First chi2 analysis for B335 data from 2007

Nov. 27, 2009

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The data set:

Approximately 85 files were collected during three nights in April 2007. The SHARC-II batteries failed unexpectedly at several times during the run. While we were at CSO collecting these data I noticed that noise problems on the IRC screen would start up a while before the batteries died.

Only 77 files were analyzed. Files were rejected for the following reasons: One full dither was rejected because it was noted in the EXCEL log that the DSOS failed during the dither. A few files were rejected because of various other problems noted in the log. The first two files of the first good night were rejected because the batteries failed almost immediately upon startup. In retrospect I discovered that one good file that should have been used was overlooked.

The chopper throw was two arcminutes. The *tau* ranged from 0.04 to 0.075, but the average was around 0.05. Tristan did a quick analysis about 18 months ago, without using chi2. He produced results roughly consistent with what I show here, but having higher significance than what I determined to be the true significance after error inflation.

Analysis steps:

As before, I used the posted RGM file and the following flags:

sharpinteg: -f 1 -em -w -sil

sharpcombine: -hwp 91 -l 51 51 -sm 2 -ma 5 -ps 9.5 -pm 12.0

-bg 10 0 -ip 0.0034 0.00017 0.0036 0.0

Inspecting all the *sharpinteg* I/Q/U maps by eye reveals problems similar to those described in my May 14th L1527 memo and in my subsequent IC348 memo. The worst problem was correlated electronic noise in row 3-4, seen to be especially bad for about an hour on the second night. False peaks in the I map of comparable amplitude to the peak source flux were seen in these files. A more pervasive problem is what I call the "correlated corner shadow" that is seen in the Q and U maps in the upper right corner especially, but also along the top ~2 rows and a bit in the upper left corner. These pixels also show elevated noise in the Q and U noise maps. There are other problems such as correlated noise in other rows (besides 3 and 4), or in groups of 2-3 pixels within a row.

Also, I did see additional noise problems that are coincident with the time when the batteries were just about to die, but these were of a different nature and seemed to affect only three specific pixels. They occur for about a half-hour just before the battery deaths on nights 1 and 2. In other words, battery-death-noise seems to be the least of our problems.

Most of these noise problems are clearly electronic noise, but the "correlated shadow" could be optical or electronic in origin. In general, these noise problems are at a lower level than what I saw in the Sept. 2008 data, but worse than what I saw in the Nov. 2007 data.

I implemented pointing corrections using fitgauss. I implemented smoothed tau corrections using the smoothed tau fit coefficients posted on the SHARC-II web page.

I dealt with the noise problems by creating 4 different versions of the rgm file to account for different noise conditions. Each file was then re-processed using one of these four rgm files. In developing these rgm files, some particularly troublesome pixels are eliminated from all files. One version of the rgm file removes all of rows 3 and 4. Another version is specifically tailored to deal with the noise that occurred when the batteries were dying.

In this memo, just as in the May 14th memo, when I report χ_r^2 results these are the result of averaging map-wide results for Q and U.

<u>Dependence of reduced chi-squared on time scale:</u>

I divided the 77 files into six bins of 7-25 files each. Within 20%, all bins had the same nominal statistical weight, determined from the minimum nominal Q/U error. Using the *chi2* program, the results for the map-wide Q-U average χ_r^2 are:

Bins 1, 2, and 3: Stokes $\chi_r^2 = 2.34$

Bins 4, 5, and 6: Stokes $\chi_r^2 = 2.45$

The level of systematic error on three-bin time scales can be estimated as Stokes $\chi_r^2 = 2.39$, which is the average of the above two values.

Bins 1, 2, 3, 4, 5, and 6: Stokes $\chi_r^2 = 2.79$

Since the Stokes χ_r^2 does not go up too much (~2.4 to ~2.8) as we lengthen the time-scale sampled, its probably reasonable to treat our extra errors as random errors occurring on the time scales that characterize the three-bin groupings. Accordingly I simply inflate the nominal errors by the square root of the Stokes χ_r^2 .

In general, the U χ_r^2 is worse than the Q χ_r^2. For the three-bin maps, the difference is about a factor of two. For the six-bin maps it's more like a factor of 1.5. The appearance of the Stokes χ_r^2 maps outputted by *chi2* for the three-bin analysis is fairly random. For the six-bin case, the Q χ_r^2 map has its peak values nearer the center, but the U χ_r^2 map does not.

<u>Methods for error-inflation and results:</u>

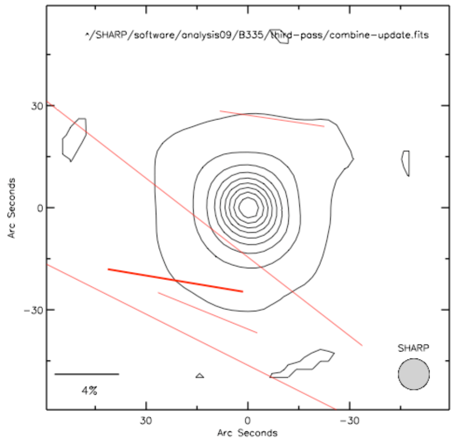
As in my previous work (see May 14th memo), I use two different methods for inflating the nominal errors: the *update* method and the *map-wide inflation factor* method.

Maps are shown on the next page. On the left I show maps made using the *update* method and on the right I show the results of the *map-wide inflation* method. For all maps, thick bars are 3-sigma, thin bars are 2-sigma. The top row is the six-bin case, the next row is the first group of three bins, and the bottom row is the last group of three bins.

Contours are 90%, 80%, 70%, … 10% of peak flux. Note that the use of the *update* method is quite inaccurate when there are only 3 bins (as is the case for bottom two rows).

If we follow the procedure used for the IC348 and L1527 maps shown in our CSO proposals, then we would degrade each vector's significance to the lesser of that given by each of the two inflation methods. This would give us just two vectors for this source, and they would both be two-sigma vectors, located respectively near the top and bottom of the map, near the 10% contour.

The results and analysis shown here are less satisfying than what I found for L1527 and IC384 this past spring, because the χ_r^2 is higher (2.79 vs. 1.73 and 1.72) and because the agreement between the first three bins and the second three bins seems worse. Maybe I should use a much more aggressive noise-elimination strategy for these data as I did for the September 2008 data (see May 14th memo). Note also that if we assume that the number of independent points in the map is of order (10 arcsec)^2/(60 arcsec)^2, then we expect 1.8 fake 2-sigma vectors just from statistics alone. This is about what we are getting.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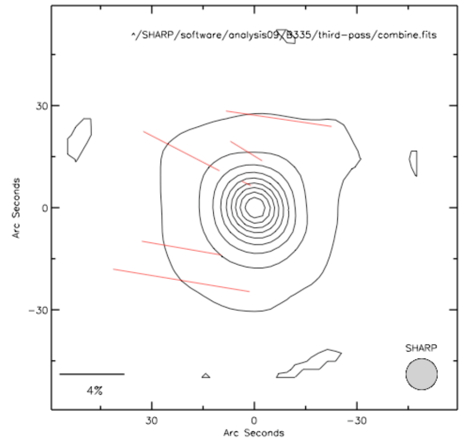
Arc Seconds
Arc Seconds
SHARP
4%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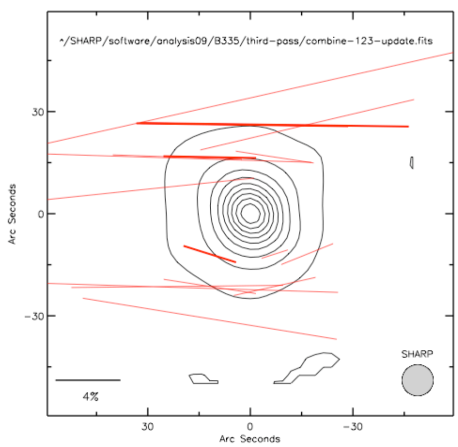
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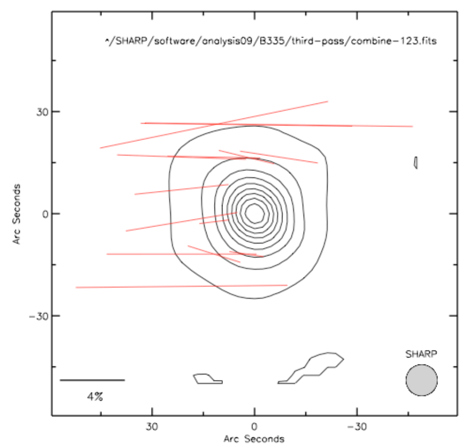
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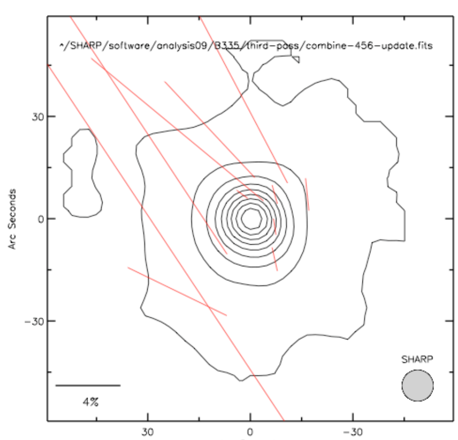
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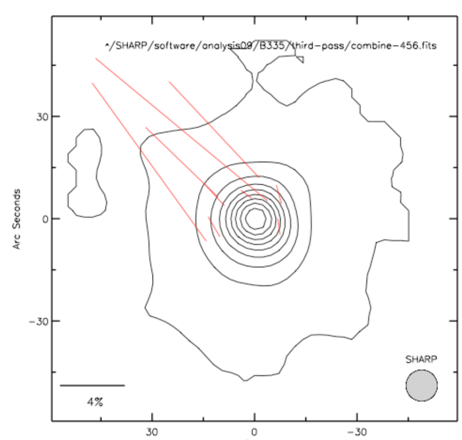
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Arc Seconds
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<u>Upper limits:</u>

This is the same map as on the upper left of previous page, but with points having P < 1% (two sigma upper limit) shown as circles. (Note that for our L1527 and IC 348 maps, there are no points that satisfy this criterion.)