Detectability of modulated X-rays from LISA's supermassive black hole mergers

Tito Dal Canton[1], Alberto Mangiagli[2], Scott C. Noble[1,3], Jeremy Schnittman[1], Andrew Ptak[1], Antoine Klein[4,5], Alberto Sesana[5], and Jordan Camp[1]

[1]NASA Goddard Space Flight Center, Greenbelt, USA
[2]University of Milano - Bicocca & INFN, Milano, Italy
[3]The University of Tulsa, Tulsa, USA
[4]Institut d'Astrophysique de Paris, CNRS & Sorbonne Universités, Paris, France
[5]University of Birmingham, UK

One of the central goals of LISA is the detection of gravitational waves from the merger of supermassive black holes. Contrary to stellar-mass black hole mergers, such events are expected to be rich X-ray sources due to the accretion of material from the circumbinary disks onto the black holes. The orbital dynamics before merger is also expected to modulate the resulting X-ray emission via Doppler boosting in a quasi-periodic way, and in a simple phase relation with the gravitational wave from the inspiral of the black holes. Detecting the X-ray source would enable a precise and early localization of the binary, thus allowing many telescopes to observe the very moment of the merger. Although identifying the correct X-ray source in the relatively large LISA sky localization will be challenging due to the presence of many confounding point sources, the quasi-periodic modulation may aid in the identification. We explore the practical feasibility of such idea. We simulate populations of merging supermassive black holes, their detection with LISA and their X-ray lightcurves using a simple model. Taking the parameters of the X-ray Telescope on the proposed NASA Transient Astrophysics Probe, we then design and simulate an observation campaign that searches for the modulated X-ray source while LISA is still observing the inspiral of the black holes. Assuming a fiducial LISA detection rate of 10 mergers per year at redshift closer than 3.5, we expect a few detections of modulated X-ray counterparts over the nominal duration of the LISA mission.