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Gamma-ray propagation, magnetic field and EBL constraints from HE and VHE observations

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At first glance, the question of what the universe is made of may seem unrelated to astroparticle physics. It is in fact optical and microwave observations that have revealed that the energy balance of the universe is dominated by the density of dark energy (70%) and dark matter (25%). The nature of these two entities is elusive to this day. The remaining 5% is sometimes erroneously excluded from the realm of cosmology and attributed to gastrophysics, a form of sophisticated cuisine that would incorporate warm-hot plasma (approximately 4%), stars in various stages of evolution (a few per thousand), and supermassive black holes (a few parts per million). These entities would be distinguished by their complexity from the pre-dark ages relics, namely hydrogen, helium, and the diffuse neutrino and microwave backgrounds (total of less than two per thousand). This presentation will demonstrate how astroparticles, particularly gamma rays, are employed as a powerful tool to investigate the components of what is referred to as gastrophysics. Photons in the GeV-TeV energy range emitted in the vicinity of stellar-sized and supermassive black holes at cosmological distances have been used by the astroparticle community to study the plasma of the intergalactic medium and the associated magnetic fields, to measure the photon fields radiated by all the stars and dust grains in the universe, and to constrain the cosmological parameters themselves. The preparation of such culinary delights over the past decade heralds the advent of a more substantial banquet in the decade to come, which will require astroparticle physicists, gamma-ray astronomers, radio astronomers and optical astronomers to gather around the table.

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