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Phenomenology: Nonlinear photon-plasma interaction and the black-hole superradiant instability

Thursday, September 7, 2023 5:00 PM (15 minutes)

Superradiant scattering provides a interesting way of extracting energy from a rotating black hole by means of amplification of low-frequency electromagnetic (EM) radiation. If plasma in the accretion disk prevents the outgoing radiation from escaping to infinity, this process can happen repeatedly, triggering an instability that can lead to the appearance of bursts.
However, investigating this scenario requires a nonlinear treatment of the interaction between the EM field and plasma, due to the high intensity of radiation generated by the numerous superradiant scatterings. In this context, a particularly interesting possibility that has been suggested in literature is that overdense plasmas become transparent to intense EM fields, leading to an energy leak that quenches the instability.
In a recent work done in collaboration with Enrico Cannizzaro and prof. Paolo Pani, we simulated in a flat spacetime 3+1 setup the fully nonlinear interaction between an EM wave packet and a plasma barrier, with the purpose of exploring the phenomenology of this interesting regime. While we did not observe transparency, we found that the momentum transferred by the EM field to the barrier can set the system in a blow-out state in which energy can escape from the black hole. In this talk I will present the results of our numerical simulations, discussing the possible implications for superradiant instability.

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