The Observational signatures of cosmic strings

Cosmic strings were postulated by Kibble in 1976 and, from a theoretical point of view, their existence finds support in modern superstring theories, both in compactification models and in theories with extended additional dimensions. One of the best observational evidences for cosmic strings is the gravitational lensing effects they produce. A first effect is produced by an intervening string along the line of sight which splits in two components (double images) faint background galaxies, thus forming a chain of lensed galaxies along the path of the string. The second optical method is the serendipity discovery through anomalous lensing of extended objects. The huge ratio existing between the string width and length leads to a sort of step function signature on the gravitationally lensed images of background sources. The optical research of cosmic strings signatures suffers from many spurious effects mainly induced by the fact that, in order to be effective, the detection of background galaxies needs to be pushed down to very low flux limits.

The second fundamental observational evidence for cosmic strings is the signature they are expected to leave in the CMB a signature which may be sought for in the available WMAP data and in the soon to come Planck data. Theory shows that a moving string should produce a step-like discontinuity of low S/N ratio in the CMB, as a consequence of the Doppler shift due to the relative velocity between the string and the observer, thus causing the temperature distribution to deviate from a Gaussian.

In the simplifying assumption that the string is a straight discontinuity in space time, we used the S.Co.P.E. computational grid to produce a large number of simulations covering a wide range of values for the velocity of the string, its direction and its distance from the observer. Simulations are produced using a C++ code that generates realistic maps of the CMB temperature distribution in presence of a straight cosmic string. By varying its characteristic parameters, it is possible to explore the signatures left by various types of moving strings. In order to amplify the step-like discontinuity and smooth the noise, maps are then subjected to a “squeezing” procedure. Successively, on the “squeezed” maps, we tested a filter that recognizes high value differences between close pixels. The good results of our filter on simulations prompted us to apply it on WMAP 5 years data.