

# Unification

Director of IPMU

Hitoshi Murayama

I lived in West Germany for four years in my childhood. In the year 1978, teachers organized a school trip to Berlin. We took *Pan Am* flights for the trip, because the East Germany did not allow Lufthansa to fly over its territory. We visited the section of the Berlin wall where many from East Berlin threw themselves from apartment windows to reach West Berlin and died. Eleven years later, I was overjoyed watching the crowd crashing down the wall on TV. Germany became unified.

Unification has also been very important in our understanding of the universe. Newton unified apples with planets with his theory of gravity. It was a revolutionary theory that applies both to earthly and heavenly bodies, and changed the human conception of the universe forever. Maxwell unified the theories of electricity and magnetism, and proposed that light must be a dance between electric and magnetic fields. Without his theory, much of modern technology would not have existed, such as radio, TV, microwave oven, or DVD.

Since then, physicists discovered two other forces of nature beyond gravity and electromagnetism: *weak* and *strong*, both needed for our daily life. The strong force is needed to keep the atomic nuclei from falling apart, making chemistry and biology possible. The weak force allows the Sun to burn by turning ten billion pounds of mass every second into energy, allowing for Earth to sustain life. But we are not familiar with them because they do not go very far. The weak force goes only over a *billionth* of a *nanometer*!

Physicists are optimistic that we can unify all of these forces that look so different from each other and come up with a truly *unified theory*. In this issue of IPMU News, Hank Sobel talks about his lifelong attempt to prove the unification of forces by discovering that every atom is ultimately unstable. Hank and many other members of IPMU built the Super-Kamiokande experiment and could show that a hydrogen atom lives longer than a million billion billion billion years. It is amazing that they could show it lives *much much* longer than the age of the universe, which is *only* 13.7 billion years! This quest still continues, and we hope to build a new experiment some twenty times larger than SuperK.

Theoretically, unifying gravity with other forces proved very difficult. The main problem is that we believed elementary particles are *points*, and when two points meet, they go *bang* and give us infinities that don't make sense. If the particles are spread out like little rubber bands, they would rarely overlap exactly with each other and the theory is safer. Hirosi Ooguri in this issue tells you how the ambitious attempt to restructure the whole physical theories in terms of strings need help from mathematicians, who in turn get inspiration for their own research. IPMU held a very fruitful joint workshop of physicists and mathematicians, with the added excitement of new influenza, masks, sterilizing alcohol, and thermographic camera.

We are all looking forward to the day when the Berlin wall between forces and matters in nature will come tumbling down, and IPMU wishes to play a major role in this endeavor.