Extended gamma-ray emission from blazars: prospect of detection with future Cherenkov Telescopes

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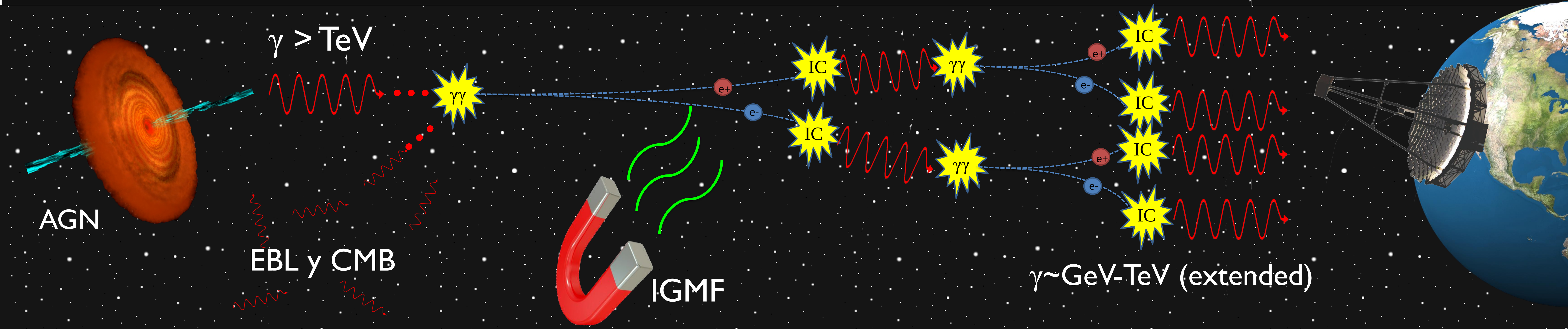
Very high energy (VHE: >100 GeV) gamma rays coming from blazars can pair-produce on the extragalactic background light (EBL) generating an electromagnetic cascade. If the Intergalactic Magnetic Field (IGMF) is sufficiently strong, this cascade may result in an extended isotropic emission of high energy photons around the source, or *halo*. The detection of this effect may lead to important constrains both to the IGMF intensity and the EBL density, quantities with great relevance in cosmological models. We use Monte Carlo simulations of these cascades to build the angular and spectral distributions of photons coming from a source at a given redshift. We consider different astrophysical scenarios, varying IGMF intensities and source luminosities, and study the possible detection of the effect using a simplified approach for the response of future Cherenkov Telescope systems.



Many blazars are known to have significant gamma ray emission beyond TeV energies. These photons travel a distance of typically 1Mpc before interacting with the CMB producing $e^+ e^-$ pairs.

These pairs can as well interact and upscatter CMB and EBL photons to TeV-GeV energies, generating an electromagnetic cascade†. Pair trajectories are deflected by the IGMF in greater or less extent depending on its intensity.

Possible scenarios:

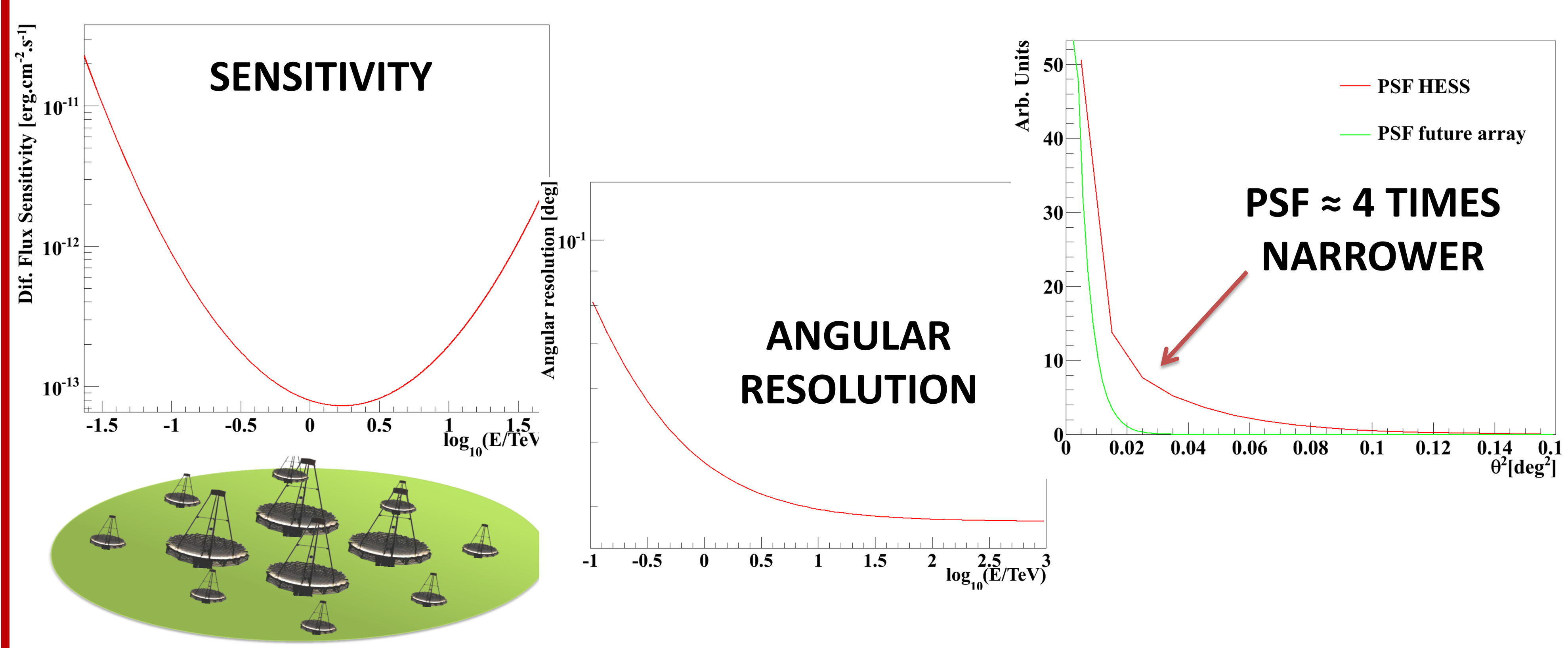
10^{-12} G < B < 10^{-7} G → Pair Halo (extended)

0 < B < 10^{-14} G → Magnetic broadened cascade

Detection of secondary photons depends on both the source and the telescope properties.

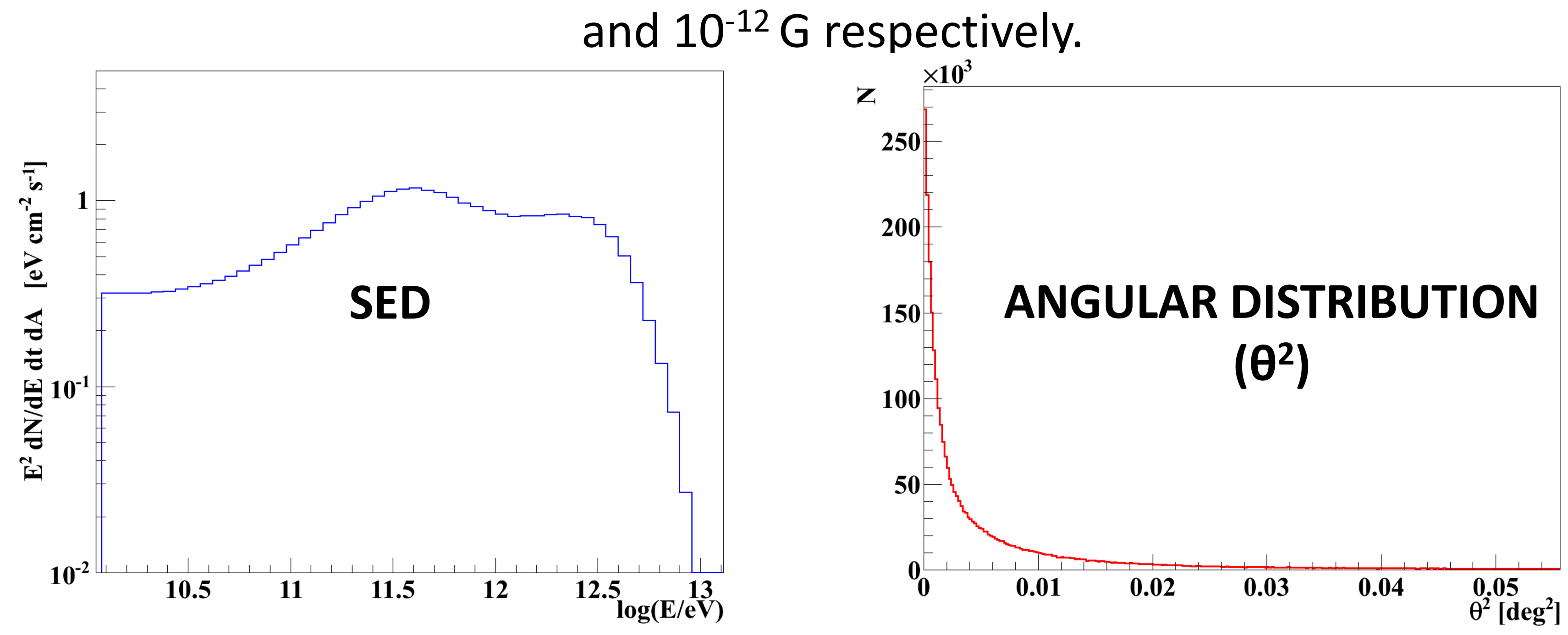
Telescope features

Future generation Cherenkov telescope arrays will have better sensitivity and angular resolution. We use the next simplified model for the response of a future array††.



Simulation

We simulate Intergalactic cascades (Elmag†††) to build the angular and spectral distribution of photons reaching the Earth. We consider a monochromatic source emitting 100 TeV gamma rays collimated in a 6° jet, which is more realistic approach than previous studies. The source distance and in IGMF intensity are set to z=0.129 and 10^{-12} G respectively.



Procedure and statistics

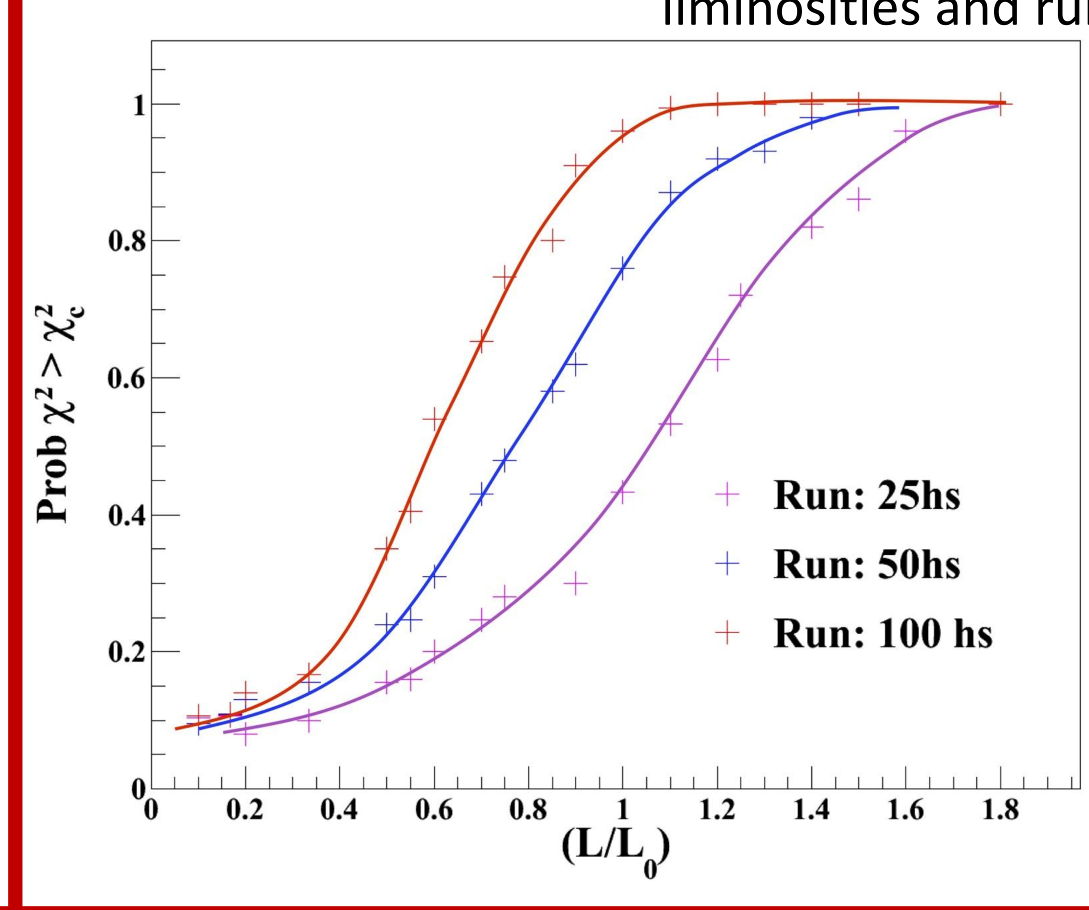
To search for an extended contribution we compared the source θ^2 excess distribution with the telescope PSF. We construct a "wobble" background using the telescope effective area and sensitivity.

1. **Obtain θ^2 ON distribution from simulation**
2. **Substract background to obtain θ^2 excess**
3. **Fluctuate it (Poisson) to generate N samples**
4. **Use χ^2 test to compare each sample to PSF**

$$\chi^2 = \sum_{bin} \frac{(N_{excess} - N_{PSF})^2}{N_{excess}}$$

Preliminary results

From the χ^2 test results we calculated the probability of rejecting the null hypothesis considering the fraction of samples that overpass the rejection threshold (set in 95% C.L). In other words, this probability tells **how likely** it is to **detect** extended emission with the telescope array. The analysis was done for different source liminosities and run durations.



The probability increases with luminosity, as expected, and it grows faster for longer runs. We developed a method to test the power of detecting extended emission with future Cherenkov telescopes. The next step is to apply it in a more realistic case.

References

† Aharonian, F. A.; et al. Astrophysical Journal, Part 2 - Letters, vol. 423, no. 1, p. L5-L8.

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