A sample of good miliparsec separation massive black hole binaries

Whilst stellar mass black holes form at the end of the lives of massive stars, the formation of supermassive black holes is less clear. The detection of high-mass quasars at redshifts greater than 7 make it difficult to reconcile their origin with stellar mass black hole seeds. Different possibilities are possible to explain their emergence; accretion, mergers or intermediate mass black hole seeds, or a combination of two or three of those scenarios. The recent plausible detection of gravitational waves at nanoHz by Pulsar Timing Arrays hints at the ability of relatively low redshift (1-2) supermassive black holes to form tight binaries. A few dual AGN or massive black hole binaries (MBHBs) with kiloparsec separation have been discovered but observational evidence for close sub-parsec separation MBHBs is weak. Such systems are expected to display detectable periodic oscillations in the optical/UV, due to the accretion flow in the binary. We conducted a systematic search for sub parsec separation MBHBs, looking for sinusoidal variations in optical lightcurves using Catalina Real-Time Transient Survey (CRTS) and Zwicky Transient Facility (ZTF) data and found 36 good candidates showing between 3 and 5 cycles. We confirmed their periodic variability using several methods and tested their modulation with a red noise process, usually observed in AGN. Also, considering the redshift of these candidates, the number density we find is in agreement with predictions from simulations. The X-ray flux of the candidates, when available, hints that they are high-accreting objects, as expected from MBHBs. Moreover, we created a catalog of 221 weaker candidates that would require additional observations. In addition, thanks to joint XMM-Newton and NuSTAR observations, we study the X-ray spectrum of one of the best candidates that we propose, revealing further evidence for the MBHB possibility. Considering the mass and period of the candidates, they will not be detected as individual events by the next space-based gravitational wave observatory LISA, however they might still contribute to the gravitational background.