Searching for Pair Halos

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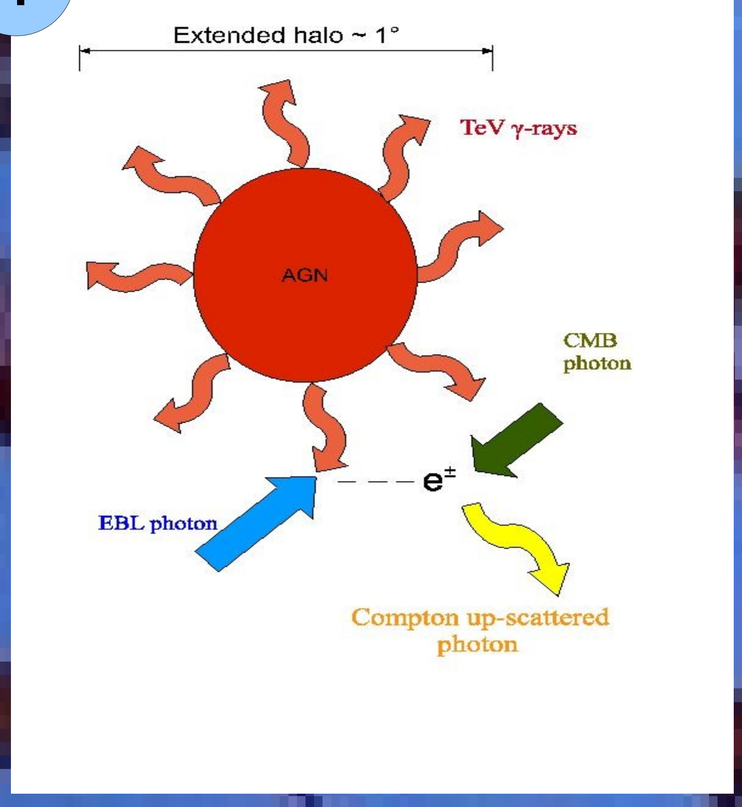
Introduction

1



Pair Halos are giant electron-positron ($e^{\pm}$) structures which are formed due to the development of pair cascades, initiated by interactions of primary multi-TeV photons from high energy electromagnetic sources with the extragalactic background photon fields (see original publication on this topic by Aharonian, Coppi & Voelk: ApJ,423L, 5A (1994))
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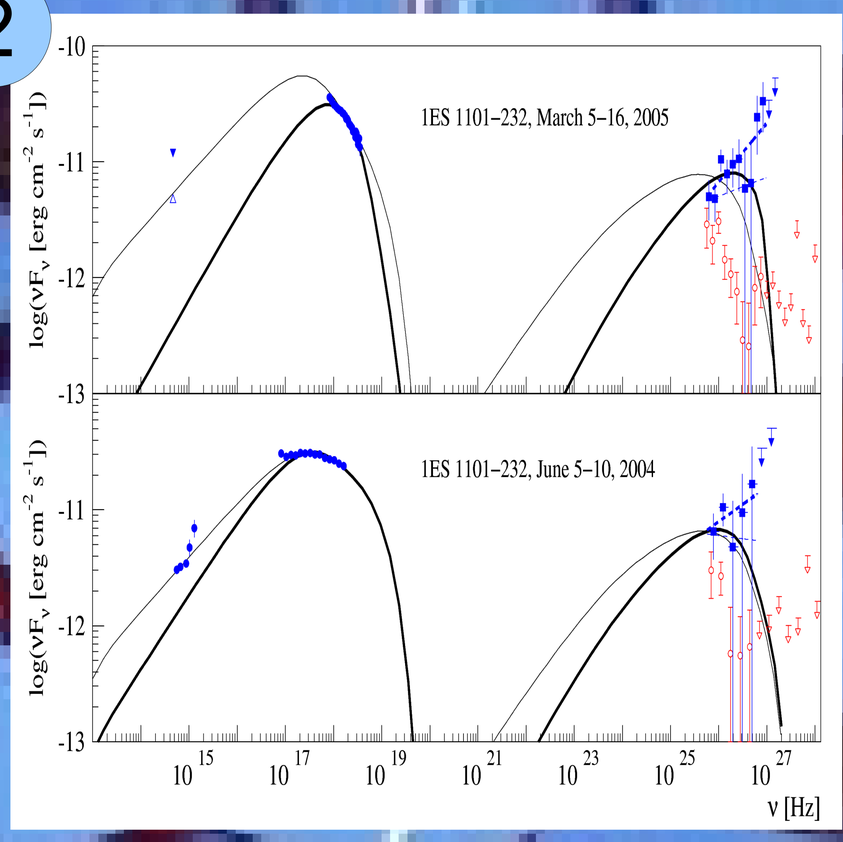


Theory

A cartoon model of pair halo formation is shown in Figure 1. The main processes involved are pair production and inverse Compton scattering. Pair halo formation requires an extended energy spectrum into >> 1 TeV energies as well as a sufficient B-field ($B > 10^{-11}$G). Fig. 2 is taken from the 2007 discovery paper of 1ES 1101-232 by the HESS collaboration (A&A 470, 475–489 (2007)). The deabsorbed spectrum (blue squares) hints at being a suitable candidate for halo formation.

3

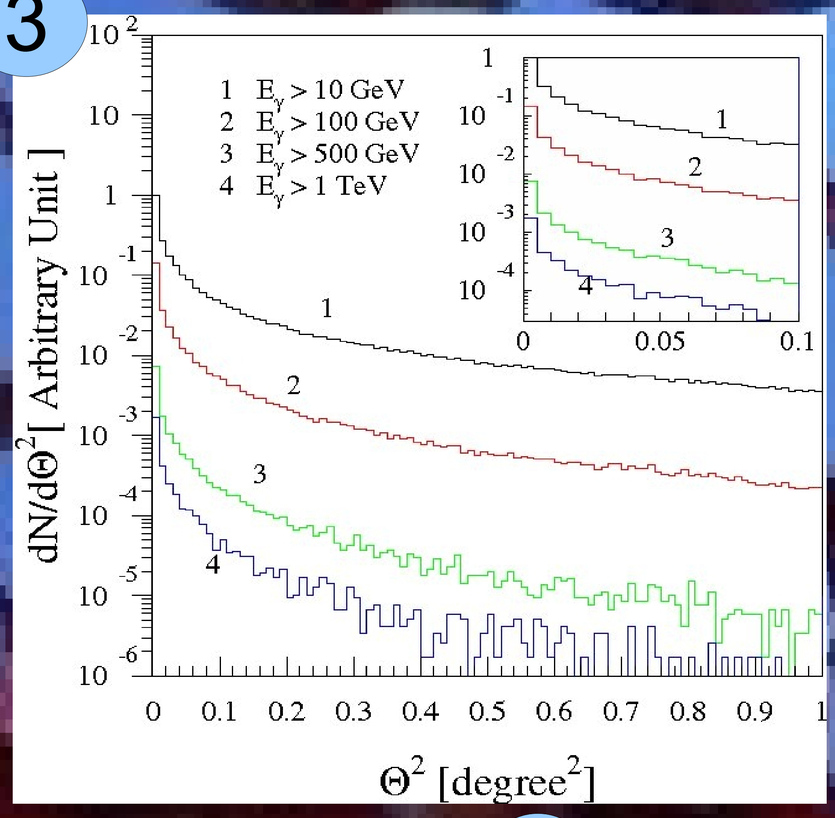
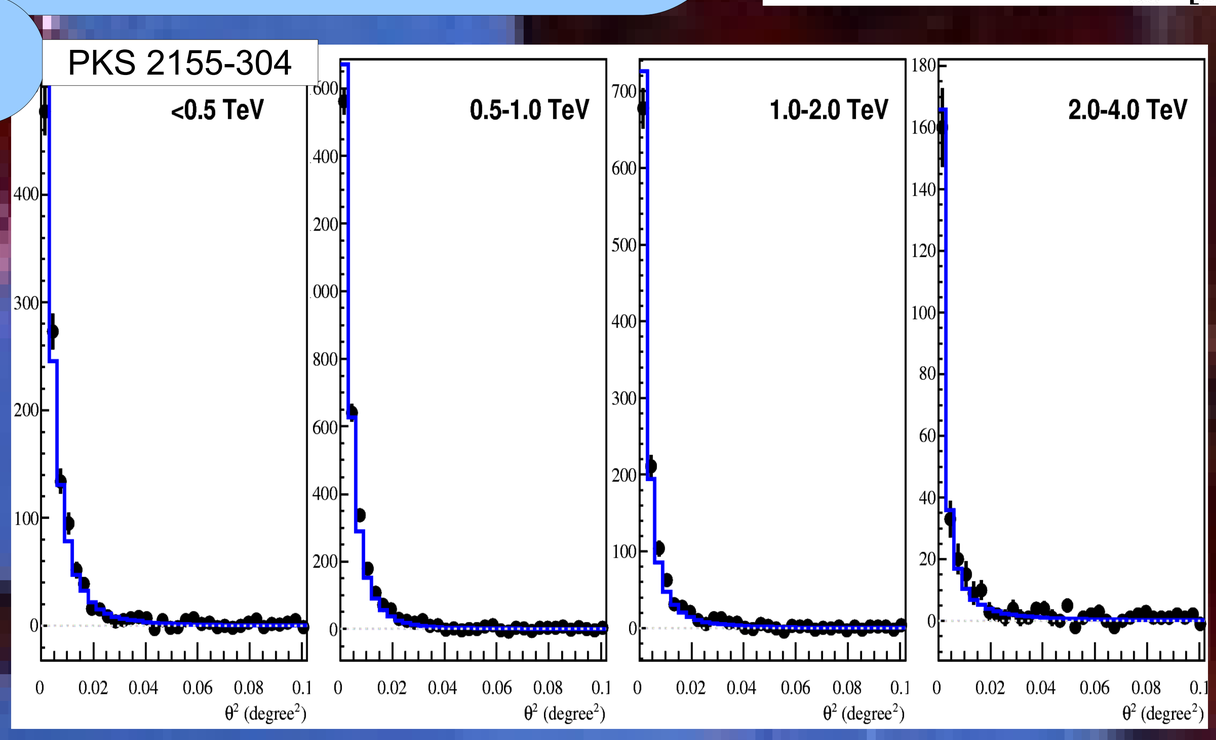


Fig. 3 is taken from a publication by A. Eungwanichayapant & F. Aharonian (IJMPD 18, 911E (2009)). This figure illustrates the theoretical predictions for pair halo angular distributions at different energies. We will use this as part of our future analysis to compare HESS observations with the most up-to-date theory.

Results

4



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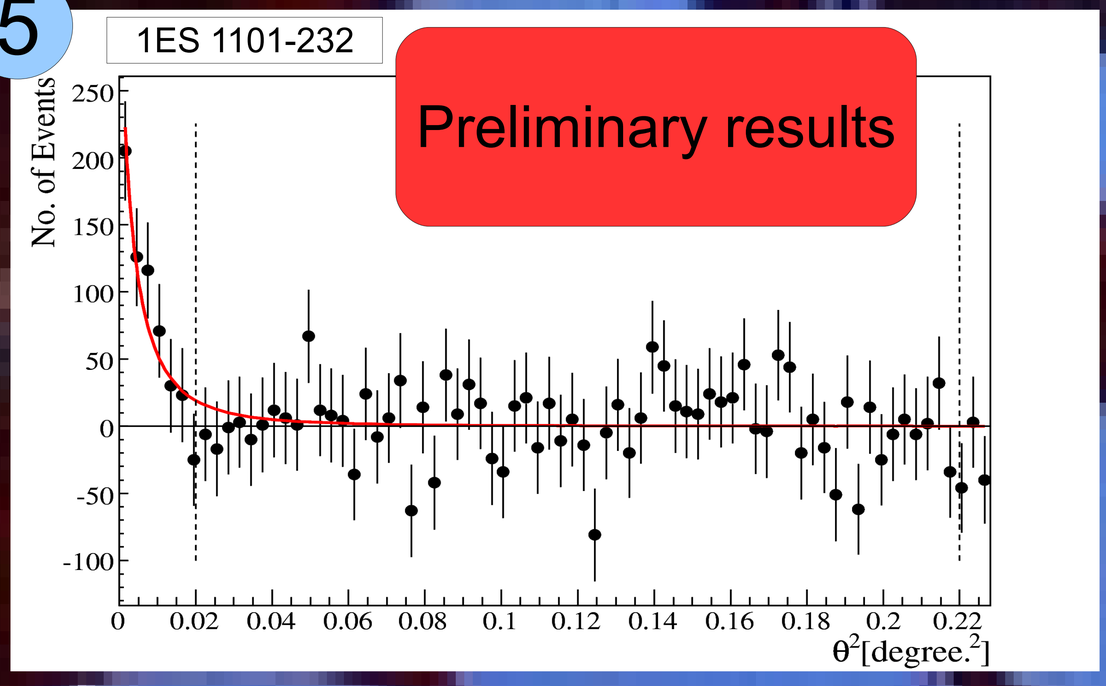

Conclusions

In our analysis, we have studied 3 sources: 1ES 1101-232, 1ES 0229+200 and PKS 2155-304. In the case of PKS 2155, we have divided it into a high state and low state. In Figure 4, the flaring (high) state is shown fitted with the HESS point spread function (psf) in different energy bands. This represents a “perfect” point source. Fig. 5 shows the angular distribution for the source 1ES 1101-232, for E > 100 GeV. No significant halo excess was detected. We obtained an upper limit of 2.50×10^{-12} cm^{-2} s^{-1} above 1 TeV for this source. Similar results have been obtained to date for 1ES 0229+200 and PKS 2155-304.

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