

Robust constraints on LIV from H.E.S.S., MAGIC and VERITAS data combination

Some quantum gravity (QG) models predicted Lorentz invariance violations (noted LIV) expected to occur at energies approaching the Planck scale. The overall effect can be taken into account with 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.

We present analysis tools dedicated to population studies for the search of LIV-induced time delays with the aim of producing robust constraints on QG effects. These tools have been designed to combine for the first time the data obtained with the three experiments, H.E.S.S., MAGIC and VERITAS using a maximum likelihood method. Two lag-distance models, from a pure LIV framework (noted J&P) and from Doubly Special Relativity (DSR) are confronted in this study to test distance dependence of the LIV-induced time-lags. The method is tested and calibrated on simulated datasets based on several representative sources observed at TeV energies, along with an evaluation of statistical and systematics errors.

Figure (1) gives a summary of our results. GRBs appear as the most constraining sources due to their characteristics especially favorable for LIV studies, and dominates the combinations when included in the studied sample. Then come AGNs, followed by PSRs which are the least constraining sources but also the only sources independent of lag-distance models. The J&P model appears to emphasise the impact of large distance sources, while the DSR model tends to balance sources' contribution such that their combination leads to a significant improvement on limits. Combinations are dominated by the most stringent source in the sample and its dominant systematic which often divides the E_{QG} limits by a factor 2. For most sources, the newly derived upper limits are less constraining indicating systematics may have been underestimated in previous analyses.

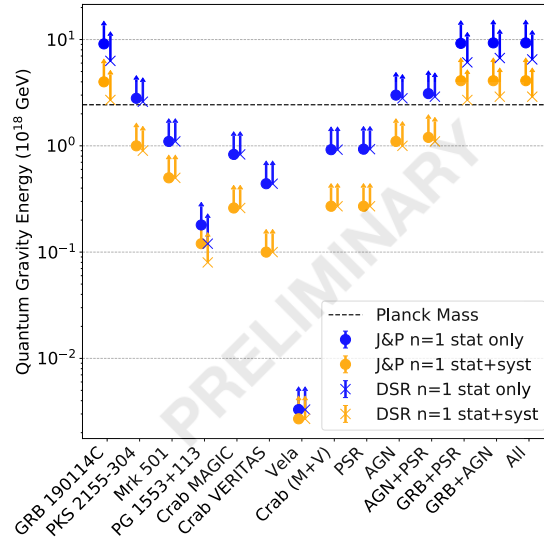


Figure 1: $E_{QG,n}$ upper limits with and without systematics for J&P and DSR linear cases.