Abstract

Pulsars are fast-rotating, highly-magnetized neutron stars, visible at radio wavelenghts as pulsating objects thanks to two beams of emission that are focussed on the magnetic poles and co-rotate with the star, the rotational axis of which is not aligned with the magnetic one. The rotational stability and the possibility of measuring the time-of-arrival of the "pulses" of emission with an extreme precision allows to constrain the physical parameters of these sources, and to undertake a wide number of studies. In this PhD Thesis, we exploit this characteristic to explore several aspects of pulsar physics, mainly related with the "Pulsar Timing Array" experiments.

The first aspect is pulsar polarization. Pulsars are among the most polarized objects of the radio sky ever known, however, the origin of pulsar polarization and of the "modes" of polarization that characterize pulsar emission is still obscure. Here we present a classic polarimetric study of long-period pulsars discovered during the High Time Resolution Universe survey and a new approach to classify the combination of the polarized mode, along with a first application to the data.

The second aspect directly concerns the Pulsar Timing Array experiments, whose main goal is a direct detection of gravitational waves using pulsars. So far, no detection has been claimed. However, given the increasing sensitivity of these experiments, it is extremely important to develop solid sanity checks on the data to state if a future detection is genuine or not. We present here a study about false detection induced by correlated signals in Pulsar Timing Array experiments, along with a sample of possible routines to mitigate these effects.

The third aspect is the long term decadal stability of millisecond pulsar template profiles in flux, that is one of the hypothesis of the procedures to obtain extreme precisions in measuring the pulsar parameters. We study 10 millisecond pulsars using the longest and most uniform data set in the world. We also present the surprising result that one of the sources in our sample seems to present a sistematic profile variation along the years covered by the data set.