Fórum do Futuro, Teatro Rivoli, 21:30, Porto, 4 November 2015

Praise to Professor John Mather

Prof. John Mather is a leading and founding figure of the so-called observational cosmology. He is a top scientist of the Observational Cosmology Laboratory of NASA at Goddard Space Flight Center in Maryland, USA. He was the Principal Investigator of the FIRAS (Far Infrared Absolute Spectrophotometer), one of the key instruments that has flown at COsmic Background Explorer satellite (COBE) and that allowed for one of the main discoveries of that satellite. For his major contribution to that mission he was awarded the Nobel Prize of Physics in 2006, shared with George Smoot, the Principal Investigator of the DMR (Differential Microwave Radiometer) another COBE instrument. Prof. John Mather has also received countless prizes and awards, and is Doctor honoris causa of several universities.

In 2007, Prof. John Mather was listed among the 100 most influential people in the world by the Time magazine.

Since 1995, he has been involved as a senior scientist in the construction of the James Webb Space Telescope, the successor of the Hubble Telescope, an instrument about which we will hear in a while.

Prof. J. Mather is also a senior scientific advisor of the ALMA (Atacama Large Millimeter Array) telescope of ESO and of the Centre for Astrophysics Research of the Antarctic.

In 2012, Prof. John Mather was listed among the 25 most influential people in space, in the issue of the New Space Discoveries of the Time magazine.

To better appreciate the importance of Prof. John Mather's contribution let us say a few words:

In the early 1980s, cosmology, the science that studies the Universe as a whole, was still on its youth. Above all, it was still regarded as a purely theoretical and speculative endeavor. But this standing was dramatically changed after the launch of the COBE satellite in 1989. The objective of COBE was to study the microwave background radiation (CMB), discovered fortuitously by Arno Penzias and Robert Wilson in 1965. This radiation, with sub-millimeter wavelength, permeates the whole cosmos and is a remnant of the Big Bang. Its temperature was estimated to be -270°C. In 1970s it was found that we are moving with respect to the referential where the radiation is homogeneous and isotropic, an effect of a few parts per thousand. However, key issues about the CMB remained to be unraveled. Was the CMB a black body radiation (BBR)? To which extent was it really homogeneous and isotropic?

A BBR is a model that allows physicists to understand how bodies radiate thermal energy. It determines the amount of radiated energy for a given wavelength or frequency by just knowing the temperature of the body. It was then crucial to establish whether the CMB emitted as a BB.

Furthermore, theoreticians expected that extremely small fluctuations of temperature should be imprinted in the CMB, of order of parts per million. These would be related to density fluctuation, the seeds of structure formation in the Universe that is, of galaxies, clusters of galaxies and superclusters of galaxies.

But, these issues were completely open before the launch of COBE, as only a partial and modest fraction of the sky was accessible from ground and from balloon experiments. Thanks to the monumental work of Prof. John Mather, George Smoot and their collaborators it was possible, after a swift calibration of FIRAS, the instrument whose construction was led by Prof. John Mather, to established after just a few minutes of data taking that the CMB spectrum was an almost perfect BB, with a temperature of about -270°C.

The DIRBE (Diffuse Infrared Background Experiment), another COBE instrument, detected the infrared radiation from the galactic plane and this allowed for the measurement of the temperature fluctuations by the DMR instrument, these found to be about 50 parts per million.

The findings of COBE were as fundamental as the discovery that the Universe is expanding as established by Edwin Hubble in 1929. The contributions of Prof. John Mather and his colleagues opened the door to the era of modern cosmology and paved the way to subsequent CMB space missions such as WMAP, launched in 2001 and which allowed for 9 years of data taking, and PLANCK, launched in 2009 and turned off in 2013.

The knowledge accumulated by these missions allowed to state that the Big Bang took place 13.8×10^9 years ago and that the CMB is a "picture" of the Universe about 374×10^3 years after the Big Bang. The advancement of cosmology after COBE is impressive, but there are still many discoveries at stock. Most likely, Prof. John Mather will mention in his talk the major discovery of 1998, namely that the expansion of the Universe is actually an accelerated one!

As for the mention of Happiness in the title of Prof. John Mather talk, I can only but agree! The pleasure of understanding Nature, our human fellow, of grasping ideas, feelings and thoughts is one of the most persistent joys of life.

Orfeu Bertolami
Departamento de Física e Astronomia
Faculdade de Ciências da Universidade do Porto