Wystan's AGN Search

- Wystan Benbow did a search for 27 AGN during the period July 20, 2000 to January 28, 2002
- Detected Mrk 421 at a significance of 4.0 sigma—3.1 sigma after trials
- Taking a 154-day flare interval defined by RXTE data, 4.3 sigma (2 Crabs)
- Set upper limits on the other 26 AGN
- 4 of the AGN are reported TeV sources
  - Mrk 501, 1ES2344+514, 1ES1426+428, 1ES1959+650
  - The limits are above the reported fluxes, and hence compatible
- Whipple has reported tighter limits for 8 of the sources
- 15 of the sources do not have a TeV result in the literature
- Costamante and Ghisellini have predictions for 7 of the sources
- Thesis is on the Publications page: http://scipp.ucsc.edu/milagro/papers/benbow_thesis.pdf

AGN	z	N_{90}	Median Energy $E_\circ$ (TeV)	$I_\circ$ x 10^{-13} (cm^{-2} s^{-1} TeV^{-1})	$I(\geq E_\circ)$ x 10^{-13} (cm^{-2} s^{-1})
1426+428	0.129	1325	2.5	4.7	7.3
Mrk 501	0.034	3800	2.5	12.9	20.1
1959+650	0.048	1131	6.0	1.5	5.6
2344+514	0.044	3814	3.0	11.5	21.5
0033+595	0.086	940	4.0	2.2	5.5
0110+418	0.096	3114	2.5	10.8	16.8
0152+017	0.080	1182	8.0	2.2	10.9
0153+712	0.022	746	10.0	0.7	4.1
0214+517	0.049	1795	3.0	5.4	10.1
0314+247	0.054	1434	2.5	6.5	10.1
0656+426	0.059	1270	2.5	4.4	6.9
Mrk 180	0.046	821	8.0	0.9	4.6
1532+302	0.064	1443	2.5	5.4	8.4
1610+671	0.067	1261	7.0	1.5	6.3
I Zw 187	0.055	1500	3.0	4.1	7.6
1741+196	0.083	3371	3.0	12.8	24.0
2321+419	0.059	1390	2.5	4.8	7.5
2322+346	0.098	3793	2.5	13.1	20.4
III Zw 2	0.090	1674	5.0	3.6	11.2
0138+398	0.080	1339	2.5	4.5	7.1
0321+33	0.062	2056	2.5	7.2	11.1
1413+436	0.090	2067	2.5	7.4	11.5
2209+184	0.070	2173	3.0	8.8	16.4
W Comae	0.102	1968	2.5	7.8	12.1
3C371	0.051	1282	8.0	1.4	6.7
BL Lac	0.069	2404	2.5	8.4	13.2

Table 6.8: Table showing the redshift, median energy of observation ($E_\circ$), 90% confidence limits of the number of events (N_{90}), differential flux normalization ($I_\circ$), and integral flux above the median energy, $I(\geq E_\circ)$, for each of the candidate AGN not detected by Milagro. A power law spectrum with spectral index $\alpha = 2.6$ and no cutoff is assumed.

- Chosen to be close sources
- Most distant source is z=0.129 (1426+428)
- Looked for (did not find) variability on time scales from 1 to 150 days

AGN	z	Whipple $E_\circ$ (TeV)	Whipple $I(\geq E_o)$ x 10^{-11} (cm^{-2} s^{-1})	Milagro $I(\geq E_o)$ x 10^{-11} (cm^{-2} s^{-1})	$\frac{I_M}{I_W}$
3C371	0.051	0.35	1.9	15.0	7.9
BL Lac	0.069	0.35	0.53	4.6	8.7
W Comae	0.102	0.35	0.59	4.4	7.5
Mrk 180	0.046	0.35	1.1	11.4	10
I Zw 187	0.055	0.5	0.69	2.2	3.2
1ES1741+196	0.083	0.35	0.48	9.8	20
1ES1959+650	0.048	0.35	1.3	8.5	6.5
1ES2321+419	0.059	0.35	1.1	3.0	2.7

Table 6.9: Table showing the redshift, Whipple energy threshold ($E_\circ$), Whipple 99% confidence limits of the integral flux above the threshold, $I(\geq E_\circ)$, Milagro 99% confidence limits of the integral flux above the threshold, $I(\geq E_\circ)$, and the ratio of those upper limits. For the Milagro results, a a power law spectrum with spectral index $\alpha = 2.6$ and no cutoff is assumed.

- Whipple limits from Buckley, *Astroparticle Physics* 11, 119 (1999)
- All limits in the table are 99% c.l.
- Whipple limits are factor of 2.7 to 20 better

AGN	SSC (low E fit) Model I(≥1 TeV)	Avg. SED Model I(≥1 TeV)	Milagro 90% Upper Limit I(≥1 TeV)
BL Lac	NA	0.43	0.57
1ES0033+595	0.04	0.48	0.51
RGB0214+517	0.0062	1.43	0.59
Mrk 180	NA	1.93	1.3
I Zw 187	NA	1.23	0.44
1ES1741+196	0.01	0.84	1.4
1ES1959+650	NA	1.74	0.99

Table 6.10: Table showing the predictions of two models for the integral flux greater than 1 TeV from selected AGN, as well as the 90% upper limit on that flux determined by Milagro. The SSC (low E fit) model is the first described, and the Avg. SED Model is the second. The units are 10^{-11} cm^{-2} s^{-1}.

- Predictions from Costamante and Ghisellini
- 3 of our limits are below the Average SED model
  - Whipple has even better limits on 2 of them

Outline of Paper—Probably Ap J

- Introduction
- Brief Milagro Description
- Selection of AGN
- Brief Analysis & Data Set
- Significances for Whole Interval
- 421 (consistent with being constant over whole interval, but using RXTE..., Flux & comparison to HEGRA)
- Other Upper Limits & Comparisons to Other Observatories' Results/Costamante's Models
- Conclusion

Questions from Wystan

DAW's Suggested Answers in Red

Results of Discussion in Blue

- What interval should we use? My nominal study goes from July 2000 until January 2002. However the first 6 months of the data or so is without Greg's Core Fitter.
  - Don't change this now <– agreed
- Should Mrk 421get some special treatment, i.e., use the RXTE interval as well. Do we report both Integral Fluxes or ignore the RXTE interval?
  - Quote flux for both the whole data set and RXTE flare interval <– agreed
- Issues with the calibrations that were new in later 2002. I figure not to use the re-reconstructed data on 421 since it makes little difference & will keep the study of the other AGN consistent.
  - Just use the REC data <– agreed

Questions from Wystan (continued)

- Should we ignore the time analysis in my thesis & just mention that temporal accumulation of our excess from 421 is consistent with being constant (other AGN too, but this might not be worth mentioning)
  - From our data 421 is consistent with being constant
  - Based on data from RXTE we find define a flare interval
  - Mention no evidence for emission on shorter time scales from other AGN, but don't dwell on it
  - Variability on various time scales is an important part of what we have to add, so DO dwell on it
  - Give upper limits on the different time scales for all the sources

Questions from Wystan (continued)

- Systematic errors on the upper limits/flux? Are the ones in my thesis OK. How much time should I spend justifying them?
  - Errors are reasonable and generous now, ±65%. Not worth trouble refining them. Can defend them in a few sentences
  - These are consistent with Crab paper; sounds fine
- Should we even mention (or compare to) the Crab anywhere in the paper?
  - Describe that the analysis is consistent with the Crab, and that to some degree the systematic errors come from that comparision, but don’t report Crab results. <– Agreed
- How much detail on the detector? Since there is no NIM paper to reference, I am not sure what to do...
  - What can I say?