Multi-messenger Astronomy with LISA

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LISA will be the first observatory to open the milli-Hertz band of gravitational waves to the astronomical community. A number of astrophysical processes at the frontier of astronomy are expected to emit gravitational waves in this band, ranging from the seed black holes of the early Universe through to the merger of masssive black holes in the current epoch, as well as the evolution of stellar remnants within our own galaxy. Many of these sources of gravitational waves (GW) are also targets for current and future electromagnetic observatories, including Athena.

The science cases of both LISA and Athena are outstanding, leading to the missions being selected as the 2nd and 3rd Large class (flagship) missions of ESA's Cosmic Vision Programme. Both missions will observe the most energetic and extreme objects in the universe; the supermassive black holes theorised to be powering the Active Galactic Nuclei (AGN) and to be, when in a binary system, the loudest sources of low-frequency gravitational waves in the Universe. Athena can detect the emission from hot gas around the massive black holes during a merger, whereas LISA will detect the gravitational waves emitted during the inspiral, merger and ringdown.

The main limitation in performing concurrent observations with LISA and Athena lies in the poor sky localisation of the source during the inspiral phase. The LISA sky localisation error box shrinks dramatically shortly before the final merger, when the SNR respectively increases. In the best cases, LISA will locate the source within an Athena WFI error box only hours before the final merger. This leads to additional requirements on the ground segment processing required to issue alerts in a timely manner.

This presentation will describe the additional science achievable with multi-messenger observations specifically from the concurrent operation of LISA and Athena; namely the merger of supermassive black holes (M_{tot} ~$10^6 M_\odot$) out to redshift, $z < 2$. In addition to the science, the presentation will also focus on the operational constraints imposed by both missions, for example, the sky localisation capabilities of LISA, coupled with the field-of-view of the Wide Field Imager (WFI) of Athena, as well as the requirements levied on the ground segment of both missions.