The last electromagnetic breath of binary black holes

Raphaël Mignon-Risse (NTNU, CNES/APC), Peggy Varniere, Fabien Casse, Alexis Coleiro, Pierre-Alexandre Duverne (APC)

The many recent detections of gravitational waves (GWs) of binary black hole (BBH) 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. For supermassive BHs, the GW frequency enters the detection band of the Pulsar Timing Arrays (not as individual sources so far) and of the future space-based detector LISA. A GW-EM co-detection would be precious for various fundamental problems (e.g. linking BH and galaxy growth, constraining the engine properties of active galactic nuclei…) and could be performed then with the next generation of electromagnetic facilities (e.g. Athena, Vera Rubin), but it needs to be anticipated. However, the EM signatures of BBHs approaching merger are not firmly identified because few numerical codes are able to model the gravitational impact of the BBH on its accretion flow in General Relativity (GR).

In this talk, I will present recent results obtained with e-NOVAs, our "extended Numerical Observatory for Violent Accreting systems" which performs GR-(magneto-)hydrodynamical simulations of accretion flows followed by a GR ray-tracing step to produce synthetic observables from these, in an approximate BBH dynamical spacetime valid until the BHs come to close to each other. I will briefly present the electromagnetic, thermal, variability of the circumbinary disk emission (MR+24, subm.) when the BBH inspiral motion is very slow, i.e. at large separation. Then, we will follow the system’s evolution as the BBH accelerates up to the point where the circumbinary disk gas cannot follow the BBH anymore, the so-called “decoupling” phase. Beyond this crucial point, I will show that some of the circumbinary disk EM variability remains active down to ~100 (M/10^5 solar masses, with M the BBH mass) seconds prior to merger, while the GW localization is nearly optimal, and even possibly beyond. This is the last EM breath of BBHs.