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Systematics in the Interpretation of Aggregated Neutrino Flux Limits and Flavor Ratios from Gamma-Ray Bursts

Philipp Baerwald, Svenja Hümmer, Walter Winter

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Gamma-ray burst analyses at neutrino telescopes are typically based on diffuse or stacked (i.e., aggregated) neutrino fluxes, because the number of events expected from a single burst is small. The interpretation of aggregated flux limits implies new systematics not present for a single burst, such as by the integration over parameter distributions (diffuse fluxes), or by the low statistics in small burst samples (stacked fluxes). We simulate parameter distributions with a Monte Carlo method computing the spectra burst by burst, as compared to a conventional Monte Carlo integration. With this approach, we can predict the behavior of the flux in the diffuse limit as well as in low statistics stacking samples, such as used in recent IceCube data analyses. We also include the flavor composition at the detector (ratio between muon tracks and cascades) into our considerations. We demonstrate that the spectral features, such as a characteristic multi-peak structure coming from photohadronic interactions, flavor mixing, and magnetic field effects, are typically present even in diffuse neutrino fluxes if only the redshift distribution of the sources is considered, with z \simeq 1 dominating the neutrino flux. On the other hand, we show that variations of the Lorentz boost can only be interpreted in a model-dependent way, and can be used as a model discriminator. For example, we illustrate that the observation of spectral features in aggregated fluxes will disfavor the commonly used assumption that bursts with small Lorentz factors dominate the neutrino flux, whereas it will be consistent with the hypothesis that the bursts have similar properties in the comoving frame.

Comments:	46 pages, 21 figures, 2 tables. Minor corrections in Sec. 3.3 (Gamma dependence of model FB-D). Fixed some typos
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