Focus Week on Gravity and Lorentz Violations

Shinji Mukohyama
Kavli IPMU Associate Professor

A workshop entitled "Focus week on gravity and Lorentz violations" was held at Kavli IPMU for five days from February 18 to 25, 2013.

Special and general theories of relativity are milestones in modern physics. Actually, various experiments and observations verify relativity, and the Lorentz symmetry is at the root. On the other hand, there is a hope that some of the mysteries of the universe may be resolved by allowing for minuscule violation of Lorentz symmetry within the limits of experiments and observations. Moreover, even if the nature respects the exact Lorentz symmetry, the only way to confirm it is to compare predictions of Lorentz violating theories with observational and experimental data.

Let us imagine the time is reversed and we go back toward the beginning of the universe. The universe in the early epoch was denser, more energetic, and more curved. At some point, quantum fluctuations become so significant that the usual description based on classical theory totally breaks down. Therefore, in order to understand the beginning of the universe we need "quantum gravity", a dream theory reconciling Einstein's general relativity and quantum theory. For this and many other reasons, finding an ultimate theory of quantum gravity has been one of the greatest dreams in theoretical physics. A new theory of quantum gravity proposed by Horava acquires a property called "power-counting renormalizability", which is an indication of good behavior of the theory at high energy, by breaking Lorentz symmetry. In this workshop, there were many discussions about this theory from both theoretical and observational viewpoints, including a talk by Horava himself.

The latest observational data suggests that more than 90% of our current universe is filled with unknown energy and matter. They are called dark energy and dark matter, respectively, but we do not know what these really are. In this workshop, we had various talks and discussions on the issues of dark energy and dark matter as well as inflationary universe, based on theories of Lorentz violations.

There was also a talk summarizing tests of Lorentz violations. Based on the reported status of experiments and observations, participants exchanged their opinions about the strategy to construct theories within the experimental and observational limits. Consequently, we reached a common understanding that the three best strategies are: (i) supersymmetry as custodial symmetry, (ii) gravitational confinement and (iii) enhanced RG flow by strong dynamics.

While continuing to tackle the mysteries of the universe such as quantum gravity, dark energy, and dark matter, I believe that ideas and opinions exchanged among participants of the workshop will come to fruition in the near future. I already look forward to seeing how it goes.

Finally, I would like to express my special thanks to Kavli IPMU staff members, especially Ms. Ujita, for making this workshop possible through their administrative support.