at the IPMU into multi-particle astronomy in order to determine their origin.

Marcos Valdes

Research Area: Cosmology

Postdoc

My main research field concerns cosmic reionization and the physics of the high redshift Universe during the transition phase that marks the end of the "Dark Ages". In particular I focus on the science of the 21cm hyperfine transition of neutral hydrogen. In the near future the neutral InterGalactic Medium (IGM) prior and during cosmic reionization will be directly studied through 21 cm observations by next generation radio telescopes. I also investigate the effects of Dark Matter (DM) decays/annihilations on the high redshift IGM properties, and as a consequence on the 21cm line. The most popular DM candidates can in fact be constrained if they leave different imprints on the IGM.