ASTR-518 HW-3 Spectral Analysis on RCW-86 Concentrated on Non-Thermal Radiations

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Introduction

SN 185 was observed in year 185 by Chinese astronomers. In the Book of Later Han, it claims that this event was remained for 8 months. With the observations by the telescopes XMM – Newton and Chandra it is suggested that RCW 86 is strongly linked with this event when the age estimations are done when counting the shock waves due to synchrotron radiation. [1] It is known that synchrotron radiations are in TeV ranges. However, it is related with post-shock magnetic field strength. When the cut off energy is determined due to synchrotron losses, it becomes independent to the magnetic field's magnitude. Unlike other young shell-type SNRs non-thermal radiation isn't confined to forward shock regions (or it is not confined in narrow region.) [2][3] It was observed that there are TeV regions in south and north regions by the HESS Cherenkov Telescope.[3] In this report, I tried to observe non-thermal radiation in NW region of RCW 86 in the ranges between 0.3-7 keV.

Data Analysis

I did this analysis by using several tools. These are CIAO (v. 4.12), CALDB (v. 4.9.0), XSPEC (v. 12.10.1f), specextract script and SAOimage ds9(v. 8.1).

I used the data (OBSID: 15608) from NW region of RCW from Chandra ACIS-I (downloaded from Heasarc). Then, I took several regions with ds9. I tried to choose dense region(B), edge region (D) where can be shocks possibly found and post-shock material region(A) where it is possible to synchrotron radiation and a nearly homogeneous background region(BKG) to reduce noise.

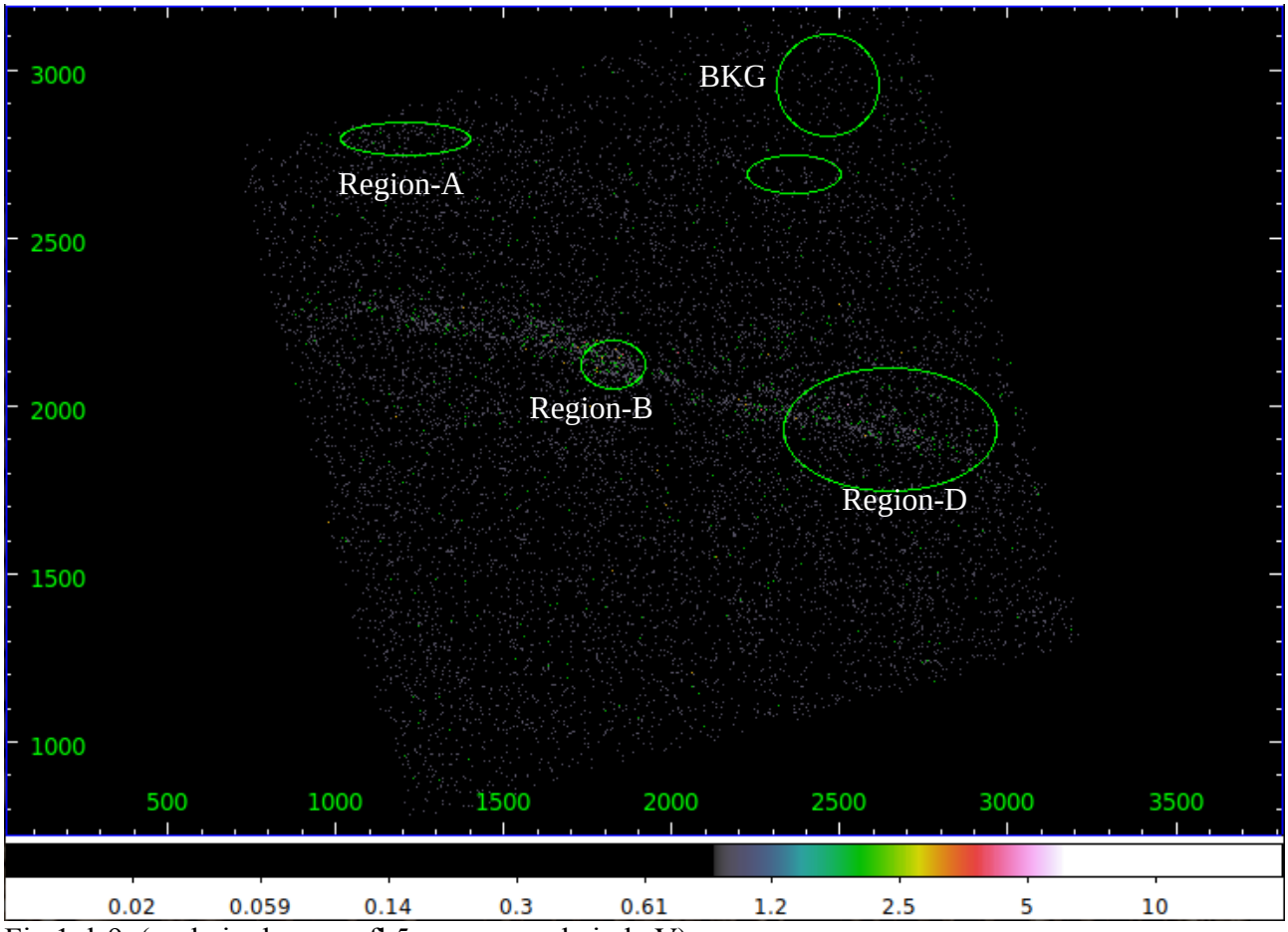
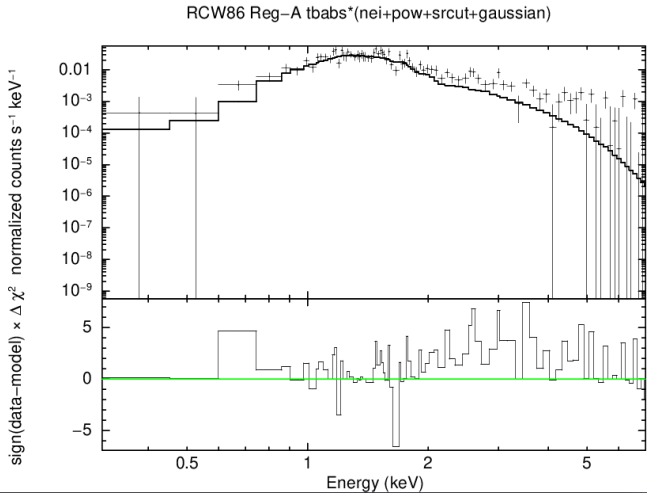


Fig.1 ds9, (scale in degrees, fk5, energy scale in keV)

Due to noise I omitted one region (region-c). From the [3] article it is found that SRCUT alpha as 0.6 by radio observation. Where I kept this value at 0.6. And I set binspec = 2 on specextract.

I used nei,powerlaw and srcut models due to figure out non-thermal radiation. Gaussian model is for Fe-Kalpha line correction. Tbabs is used for to reduce ISM radiation.

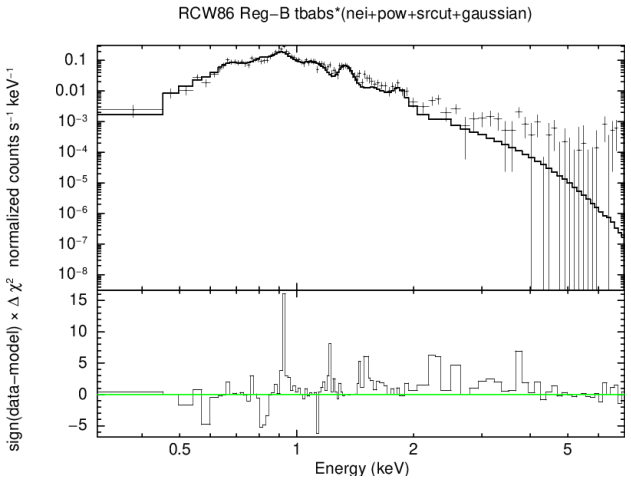


Graph-1 (Region-A)

Chi-Squared = 457.22 using 458 PHA bins

Reduced chi-squared = 1.0275 for 445 degrees of freedom

Null hypothesis probability = 3.342835e-01

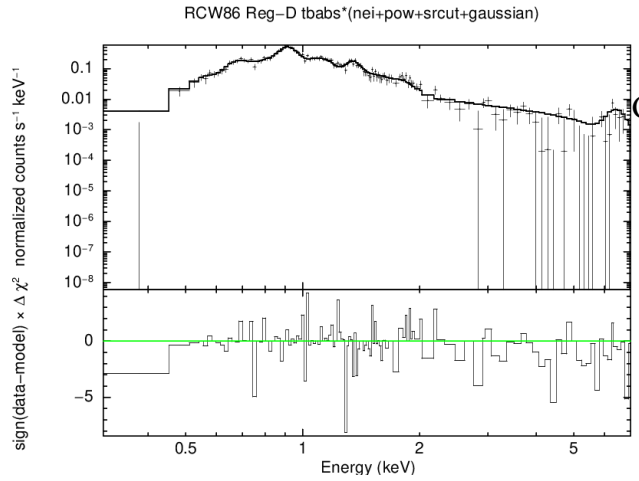


Graph- 2 (Region-B)

Chi-Squared = 478.58 using 458 PHA bins.

Reduced chi-squared =1.0754 for 445degrees of freedom

Null hypothesis probability = 1.312439e-01



Graph-3
(Region-D)

Chi-Squared =447.08 using 458 PHA bins

Reduced chi-squared =1.0047 for 445 degrees of freedom

Null hypothesis probability = 4.633582e-01

Reg	Nei kT	Nei Ab.	Nei Tau	Nei Red.	Nei Norm	Pow ph in	Pow norm	Srcut br.	Srcut norm
A	0.919432 +/- 0.131855	3.89314E-03 +/- 2.20767E-02	3.93536E+13 +/- -1.00000	9.62702E-03 +/- 3.26769E-03	1.47182E-03 +/- 5.28313E-04	2.63745 +/- -1.00000	7.75751E-24 +/- -1.00000	1.00000E+10 +/- -1.00000	8.10979E-03 +/- -1.00000
B	0.679632 +/- 0.153004	1.16308 +/- 0.512883	8.63602E+09 +/- 1.57874E+09	2.02787E-03 +/- 5.59927E-03	7.38023E-04 +/- 4.02789E-04	1.00000 +/- -1.00000	0.0 +/- 7.93535E-06	2.42000E+17 +/- -1.00000	0.0 +/- 1.36568E-02
D	0.428414 +/- 0.104651	1.06729 +/- 1.47151	8.74474E+09 +/- 2.72109E+09	-7.42523E-03 +/- 5.84004E-04	7.23776E-03 +/- 1.09402E-02	3.21047 +/- 3.51364	2.98680E-04 +/- 7.22446E-04	1.00000E+25 +/- -1.00000	5.56213E-03 +/- 6.19275E-03

Table 1

Discussion

On Graph-2 except for the Fe-Kalpha lines it fitted well especially on 1-2 keV interval. Outside this interval due to noise error bars are large and it looks similar to Graph-3. Since this two regions are on the main rig it is normal to look like same. On Graph-1 it is possible to see cut-off effects. Graph-1 has both powerlaw radiation and cut radiation which can be seen "+" points. When we look at the graph maximum kT value was obtained by region A. That shows that it have higher shock velocities according to this equation[3]:

$$V_S \approx (2650\ \mathrm{km\ s^{-1}}) \left(\frac{h\nu_{\mathrm{peak}}}{1\ \mathrm{keV}} \right)^{1/2}$$

If we calculate the shock velocity of A it approximately 0.008839 C. Only region A is responsible for 0.5 MeV. If this object has more than regions like A. It is inevitable to create TeV emissions. Which can show that synchrotron radiation exists. Also, graphs are fitting on SRCUT model. It can be said that both 3 regions are emitting synchrotron radiation but shock acceleration makes cut offs on synchrotron radiation. Diffusive shock accelerations radiates below 10^15 keV ranges. This may the cause of the cut offs.

References:
[1]https://www.esa.int/Science_Exploration/Space_Science/New_evidence_links_stellar_remains_to_oldest_recorded_supernova
[2] https://arxiv.org/pdf/astro-ph/0607307.pdf
[3] https://arxiv.org/pdf/1309.2936.pdf