HORIBA INTERNATIONAL CONFERENCE COSMO/CosPA 2010

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An international conference on cosmology and particle astrophysics was co-organized by IPMU and RESCEU from September 27 to October 1, 2010 at the Hongo Campus of the University of Tokyo.* The main venue was Yayoi Auditorium (Ichijo Hall), and several halls in the School of Science, such as Koshiba Hall, were used for parallel sessions. This conference integrated two annual international conference series: COSMO, which had been held mostly in Europe and North America alternately, and CosPA, which had been held in the Asia Pacific region, in places such as Taiwan, Korea and Australia. More than 290 researchers from 30 countries attended the conference. In the following, let us review 29 invited lectures in the order of cosmic history.

In the very early universe, quantum fluctuations are so significant that even Einstein's theory of general relativity can't work, and we need "quantum gravity," a dream theory reconciling Einstein's general relativity and quantum theory. The conference began with a talk by Horava, who had recently proposed a new theory of quantum gravity.

After exiting the realm of quantum physics, the universe is thought to have experienced an epoch of rapid accelerated expansion called inflation and then turned into a hot fireball of universe. Since inflation is not only theoretically beautiful but also able to explain the observed spectrum of cosmic microwave background radiation (CMB) correctly, it is considered as an important part of modern cosmology. Inflation was one of main themes in this conference. We had many talks such as Silverstein's model in string theory, supersymmetric models by Takahashi and Stewart, Kaloper's argument about large field models, and Senatore's effective theory of inflation. We also had Hamaguchi's talk on temperature after inflation.

Just after inflation, there were nearly equal amounts of particles and anti-particles. Since things like our bodies and the earth are made of baryons, extra baryonic particles must have been generated from them. Buchmueller gave a talk on this subject called baryogenesis. In the subsequent hot universe, most baryons took the form of protons and neutrons. How were light elements synthesized from these? Big-bang cosmology answers this question. Steigman talked about recent topics in this subject called nucleosynthesis.

The universe expands further and its dominant gravitational source changes from radiation to

* http://www.resceu.s.u-tokyo.ac.jp/symposium/cosmocospa2010/index.php

matter. Actually, most matter in the universe is unidentified and called dark matter. There were many talks on dark matter in this conference. Mahapatra and Ogawa reported the current status and future prospects of experiments aiming at direct detection of dark matter. Umetsu reported the inferred distribution of dark matter in galaxy clusters. As for theories, we have heard about the possibility of detection in colliders from Roszkowski, indirect detection with cosmic ray from Marfatia, axions from Sikivie, gravitinos from Covi and gravitational instabilities from Bernardeau.

Soon after matter dominance began, as the universe cooled down, protons and electrons recombined to form hydrogen atoms. Photons kept being scattered in plasma before recombination, but now can move straightforward. Photons released at recombination are actually observed as CMB. Correlations among photons from different directions make it possible to determine parameters describing our universe with precision. As Dunkley and Hazumi forecasted, more detailed information about our universe will be obtained in the near future. For example, we can constrain models of inflation. Moreover, as Brandenberger noted, there is a possibility to observe evidence of cosmic strings formed in the early universe.

Until this point, the universe expanded with deceleration due to its gravity. Surprisingly enough, observational data of CMB and distant supernovae indicate that the current expansion of the universe is accelerating. If Einstein's theory of general relativity is right, then this implies that the universe is filled with an unknown energy sourcing some sort of anti-gravity. Does this mysterious energy called dark energy really exist? What is it then? If relativity must be modified, then how so? This is one of the most significant mysteries in cosmology. As Miyazaki and Murayama, reported, promising observational projects were recently launched in Japan. In theories, Chen and Starobinsky gave talks on the cosmological constant problem and f(R) gravity, respectively.

Following the cosmic history, we finally reach the present time — a fortunate time for cosmology, when we can expect new observational/experimental data one after another. Apart from the observations and experiments already reviewed above, Asai reported the status of LHC and Roulet reported the observations of ultrahigh energy cosmic rays. Related theory talks were by Kim on string theory particle physics models and by Xing on cosmic neutrino oscillation, respectively. Another observational talk was given by Murphy on quasar observation. His result indicates spatial variations of physical constants in a distance of cosmic scale and will be a historical discovery, if confirmed in the future.

As we have seen, cosmology is full of mysteries and problems to be tackled. We had not only the invited talks but also about 100 contributed talks and about 100 posters, and many exciting subjects were presented there. Discussions among participants were active, and it seems that some new research projects began. We hope that communications and discussions during this conference will lead to new development of cosmology research. Finally, members of the organizing committee would like to thank Dr. Masao Horiba for his generous support through the Horiba International Conference grant. We are grateful to the JSPS Core-to-Core Program, "International Research Network for Dark Energy," and the Asia Pacific Center for Theoretical Physics for their financial support, and the Physical Society of Japan and Global COE program for their approval.