Planck Satellite ready to measure the Big Bang

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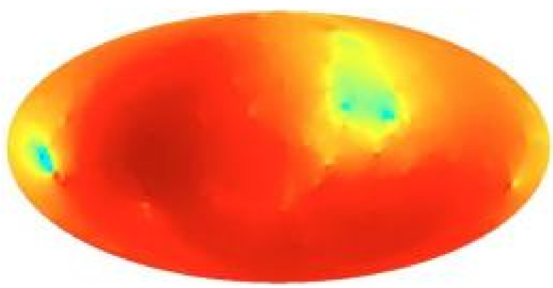

Full sky map of predicted CMB temperature fluctuations due to changing gravitational fields in the local universe, which was computed at MPA. Image: Maturi et al. 2007, Astronomy & Astrophysics 476, 83

(PhysOrg.com) -- The last tests of the Ariane 5 rocket system have been finished and ESA's Planck satellite is sitting ready for launch at the Guiana Space Centre in Kourou. Together with ESA's space telescope Herschel, Planck will lift off into space on 14 May to begin its studies of the cosmic microwave radiation and of the clues it gives about the Big Bang, the earliest phases of the cosmic history, and the structure and composition of the Universe. The Max Planck Institute for Astrophysics (MPA) in Garching has developed important software components for Planck and is getting ready to participate in the analysis and scientific interpretation of the mission data.

According to the standard model of cosmology, our Universe began 13.7 billions years ago in a Big Bang, the origin of space and time. The

Cosmic Microwave Background (CMB) is the relic heat from this Big Bang, released 380.000 years after beginning and still travelling freely through space today. At that early time, weak fluctuations of matter density were present, which are seen as variations of temperature in the CMB. By observing these fluctuations, cosmologists can infer how the large-scale structure of today's Universe - galaxies, galaxy clusters and filaments - was formed.

The Planck satellite will be placed at the second Lagrangian point of the Sun-Earth-Moon system (L2), located about 1.5 million kilometres away from the Earth - four times the distance to the Moon. The satellite will spin around its own axis, always point towards the Sun, with each rotation recording another strip of the sky and mapping the sky's temperature to an accuracy of about one millionth of a degree. The data are sent to Earth and converted into temperature maps of the sky in data processing centres in France and Italy. What the maps look like depends on certain characteristics of the Universe, for example on the curvature of space. For hypothetic Universes with specified properties, computer simulations using the MPA software generate virtual maps which will be compared with maps of the real sky. "From the comparison we can draw conclusions about the structure of our own Universe, for example how much ordinary matter and dark energy exist in it", explains Torsten Enßlin, head of the Planck group at MPA.

The physics of structure formation and the formation of galaxies will be studied via the so-called Sunyaev Zeldovich effect - the heating of CMB photons by scattering in the atmosphere of galaxy clusters. Due to this effect distant galaxy clusters become visible as "shadows" in front the cosmic microwave background.

However the galaxy clusters are only the densest parts of the cosmic matter distribution. 85 percent of the cosmic matter remains invisible and dark. The composition of this Dark Matter is still not known. From their computer simulations, MPA cosmologists have shown how the CMB is influenced the gravitational field of dark matter. The unseen structures of dark matter can therefore be deduced from temperature variations in the CMB. This requires the scientists to analyse the Planck data with statistical methods, obtaining important information on the structure and future development of the Universe.

Moreover, the mission is expected to detect thousands of distant objects in a frequency range barely studied so far, and so to offer new insights into the physics of galaxies, active galactic nuclei and quasars in the submillimetre domain. These will show Planck scientists energetic processes in the immediate vicinity of massive black holes. Planck may also help us to understand the birth of the first stars in the Universe and the structure of our own galaxy, the Milky Way.

"With the start of the Planck satellite a dream comes true", says Rashid Sunyaev, MPA director and pioneer of CMB research. "Planck will provide the most precise data on the early Universe ever. We have never been so close to the Big Bang." "We will understand the past of our Universe’s past and throw a glance at its future", adds Sunyaev’s colleague Simon White. "Will it keep on expanding for ever or some day collapse back upon itself? What is the nature of the mysterious dark energy causing this expansion? Planck will provide an answer to many important questions of cosmology. The satellite is the most powerful tool ever for studying the Cosmic Microwave Background developed."

Provided by Max Planck Institute