Predicting the electromagnetic signatures of pre-merger binary black holes

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The many recent detections of gravitational waves (GWs) of binary black hole (BBHs) mergers have opened the way for future multimessenger compaigns. One expected result, not achieved yet, is the co-detection of electromagnetic (EM) radiation from a pre-/post-BBH merger system together with its GW inspiral emission, detectable for stellar-mass BHs with LIGO/Virgo, intermediate-mass BHs (and stellar-mass BHs) with the Einstein Telescope and supermassive BHs with the space-based detector LISA in 2030+. This co-detection could be performed with LISA and future electromagnetic facilities (e.g. Athena) and need to be anticipated. However, the EM signatures of pre-merger BBHs are not firmly identified because few numerical codes are able to model the gravitational impact of the BBH on its accretion disk in General Relativity (GR).

In this talk, I will present e-NOVAs, standing for "extended Numerical Observatory for Violent Accreting systems" as it has been recently extended to work with any type of spacetime. It is the first European code to evolve an analytical BBH metric as it solves the equations of GR-magnetohydrodynamics and to compute synthetic observations in the same metric via GR ray-tracing. Using e-NOVAs, I will study the influence of a BBH in the inspiral regime on their circumbinary disk, especially on the formation of (unique?) accretion structures in the BBH vicinity. I will investigate the origin of these structures and show if their spectro-timing properties could be used as an EM signature allowing us to distinguish BBHs from other transient sources in the future.