# SEARCH FOR NEUTRINOS FROM THE GALACTIC PLANE AND OTHER ASTROPHYSICAL EXTENDED SOURCES WITH ICECUBE

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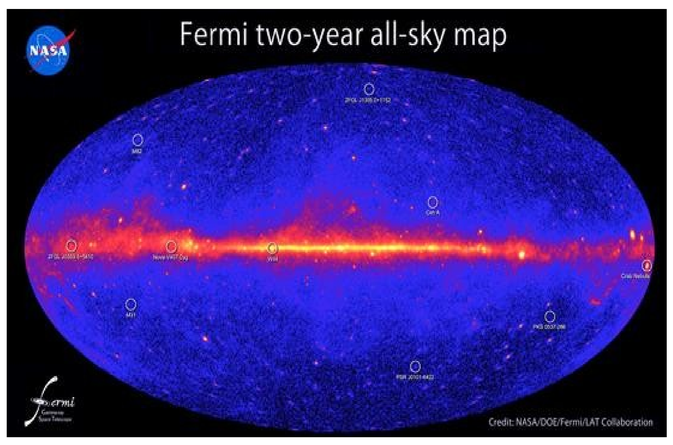
## *The detector, data, and event selection*

The IceCube neutrino observatory instruments a cubic kilometer of ice at the South Pole using 86 strings of optical sensors. The detector was built over several years and took data while construction progressed until completion in 2011. The analysis presented here uses the combined 40-string and 59-string detector data taken from 2008 to 2010. Over 140,000 events were selected after cuts based on quality of the fitted track to neutrino-induced muon-like events, and estimated energy. At 10 TeV the median angular resolution of these events are ~1°. In the northern sky, the atmospheric neutrino background dominates making the TeV-PeV region optimal for astrophysical source searches. In the opposite hemisphere, high energy atmospheric muons become the main background increasing the source sensitivity energy range to PeV-EeV. (For more on event selection and performance, see S. Odrowski's poster; abstract ID 134 and ArXiv:1111.2741v1). Two analysis results based on this data set are shown below.

# Diffuse Neutrino Search from the Galactic Plane

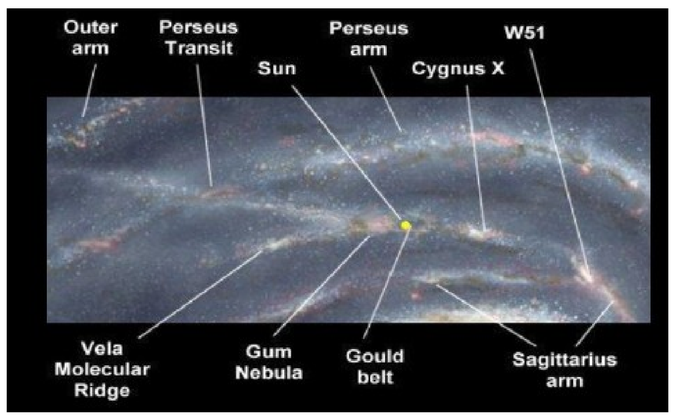
## *Motivation*

Shown to the right is a sky map of gamma-rays observed by Fermi's Large Area Telescope (http://heasarc.gsfc.nasa.gov/). The two notable features seen are point sources and the diffuse haze from the galactic plane. Here we aim to detect the galactic haze in neutrinos.



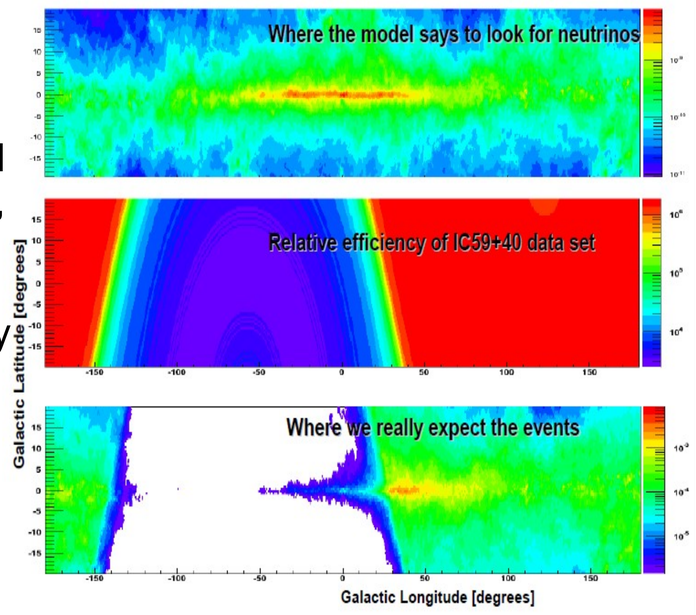

## *Deciding where to look*

The expected flux of neutrinos along the galactic plane is not expected to be uniform. A spatial template to test must be chosen. The question is then whether neutrino production in the plane traces high-energy cosmic ray source location (as shown to the right), or the matter (gas) density.



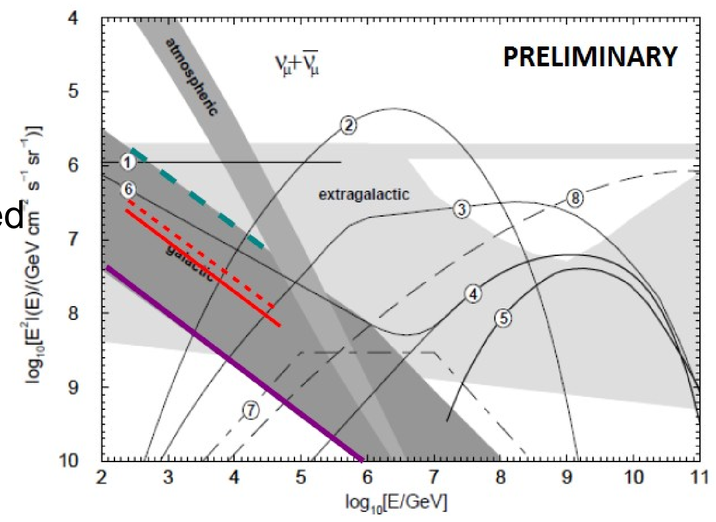

## *Testing the Fermi model*

In this analysis, we chose the pion component of the Fermi diffuse galactic gamma-ray model (M. Ackermann *et al.* 2012 *ApJ* 750), which traces matter density. The mode model is shown in the top plot. IceCube's detector sensitivity is zenith angle dependent, and shown in galactic coordinates (middle). Convolving these, a map of expected neutrino arrival direction distribution is obtained (bottom).

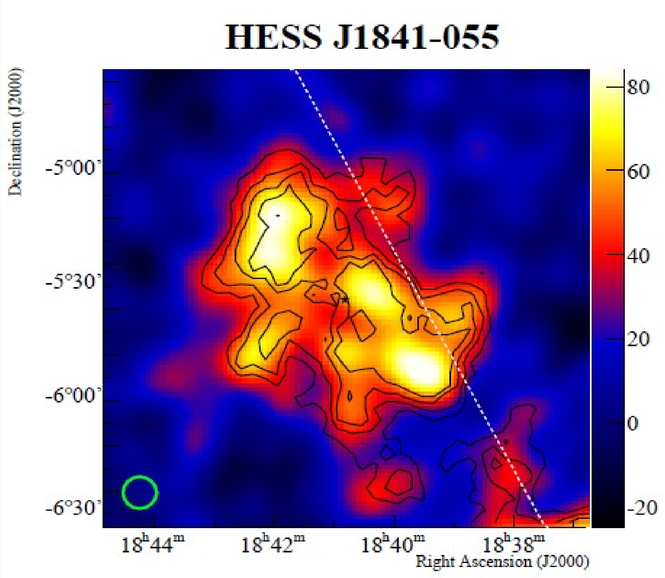



## *Results*

An energy spectrum of $E^{-2.7}$ is assumed following the gamma-ray measurement. A likelihood analysis is performed to see no evidence of signal. The 90% (red solid) and 99% (red dotted) upper limit of this signal hypothesis is plotted along with the model prediction (purple). Both are all-sky averages. The underlying plot is taken from Learned & Mannheim, Annu. Rev. Nucl. Part. Sci. 2000.




# All-sky extended source search

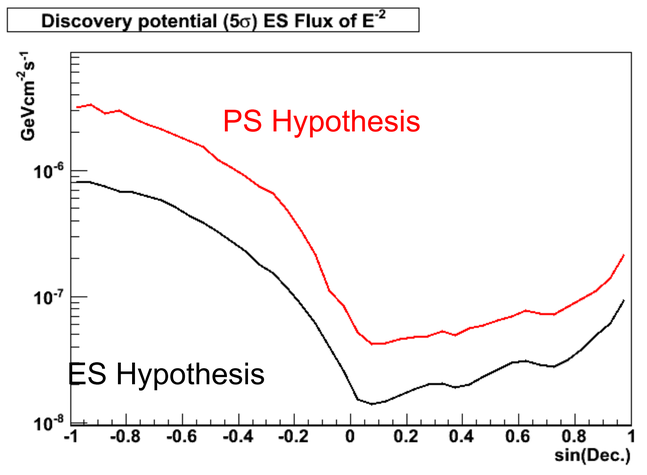


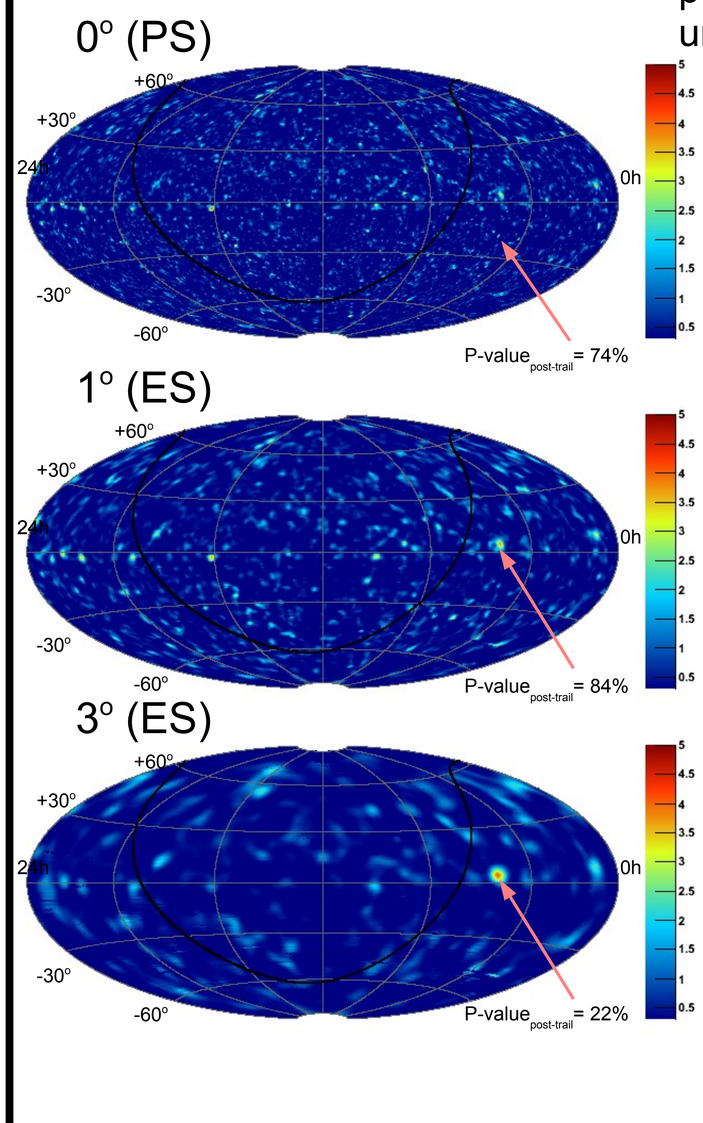

## *Motivation*

Shown to the left is an extended TeV gamma-ray source (Aharonian, *et al.* 2008 *A&A* 477). In order to look for extended sources (ES) of neutrinos, an all-sky likelihood search similar to an all-sky point source (PS) search (S. Odrowski's poster; abstract ID 134, ArXiv:1111.2741v1) is performed.

## *Why a dedicated search?*

The ES all-sky search replaces the 0° source extension hypothesis with up to a couple of degrees. The estimated flux needed for a 5-sigma discovery of a 3° extended source is compared for a point source and extended source analysis. It was also shown that overestimating the extension performs better than underestimating it.




## *Results*

The sky maps plot the pre-trial p-value of a 0.5° x 0.5° grid on the sky. The black solid line denotes the galactic plane. For the PS map, the hottest spot is (RA, deg) = (75.45, -18.5) with a post-trial p-value of 0.74, while for both the 1° and 3° maps, the hottest spot is (RA, deg) = (80.75, 4.25). For the 1° sky map, the hot spot post-trial p-value was 0.84, and 3° sky map, the hot spot corresponds to a post-trial p-value of 0.22.