

Neutrinos from Starburst-Galaxies

A source stacking analysis with AMANDA II and IceCube data

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Starburst-Galaxies:

Starburst-Galaxies differ from late type galaxies (“normal“ galaxies) through their enhanced star formation rate (SFR). An area with higher than average star formation activity is labeled as a *starburst* region.

Thus *Starburst-Galaxies* are galaxies which show an enhanced SFR. The SFR can be derived from various measurements, from the HCN emission for example. Please see [1] for details.

A local sample:

For the analysis presented here a sample of local ($z < 0.03$) Starburst-Galaxies was collected from various references, see [2] and references within. To ensure that the galaxies in the sample are indeed Starbursts the ratio between FIR flux and radio flux was required to be larger than 30, however a negligible contamination with Seyfert galaxies is still possible. Further it was required that the FIR flux at $60\mu\text{m}$ is larger than 4 Jy and the radio flux at 1.4 GHz is larger than 20 mJy. From 309 previous selected sources 124 were left after applying the cuts. Figure 1 shows the distance-luminosity diagrams for the FIR and radio wavelengths and illustrates the cuts.

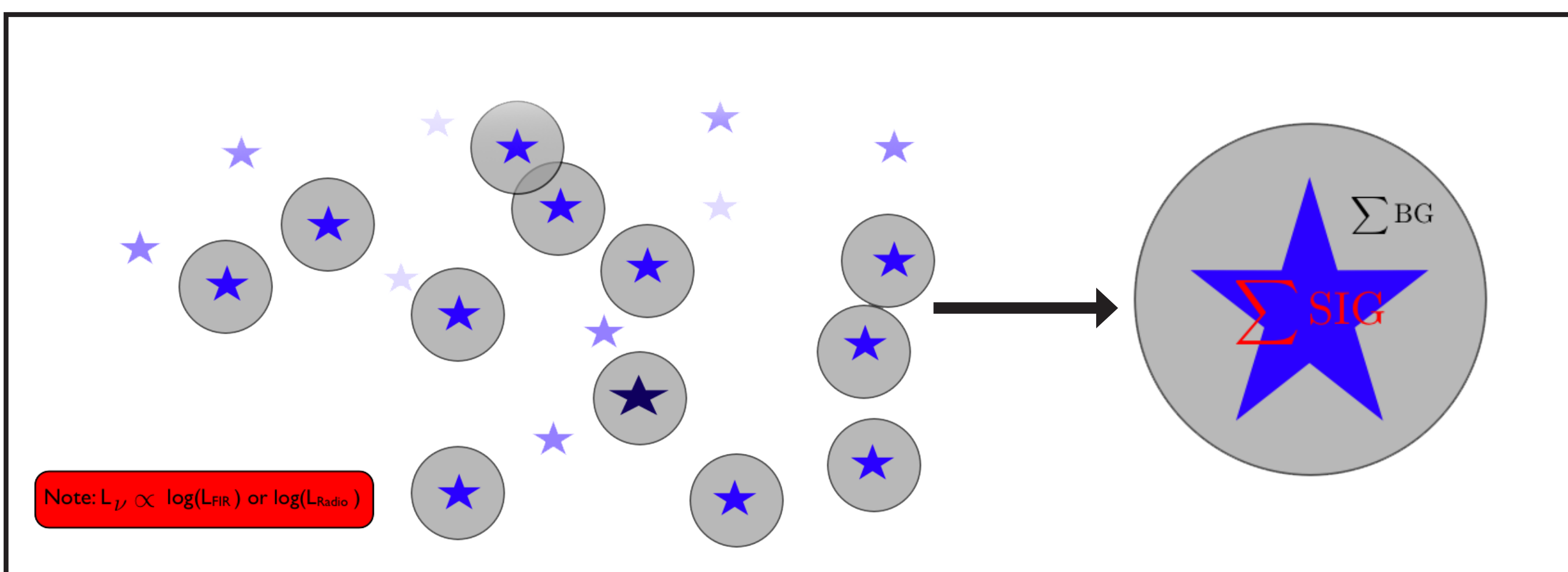


Figure 3: A cartoon illustrating the stacking technique. The sources are sorted according to the signal hypothesis. Then a search bin around every source is defined and the number of signal events (stars) and background events (grey circles) are summed up for the whole sample (big grey circle and star).

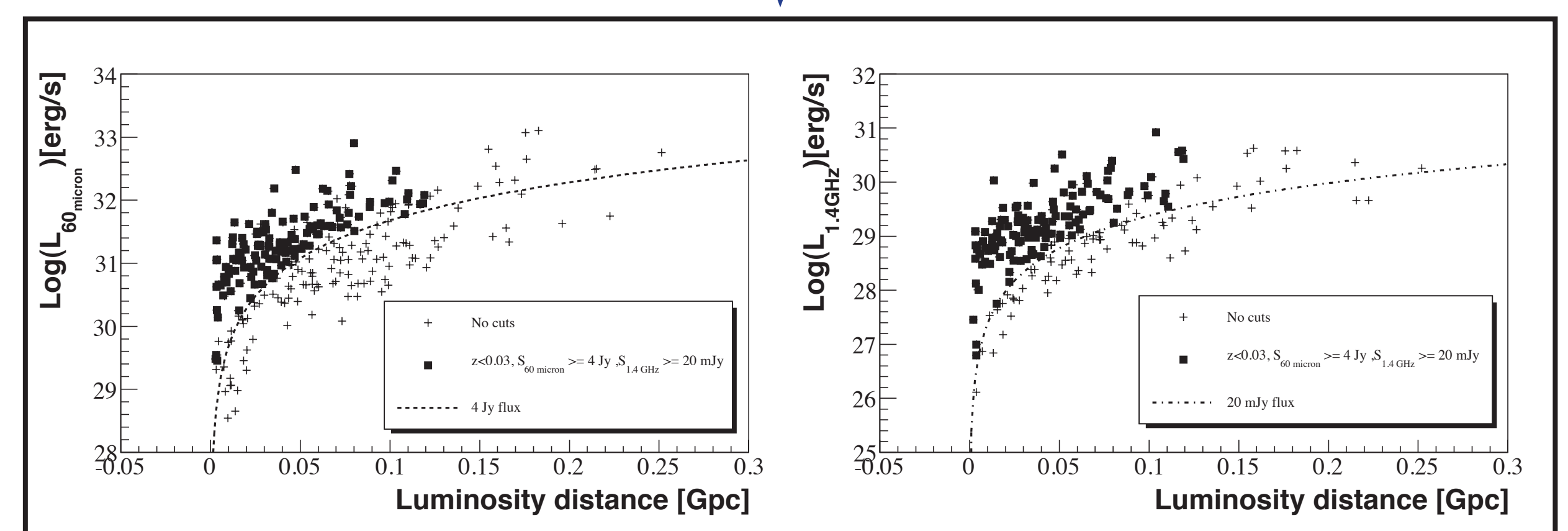


Figure 1: The luminosity-distance diagrams for the FIR flux (left) and the radio flux (right). The dashed lines show the applied 4 Jy cut and the 20 mJy cut respectively.

The analysis:

This analysis makes use of the stacking technique which is an analysis technique which is sensible to generic source classes. The source classes as well as a signal hypothesis have to be defined carefully beforehand. Next to the Starburst-Galaxies mentioned above several classes of AGN as well as pulsars were analyzed. In a stacking analysis signal and background inside a defined search bin around the source are summed up, the signal increases since it grows faster than the background. The number of sources to stack and the size of the search bin were determined using simulated data. For details see [3].

The analysis was performed with seven years of AMANDA-II data [4] and data obtained in 276 days with IceCube in its 22 string configuration (IC22) [5]. The results for both analyses are shown in figure 2. No significant signal was found in both analyses, flux limits for an E^2 flux were set. For the AMANDA data an improvement in sensitivity for all classes could be archived while some classes in the IC22 analysis did not benefit from the stacking technique.

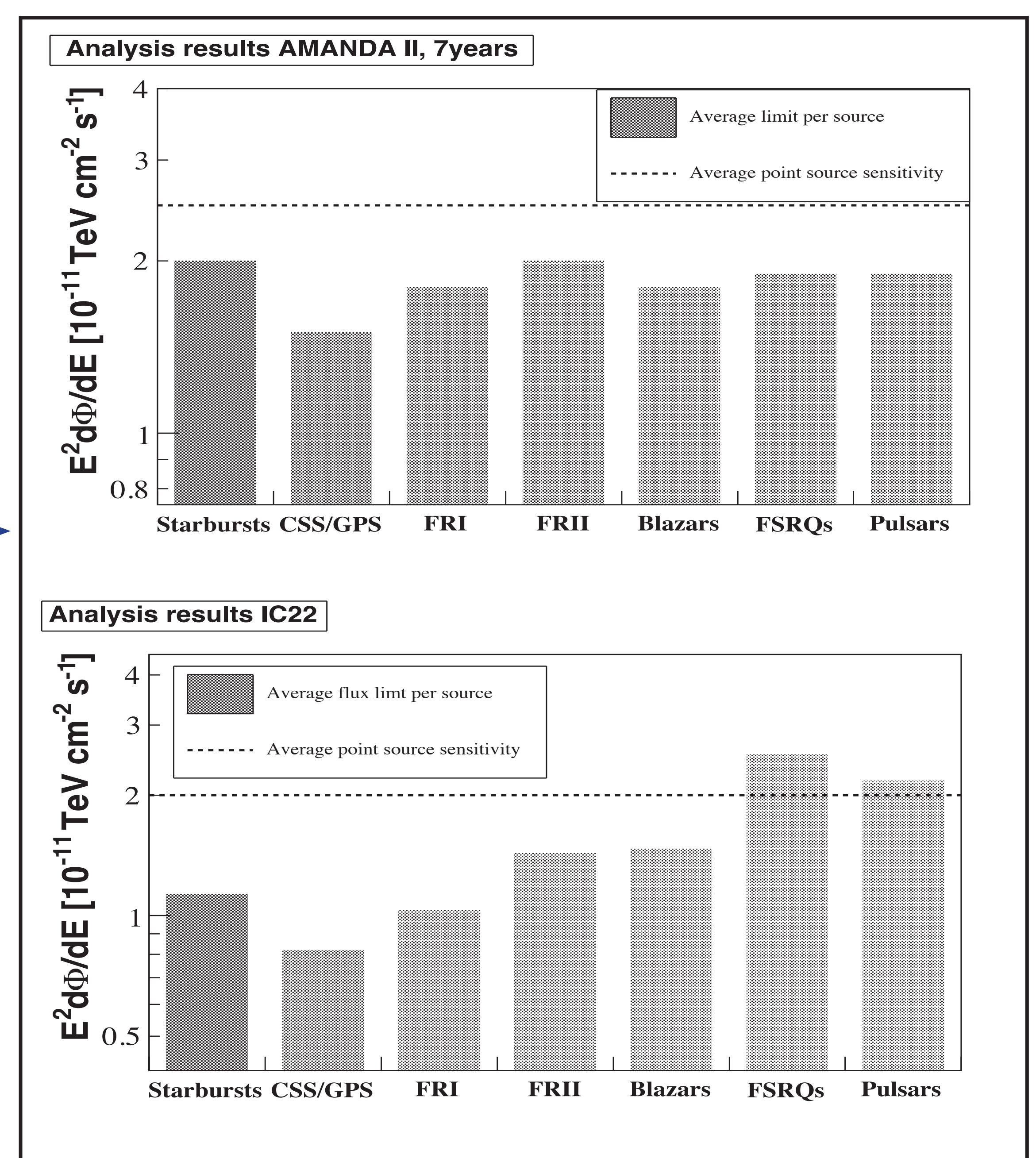


Figure 2: The results of both stacking analyses. The obtained flux limits for an E^2 flux are compared to the average point source sensitivity (dashed line). The sensitivity was improved for all source classes in the AMANDA-II analysis while the FSRQs and Pulsars did not gain sensitivity in the IC-22 analysis.

References:

- [1] Y. Gao et al. „The Star Formation Rate and Dense Molecular Gas in Galaxies“, *ApJ* **606**, 271-290, 2004
- [2] J. K. Becker, P. L. Biermann, J. Dreyer, T. M. Kneiske „Cosmic Rays VI - Starburst galaxies at multiwavelengths“, arXiv 0901.1775, 2009
- [3] J. Dreyer „Neutrinos from Starburst-Galaxies - A source stacking analysis with IceCube and AMANDA-II data“, PhD thesis TU Dortmund, 2010
- [4] R. Abasi et al. (IceCube Collaboration) „Search for point sources of high energy neutrinos with final data from AMANDA-II“, *Phys. Rev. D* **79**, Issue 6, 2009
- [5] R. Abasi et al. (IceCube Collaboration) „First Neutrino Point-Source Results from the 22 String Icecube Detector“, *ApJL* **701**, 47-51, 2009

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