

# **“COSMOLOGY WITH THE CMB AND ITS POLARIZATION” WORKSHOP SUMMARY**

In the winter of 2015, FTPI sponsored the workshop “Cosmology with the CMB and its Polarization” held in Minneapolis from Wednesday, January 14th to Friday, January 16th 2015. The meeting organizers were Clem Pryke, Keith Olive, Marco Peloso and Shaul Hanany.

The purpose of the workshop is to assemble the US and international CMB community to assess the current status of experimental and theoretical studies, and to look forward to the future. The Cosmic Microwave Background (CMB) has always played a central role in Big Bang Cosmology. Its discovery in 1964 pointed to the big bang as the leading theory describing the Universe. The background radiation is observed to be 2.7 degrees Kelvin across the sky. In 1990, the COBE satellite discovered slight temperature variations at the level of 10s of microKelvin. These were predicted shortly after the initial discovery of the CMB in the 1960s.

The 1990s saw a huge increase in the number of experiments (balloon borne and ground based) measuring these temperature differences. The study of CMB anisotropies entered a new age with the WMAP satellite which produced its first high precision results in 2003. The Planck satellite further improved these precision measurements with first results in 2013.

It is also predicted that there is a small amount of polarization in the CMB. This can be connected to the earliest moments after the big bang produced during a period of rapid expansion called inflation. Once again, a large number of balloon borne and ground based experiments were designed in addition to the Planck satellite which is also capable of detecting this polarization. In analogy with E+M, there are two types of polarizations, the so-called E-modes and B-modes. E-mode polarization was discovered in 2002, but the B-mode remains the holy grail of CMB physics as it can be directly related to the inflationary epoch.

The workshop will start with several presentations on the full mission Planck results which were expected to be announced in the fall of 2014. There was also a full review of the status of ground based and sub-orbital experimental programs, and of current theoretical aspects. The workshop included a discussion of the upcoming European M4 proposal for a post-Planck space mission and a discussion about NASA's plans for CMB and participation in M4. The workshop ended with a discussion regarding the next generation CMB S4 polarization project recently endorsed by the US P5 HEP advisory committee.

The main topics included:

New results from Planck, theoretical aspects of the CMB and its polarization, the status of funded suborbital experiments and outlooks toward the future. The Planck overview was

delivered by Charles Lawrence from Caltech and Polarization with Planck was discussed by Matthieu Tristram from Orsay in France. Theory talks included: primordial non-Gaussianity by Sabino Matarrese from Padova Italy; Implications for inflation by Matias Zaldarriaga from Princeton, and Lorenzo Sorbo from Amherst; The primordial 4-point function by Kendrick Smith from Waterloo. A second session of theory talks included discussions on neutrinos (Lloyd Knox from Davis), gravitational lensing (Uros Seljak from Berkeley), primordial B-modes (Carlos Contaldi from Imperial London). Other experimental talks included BICEP/Keck (John Kovac, Harvard, EBEX (Shaul Hanany, Minnesota). Future programs were discussed by Paolo de Bernardis (Rome), Julian Borill (LBNL), and Joe Silk (IAP Paris).

Summary by Keith Olive

Workshop website: <http://www.ftpi.umn.edu/workshops/2014-2015/cmb2015/index.html>