Modeling intrinsic time-lags in flaring blazars in the context of LIV searches

Some quantum gravity (QG) models predicted Lorentz invariance violations (noted LIV) expected to occur at energies approaching the Planck scale. Amongst other effects, LIV induces a modified dispersion relation (MDR) of photons in vacuum, introducing the quantum gravity energy scale E_{QG} that we want to constrain with this studies and inducing an energy-dependent velocity. A strategy currently developed to search for LIV signatures is to look for energy dependent time delays in the gamma-ray signal coming from remote and variable cosmic sources such as AGNs, PSRs and GRBs at TeV energies. However, *in situ* time delays can also be generated from the radiative process at work in the sources themselves, hence a necessity to distinguish any LIV propagation effect from sources' intrinsic effects.

One way to address this issue is the study of these intrinsic effects through the modelisation of sources emission mechanisms. We introduce a time dependent modeling of blazar relying on a minimalist one-zone synchrotron-self-Compton scenario and review the study of intrinsic time delays and their properties. We also perform a multi-frequency study highlighting a strong correlation between time delays in the X-ray (unaffected by LIV) and gamma-ray (where LIV effects could arise) domains. The measurements of euclidian distance helps quantify this correlation and may allow us to deduce intrinsic delays in the gamma-ray energies from the ones at X-ray energies. Furthermore, we have identified a euclidian distance threshold where time delays can no longer be explained by intrinsic effects in a pure SSC scenario. This threshold provides a way to identify the presence of non-intrinsic delays. Any deviation from a standard pure SSC flare, such as additional external inverse Compton or adiabatic processes, can reduce the symmetry between synchrotron and gamma-ray properties. Alternatively the presence of such a symmetry could help validate the pure one zone SSC scenario.

Introducing LIV effects in our simulations leads to a significant break of the symmetry. This asymmetry can be used to our advantage. Indeed in the eventuality where the pure one zone SSC scenario is validated with other observables, a break of symmetry would hint that another effect is at play and contributes to modify the time delays. In the case where instruments sensitvity allows it, this can also be further confirmed with the study of hysteresis where a similar break of symmetry should arise. We should thus be able to discriminate between intrinsic and LIV contributions to observed time delays with such tools and methods.

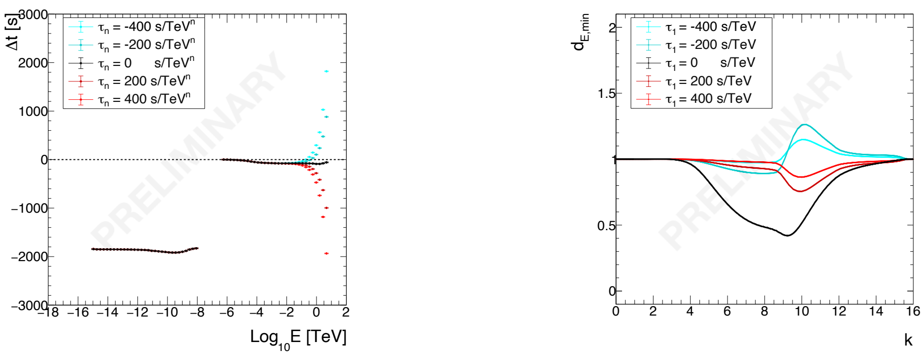

Figure 1: Time delays (a) and euclidian distance function (b) for various LIV contribution. The minimum euclidian distance $d_{E,min}$ is reached by the curve with no LIV effect (black).