

GammaLib - Bug #3889

Fix COMPTEL response computation for extended models

10/27/2021 01:59 PM - Knödseder Jürgen

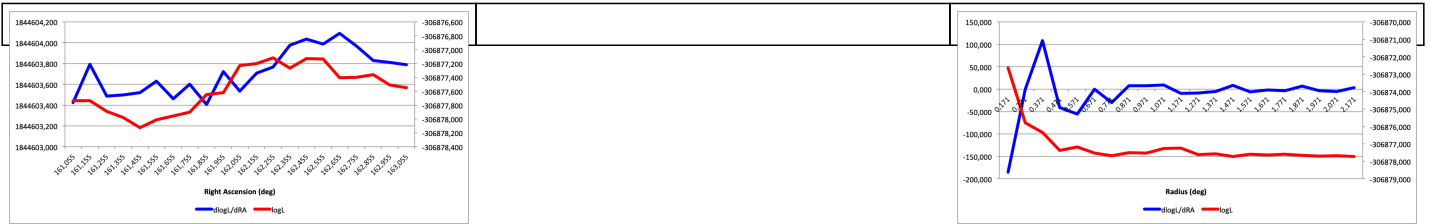
Status:	Closed	Start date:	10/27/2021
Priority:	Normal	Due date:	
Assigned To:	Knödseder Jürgen	% Done:	100%
Category:		Estimated time:	0.00 hour
Target version:	2.0.0		
Description			
Following the analysis described on https://cta-redmine.irap.omp.eu/projects/compTEL/wiki/Carina_analysis there are some issues with the convergence for radial disk models. It appears that for small initial disk radii the initial parameter values are little changed, while for larger radii they change. This issue also follows up on #2973.			

History

#1 - 10/29/2021 05:11 PM - Knödseder Jürgen

- File test_likelihood_profile_RA.png added
- Status changed from New to In Progress
- % Done changed from 0 to 10

I made some likelihood profiles for the 11 bin Eta Carinae analysis (see https://cta-redmine.irap.omp.eu/projects/compTEL/wiki/Carina_analysis) and they clearly show that there is a noise problem with the likelihood profiles that obviously prevents convergence of the maximum likelihood optimiser. Consequently, the algorithm used for the radial model computation should be reinvestigated.



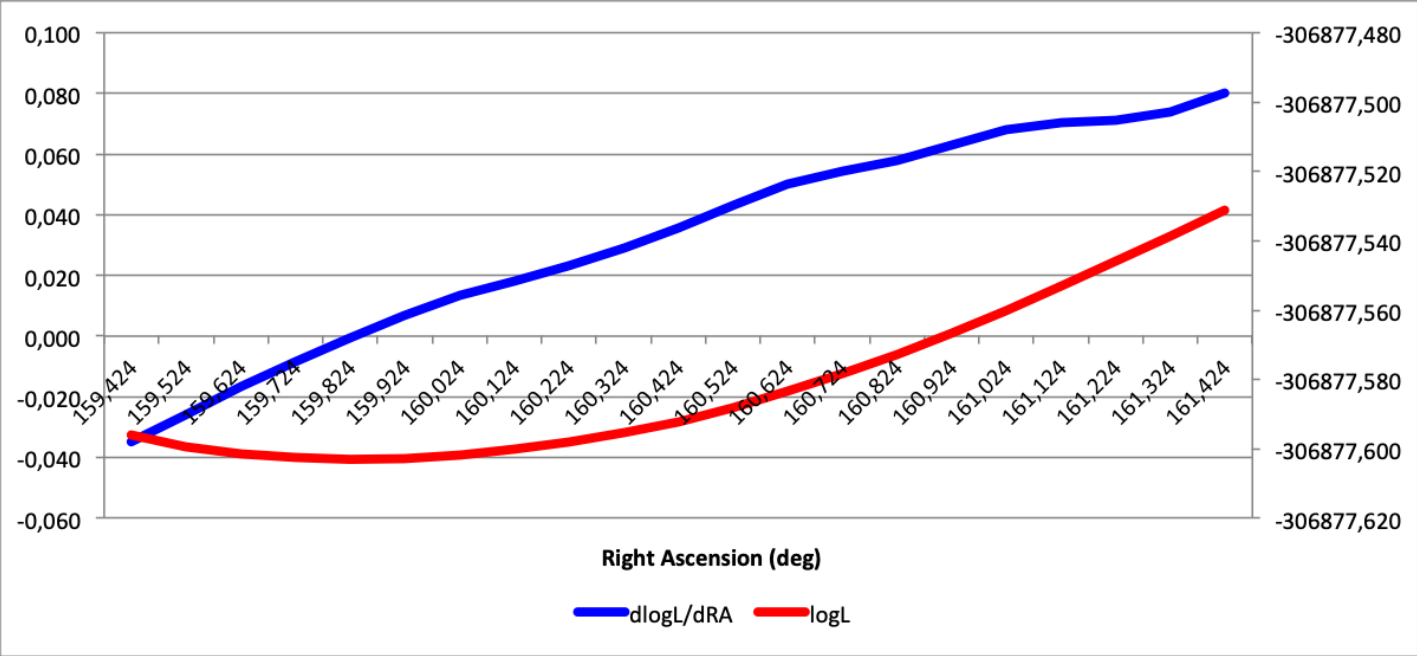
#2 - 10/29/2021 11:11 PM - Knödseder Jürgen

- File test_likelihood_profile_Radius.png added

#3 - 11/22/2021 08:47 AM - Knödseder Jürgen

- File likelihood-profile-new.png added
- % Done changed from 10 to 50

I implemented the extended model response convolution in the system of the model, which is similar to the method that is implemented for CTA. This stabilised the model fit and led to smooth likelihood profiles, as illustrated below



#4 - 11/22/2021 09:42 AM - Knödseder Jürgen

I redid the fitting of the Crab using the new implementation. I used an initial extension of 0.1° for the tests. Initially I implemented a common extended method for radial and elliptical models, yet I switched the to a specific radial method for speed reasons.

Implementati on	logL	TS	RA	Dec	Extension	Prefactor (1e-5)	Index	CPU (sec)
Old	-67047.046	1081.959	83.78 ± 0.12	21.66 ± 0.11	1.10 ± 0.45	178.83 ± 9.29	-2.147 ± 0.037	?
New (extended)	-67044.586	1076.430	83.79 ± 0.12	21.66 ± 0.11	1.15 ± 0.43	178.55 ± 9.28	-2.149 ± 0.037	1513.17
New (radial)	-67044.586	1076.430	83.79 ± 0.12	21.66 ± 0.11	1.15 ± 0.43	178.55 ± 9.28	-2.149 ± 0.037	1209.85

#5 - 11/22/2021 10:11 AM - Knödseder Jürgen

- % Done changed from 50 to 60

Here the results with the final code as function of initial radial disk model extent:

Initial extent	logL	TS	RA	Dec	Extension	Prefactor (1e-5)	Index	CPU (sec)
0.1	-67044.586	1076.430	83.79 ± 0.12	21.66 ± 0.11	1.15 ± 0.43	178.55 ± 9.28	-2.149 ± 0.037	1209.85
1.0	-67044.610	1081.130	83.79 ± 0.12	21.66 ± 0.11	1.18 ± 0.42	179.14 ± 9.29	-2.149 ± 0.037	1116.22
5.0	-67044.477	1069.184	83.79 ± 0.12	21.66 ± 0.11	1.13 ± 0.44	177.13 ± 9.25	-2.146 ± 0.037	1137.58

While the fit results are very close, yet not identical, there is a significant difference in the TS values of the results.

#6 - 11/22/2021 11:33 AM - Knödseder Jürgen

I redid the same analysis using navgr=3 and nincl=13:

Initial extent	logL	TS	RA	Dec	Extension	Prefactor (1e-5)	Index	CPU (sec)
0.1	-67574.643	1105.155	83.812 ± 0.12	21.63 ± 0.11	1.24 ± 0.40	184.91 ± 9.39	-2.167 ± 0.037	833.48
1.0	-67574.715	1107.232	83.811 ± 0.12	21.63 ± 0.11	1.23 ± 0.41	185.07 ± 9.39	$-2.168 \pm$	801.59

							0.037	
5.0	-67574.782	1109.803	83.811 ± 0.12	21.63 ± 0.11	1.23 ± 0.40	185.51 ± 9.40	-2.169 ± 0.037	1063.94

This reduced the variation of the TS value and also stabilised the final source extension. I also did an analysis using navgr=3 and nincl=5 to investigate whether the change to navgr=3 can explain the stabilisation:

Initial extent	logL	TS	RA	Dec	Extension	Prefactor (1e-5)	Index	CPU (sec)
0.1	-70446.727	988.203	83.77 ± 0.12	21.67 ± 0.11	0.71 ± 0.67	172.94 ± 9.19	-2.187 ± 0.039	1863.39
1.0	-70446.725	990.848	83.77 ± 0.12	21.67 ± 0.11	0.69 ± 0.69	173.24 ± 9.18	-2.188 ± 0.039	1807.3
5.0	-70446.724	978.498	83.77 ± 0.12	21.67 ± 0.11	0.68 ± 0.70	171.71 ± 9.16	-2.185 ± 0.039	2041.49

There is still some variability in TS, hence the stabilisation seems more to come from the change to nincl=13. Interestingly, the extension is smaller for navgr=3 compared to navgr=5 which calls for some parametric exploration. This was all done with an initial extent of 5.0 to be off the best-fitting values.

navgr	nincl	logL	TS	RA	Dec	Extension	Prefactor (1e-5)	Index	CPU (sec)
3	5	-70446.724	978.498	83.77 ± 0.12	21.67 ± 0.11	0.68 ± 0.70	171.71 ± 9.16	-2.185 ± 0.039	2041.49
3	7	-69267.790	1067.124	83.83 ± 0.12	21.66 ± 0.11	1.04 ± 0.48	184.90 ± 9.43	-2.199 ± 0.038	1295.11
3	9	-68458.036	1117.489	83.85 ± 0.12	21.65 ± 0.11	1.20 ± 0.41	188.26 ± 9.45	-2.185 ± 0.037	1076.23
3	11	-67924.532	1120.166	83.83 ± 0.12	21.63 ± 0.10	1.22 ± 0.41	186.44 ± 9.40	-2.171 ± 0.037	1072.88
3	13	-67574.782	1109.803	83.81 ± 0.12	21.63 ± 0.11	1.23 ± 0.40	185.51 ± 9.40	-2.169 ± 0.037	1063.94
3	15	-67259.101	1121.117	83.80 ± 0.12	21.61 ± 0.11	1.27 ± 0.39	187.92 ± 9.44	-2.175 ± 0.037	872.02
3	17	-67002.840	1120.663	83.79 ± 0.12	21.61 ± 0.11	1.22 ± 0.41	186.94 ± 9.41	-2.171 ± 0.037	831.56
3	19	-66850.621	1120.838	83.77 ± 0.12	21.61 ± 0.11	1.22 ± 0.41	187.78 ± 9.44	-2.175 ± 0.037	937.08
5	5	-67044.477	1069.184	83.79 ± 0.12	21.66 ± 0.11	1.13 ± 0.44	177.13 ± 9.25	-2.146 ± 0.037	1137.58
5	7	-66664.677	1112.682	83.82 ± 0.12	21.65 ± 0.11	1.25 ± 0.40	186.69 ± 9.45	-2.171 ± 0.037	1039.57
5	9	-66391.486	1120.405	83.84 ± 0.12	21.64 ± 0.10	1.23 ± 0.40	188.29 ± 9.48	-2.177 ± 0.037	1083.66
5	11	-66185.036	1123.623	83.82 ± 0.12	21.63 ± 0.10	1.24 ± 0.40	187.18 ± 9.44	-2.169 ± 0.037	1083.93

#7 - 11/22/2021 02:05 PM - Knödseder Jürgen

- % Done changed from 60 to 70

I now analysed the Crab data for different spatial models to check if they give consistent results. I switched back to navgr=5 and nincl=5 for this analysis. I used the default value for the initial extent.

Model	logL	TS	RA	Dec	Extension	Prefactor (1e-5)	Index	CPU (sec)
Point source	-67045.600	1004.167	83.79 ± 0.11	21.63 ± 0.10		167.64 ± 8.56	-2.149 ± 0.038	?
Disk	-67044.610	1081.130	83.79 ± 0.12	21.66 ± 0.11	1.18 ± 0.42	179.14 ± 9.29	-2.149 ± 0.037	1116.22
Gauss	-67044.718	1100.844	83.79 ± 0.12	21.65 ± 0.11	0.62 ± 0.21	181.32 ± 9.37	-2.150 ± 0.037	1118.39
Elliptical disk	-67043.742	1027.716	83.78 ± 0.12	21.69 ± 0.10	90°, 1.23 ± 0.11, 0.46 ± 46287.68	178.49 ± 18014520.40	-2.151 ± 0.038	8225.75
Elliptical Gauss	-67045.211	1127.502	83.78 ± 0.11	21.65 ± 0.11	145.09 ± 15.99, 1.14 ± 0.74, 0.31 ± 0.77	196.44 ± 75.87	-2.132 ± 0.035	4212.23

*Fitting the elliptical disk model gave the notification Parameter "PA" has zero curvature. Fix parameter. and consequently the position angle was not fitted. This all led to large errors for the semi-minor axis value and the flux. Maybe the model extension was too small to give a non-zero gradient.

#8 - 03/14/2022 12:23 PM - Knödseder Jürgen

- Status changed from In Progress to Closed

- % Done changed from 70 to 100

The response computation seems to work now, close the issue.

Files

test_likelihood_profile_RA.png	113 KB	10/29/2021	Knödseder Jürgen
test_likelihood_profile_Radius.png	92.2 KB	10/29/2021	Knödseder Jürgen
likelihood-profile-new.png	95.1 KB	11/22/2021	Knödseder Jürgen