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With radii in the order of 10 km, masses roughly between 1 and 2 solar masses and magnetic fields that could be over 10^{14} G, neutron stars are fascinating astrophysical laboratories. After the gravitational collapse that gives their birth, they could rotate with periods from some milliseconds to some seconds. The fastest ones, millisecond pulsars (MSPs), can be used as precise clocks because of their extreme stability, with period derivatives around $10^{-20} s.s^{-1}$. This is what does Pulsar Timing Array (PTA) project in order to detect gravitational waves (GWs). Indeed, such waves modulate the pulse period that we detect modifying temporarily space-time curvature between the pulsar and the Earth. In PTA, we are probing low-frequency GWs (nHz-μHz), that would most likely be emitted by supermassive black hole binaries. Among others, we expect to detect stochastic background (isotropic or anisotropic) produced by the whole population of such black holes. This background generates angular correlations within pulsar timing observations with a peculiar signature. My project mainly concerns data reduction and noise characterizations in pulsar timing to permit their separation from the gravitational wave signal. Since the pulse is emitted from the pulsar, many astrophysical phenomemae and other mechanisms affect the period stability of the observed rotation. Internal physics of the pulsar and its magnetosphere or dispersion and turbulence in the interstellar medium between the pulsar and the observatory are good examples. Instrumental noise, clock noise and Solar System planetary ephemerides (SSEs) uncertainties also alter the regularity of the signal. A large part of my work consist in studying the impact on SSEs error signal on PTA results. Pulsar Timing Array experiment is now led in 3 continental consortia (Europe/EPTA, North America/NanoGRAV and Australia/PPTA) that are grouped together in an international collaboration logically named International Pulsar Timing Array. In this context, PTA-France group, formed by researchers working at AstroParticules et Cosmologie (APC) and Unité Scientifique de Nançay (USN), produces competitive pulsar timing data from Nançay Radio Telescope (94 m equivalent dish diameter) and develops statistical analysis methods.