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Signatures of circumbinary disks around pre-merger binary black holes

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Despite the re-birth of multi-messenger astronomy, no unambiguous electromagnetic (EM) counterpart to binary black hole (BBH) pre-/post-merger has been reported. Detecting the EM pre-merger counterpart would allow for optimal follow-up. However, the accretion properties onto pre-merger BBHs and EM signatures are not firmly identified because few numerical codes are able to model accretion and emission around BBHs in General Relativity (GR). Instead, the luminosity is often assumed to be proportional to the mass accretion rate, hence neglecting any relativistic effect.

In this talk, I will present recent results obtained with e-NOVAs (”extended Numerical Observatory for Violent Accreting systems”), a GRMHD+GR ray-tracing code recently extended to dynamical spacetimes and now incorporating an analytical BBH spacetime. Using e-NOVAs, I will study a BBH circumbinary disk evolution and its EM observables. I will briefly present the accretion structures that could potentially help us distinguishing BBHs. I will show that their EM lightcurve is modulated by non-axisymmetric structures orbiting in the disk, with special relativistic effects such as relativistic beaming amplifying the modulations' amplitude. Thus, the amplitude depends on the source inclination and occurs on the orbital timescales linked to these structures, rather than on the accretion rate variation timescales. These timing signatures can be used from now on: the binary black holes hunt is open.

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