After decades of multiwavelength (MWL) observations, it has been established that supermassive black holes lurk at the centers of most galaxies. A fraction of these SMBHs is actively accreting gas, transforming such objects into powerful emitters known as active galactic nuclei. About 10% of AGN also have the capability to launch highly collimated, relativistic jets, which are known as blazars when pointed towards our line of sight. Extending from radio up to gamma-rays, blazar emission is highly variable at different wavelengths and on different time scales. In particular, the gamma-ray light curves of these sources have been found to show a complex temporal structure. However, it is still an open question whether this variability displays a specific recurring pattern or not. The discovery of periodic emission in blazars can provide crucial information about the inner regions of the accretion disk, the structure of the jet, or potentially unveil the presence of binary SMBHs.

The search for long-term gamma-ray periodicity in blazars (periods longer than approximately 1 year) has been so far limited by the need of continuous monitoring over long periods of time gamma-ray band. In orbit for more than 12 years, the Fermi- LAT is the best-suited telescope, thanks to its capability of scanning the whole sky regularly and with high sensitivity. So far, different strategies have been employed to find periodicity in the gamma-ray LCs of blazars. Current efforts focus on few individual objects and apply at most two or three time-series algorithms. In a previous work, we studied hundreds of AGN (mostly blazars), using nine years of gamma-ray data provided by Fermi-LAT. Through a wide set of different periodicity detection methods, we found 11 blazars showing evidence of periodicity in their LCs with a confidence of 4sigma. Our preliminary analysis using the same previous methodology, but extending the telescope data to 12 years, shows that 6 (out of those 11) objects now display periodicities at ≥5sigma.

A variety of theoretical models have been proposed to explain the physical mechanisms responsible for MWL periodic emission in these sources. In general, these models can be divided according to whether they describe a single or binary SMBH. The main idea behind the class of single SMBH models relies on modulation of the emission coming from disturbances in the jet or the accretion flow (e.g. magnetic reconnection, shocks, thermal-viscous instabilities etc.). For the binary SMBH systems, such variations can be tentatively explained by perturbations in the accretion flow or jet precession mechanisms produced by the secondary SMBH.