TeV Bayesian Study of the Extragalactic Background Light

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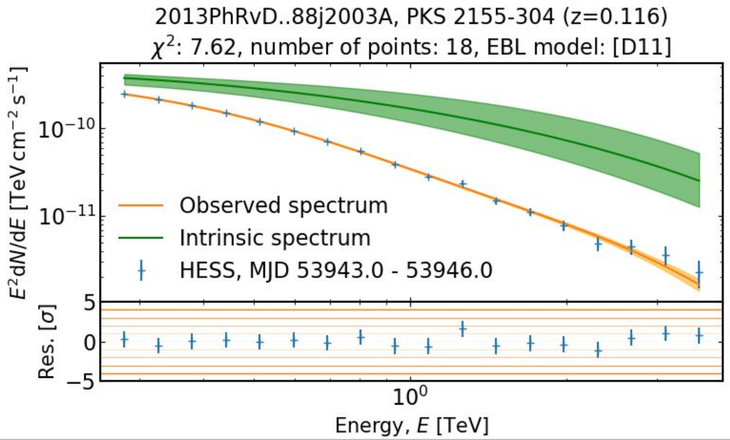
The extragalactic background light (EBL) is the aggregate of all optical and infrared emissions from thermal processes since the cosmic dark ages. While the integrated light of galaxies is expected to be the main contribution to the EBL, recent measurements beyond Pluto's orbit from New Horizons show a 4-sigma excess in the optical band. This tension can be studied within observational **gamma-ray cosmology**, by reconstructing **EBL-induced absorption** in the gamma-ray spectra of extragalactic sources at very-high energies (VHE, E>100GeV). Gamma-ray studies of the EBL remain limited by the size of the spectral corpuses and by the uncertainties on the shape of the spectra emitted at the sources. We developed a new analysis method that aims to tackle these limitations.

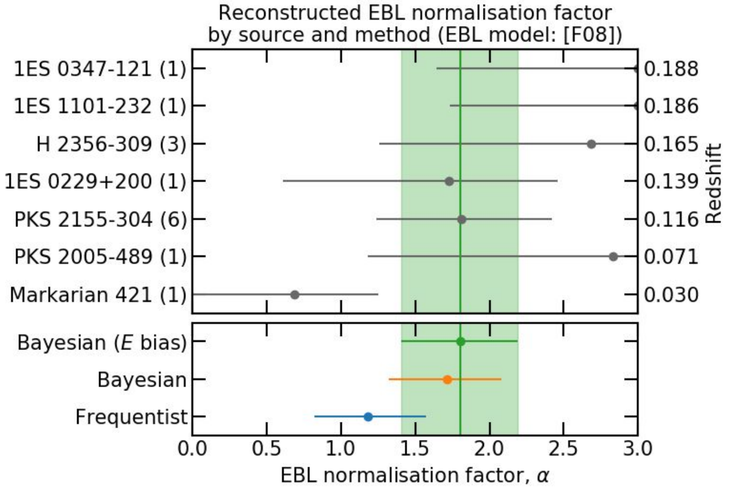
Bayesian framework

- Fully Bayesian reconstruction: intrinsic spectra as **Exponential Cutoff Log Parabolas** (with adequate prior distributions); EBL level scaled from reference model: $\exp(-\alpha \cdot \tau(E, z))$.
- For each spectrum, Markov chain Monte-Carlo (**MCMC**) are used to sample the posterior distributions of all the parameters.



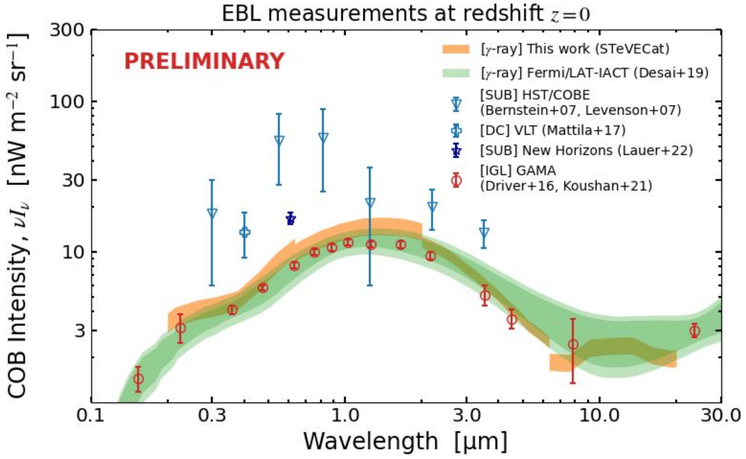
Uncertainty on the energy scale

- For each parameter of interest, the posterior distributions from all spectra are combined to reconstruct the global distribution. Uncertainties on the spectra energy scale as in **[N19]**.
- Following [H13], **14 spectra** from H.E.S.S. with [F08] EBL model: energy scale bias factor consistent with [N19], ~8%.



Using STeVECat

- **259 spectra** selected from STeVECat[a] (known redshift z > 0.01), [D11] EBL model. Energy scale bias factor: **less than 10%**.
- EBL intensity compatible with previous γ-ray measurements. Increased sensitivity using **only IACT observations**. EBL level close to integrated galaxy light. Wavelength-resolved results able to resolve the optical controversy?



Outlook

We employ a fully Bayesian framework, which allows us to remove arbitrary criteria for selecting intrinsic spectral models. This approach further enables marginalization over systematics of instrumental origin, such as the uncertainty on the energy scale of current-generation VHE observatories.

To further improve this reconstruction, we are currently working on the inclusion of contemporaneous *Fermi*-LAT measurements, and on a model-independent EBL parametrization.

[D11] Domínguez, A. *et al.* (2011). Extragalactic background light inferred from AEGIS galaxy-SED-type fractions. *Monthly Notices of the Royal Astronomical Society* 410, 2556–2578.

[N19] Nigro, C. *et al.* (2019). Towards open and reproducible multi-instrument analysis in gamma-ray astronomy. *Astronomy & Astrophysics* 625, A10.

[H13] H.E.S.S. Collaboration (2013). Measurement of the extragalactic background light imprint on the spectra of the brightest blazars observed with H.E.S.S. *Astronomy & Astrophysics* 550, A4.

[F08] Franceschini, A. *et al.* (2008). Extragalactic optical-infrared background radiation, its time evolution and the cosmic photon-photon opacity. *Astronomy & Astrophysics* 487, 837-852.

a - STeVECat: Spectral TeV Extragalactic Catalog. See other poster presented at γ-2022 by Lucas Gréaux.