

SECULAR DECREASE THE FLUX OF SUPERNOVA REMNANT CAS A ON MONITORING RESULTS TO RADIOTELESCOPE "URAN-4" IRA NASU

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ABSTRACT. This work is dedicated to the study of secular decrease of the flux of young supernova remnant Cas A according to observations by radio-telescope "URAN-4" of Odessa Observatory IRA NASU from 1987 to 2001 years on frequency of 25 MHz. On the investigation base there is a relationship analysis of flux CasA to the "stable" source – radio-galaxy Cyg A (CasA/Cyg A) which is located on a small angular distance. Results of the observations held on RT «URAN-4» show that there is no noticeable decrease of fluxes in the period 1987-1993, with the relationship ratio (CasA/Cyg A) = 1.5. While considering data from 1987 to 2001 manifested a slight decrease trend in flux equal to 8.4% for the all period. At the same time, according to various investigations the average value flux of Cas A in the interval of frequencies 38-2924 MHz is 0.8% per year. At the meantime in this frequency the range ratio (CasA/Cyg A) has become less than one. Thus, there is a noticeable contradiction of secular decrease of the flux Cas A on this radio frequencies in comparison with the predictions of the theory in 1.7% per year.

Keywords: supernova remnant, radioemission.

Introduction

In 1948 British radioastronomers Riley and Smith discovered an extremely bright radio source in the constellation Cassiopeia. They named it Cassiopeia A. This source became calibration for the majority of radio astronomy catalogs. It soon turned out that the flux varies systematically. The reason for these changes is the expansion of the supernova remnant. The theoretical explanation of the expansion of the supernova remnant was represented in the work of Shklovskii (1960).

Result of multifrequency observations

Observations of Cassiopeia A flux changes were at different wave lengths. At shorter wave lengths dominated secular decrease in flux. At longer wave lengths decrease flux was less noticeable. At the same time, at longer wave lengths we observed episodic change of flux associated with the state of the ionosphere.

Carrying out absolute changes of fluxes of radio sources is due to technical difficulties with their organizing and observations. In this regard the

determination of flux changes of Cas A is considered its relation to the flux of the radio galaxy Cygnus A (Cyg A) that is located on a small angular distance. This ratio is recorded as Cas A/Cyg A.

The results of such measurements at frequencies of 81.5, 151.5 and 290 MHz are shown in Fig. 1.

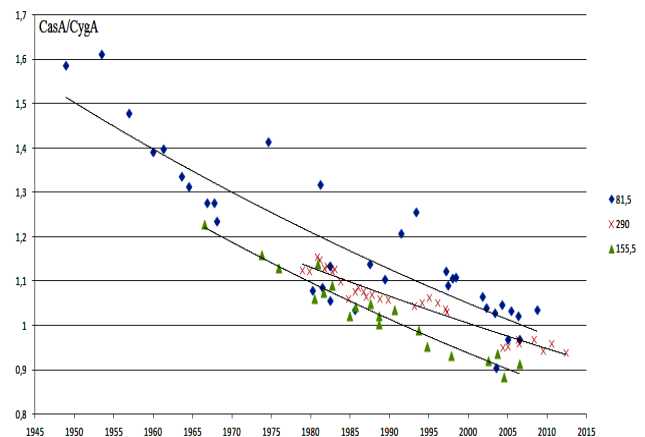


Figure 1: The ratio of fluxes Cas A / Cyg A at frequencies 81.5, 151.5 and 290 MHz.

Studies have been conducted at certain frequencies, indicated in the figures. One of the conditions is the stability of the radiation Cyg A. As a result, the rate d_v was obtained - secular decrease of the flux density of the radio emission in Cas A (Vinyakin, 2014).

$$d_{81.5}(2005.0) = 0.71 \pm 0.06 \% \text{ year}^{-1}$$

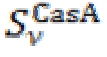
$$d_{151.5}(2005.0) = 0.78 \pm 0.04 \% \text{ year}^{-1}$$

$$d_{290}(2005.0) = 0.61 \pm 0.03 \% \text{ year}^{-1}$$

Nick Rees (1990) has studied the relationship Cas A / Cyg A. He found anomalous behavior relationships CasA/Cyg A at a frequency 38MHz (Rees, 1990). Such a deviation requires a detailed study on a longer period of time. Studies have been conducted on the meter and decimeter waves. We found four periods in the spectrum of variations relationships Cas A/Cyg A: (3.1 ± 0.02) ; (5.1 ± 0.3) ; (9.0 ± 0.2) and (24 ± 2) years. If the flux Cyg A is constant, they can be attributed to the secular variation Cas A.

According to various studies, the average decrease of flux Cas A in the frequency range 38-2924 MHz is detected in interval 0.39-0.99 % per year (see Table 1) (Bovkoon, 2010; Vinyakin, 2014).

Table 1:

ν	Epoch measurement	$-d\nu(2005)$, % year ⁻¹	 Cas A (2015.5), Ян
20 MHz	1984.5	0.71 ± 0.12	37265 ± 3120
25 MHz	1984.5	0.99 ± 0.09	32095 ± 1890
38 MHz	1980.1	0.73 ± 0.13	26540 ± 2015
927 MHz	1991.2	0.68 ± 0.03	2360 ± 140
2924 MHz	1983.2	0.50 ± 0.09	1038 ± 64
22680 MHz	2005	0.51 ± 0.01	219.7 ± 3.0
32940 MHz	2005	0.55 ± 0.02	169.4 ± 1.8
33000 MHz	2002.9	0.39 ± 0.02	171.6 ± 0.6
40620 MHz	2005	0.56 ± 0.02	144.6 ± 1.7

Currently, as a result of the secular decrease of flux Cas A over frequency intervals 38 MHz ratio of the fluxes Cas A / Cyg A was less than one. Thus, there is a noticeable difference in the magnitude of the secular decrease in flux Cas A on radio frequencies than the theoretical predictions of 1.7% per year.

Observations on radiotelescope «Uran-4»

Observation Cas A on radiotelescope "URAN-4» of Odessa Observatory IRA NASU have been held for monitoring programme of fluxes of powerful radio sources at a frequency of 25 MHz since 1987 till present time. The study is based on analysis of the ratio of the flux to the Cas A "stable" source - radio galaxy Cyg A (Cas A / Cyg A).

In 1987-1993 observations were conducted in analog regime registration during 10-14 days a month. In 1999-2014 observations were carried out continuously in digital regime registration.

The procedure for processing the observation data was the following:

1. Flux of radio emission of the source was determined in relation to the power calibration signal noise generator.

2. The effective area of the antenna in different hour angles is different.

Therefore, the data obtained in different hour angles cited to the direction of the culmination radio source.

3. Matrix of observation data was processed to detect accidental releases. After their exclusion, we determined the average daily values, average for the entire period of observation and their dispersion.

Results of observations on RT «Uran-4»

According to observation results it has been found that for a correct consideration of changes of fluxes Cas A / Cyg A it is best to divide into two intervals of data. The first interval includes observations from 1987 to 1993 (Fig.2).

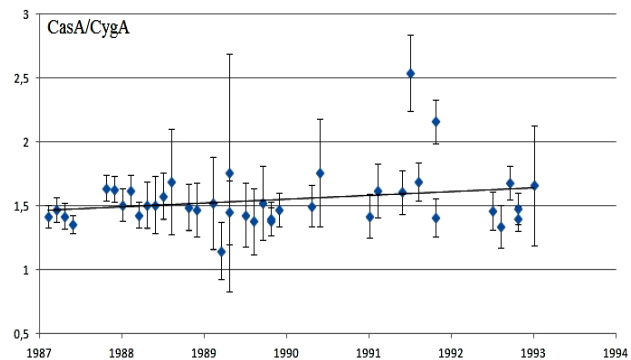


Figure 2: Observations of flux ratio Cas A / Cyg A from 1987 to 1993.

The results of observations carried out at RT "URAN - 4", show no appreciable drop in fluxes between 1987 and 1993 when the value of the flux ratio (Cas A / Cyg A) = 1,5.

The second period includes observational data from 1998 to 2002 (Fig. 3).

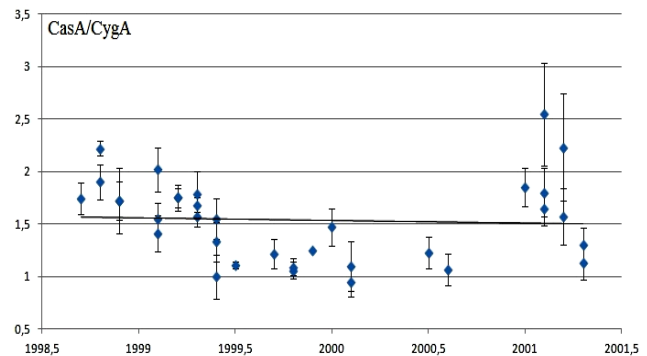


Figure 3: Observations of flux ratio Cas A / Cyg A from 1998 to 2002.

When considering the data from 1987 to 2001, there is a tendency of the flux decreasing, equal to 8.4% over a period of 14 years.

Conclusion

As a result of observations on the RT Uran-4 we received a marked contrast of the flux changes of Cas A at a frequency of 25 MHz compared to higher frequencies. The results of observations carried out at RT "URAN-4", show no appreciable drop in fluxes between 1987 and 1993 when the value of the flux ratio (Cas A / Cyg A) = 1,5.

The reason of regime change from the stability to reducing the flux of Cas A at decameter wavelengths may be the existence of a compact component in the center, especially the angular structure of the residue found in the X-ray space telescope "Chandra" and variations of the state of the ionosphere in the changing solar and geomagnetic activity. This can be quite a strong modulation of the flux of source, due to the influence of solar activity and seasonally-day effects. Hence, for solving the problem of secular decrease of Cas A radio flux at low frequencies, the season-day effect determined by observation should be taken into account. This effect

results in scatter of the ratio $3C461/3C405$ within the range 1.3-1.7 and enhanced dispersion if one or both sources are observed through non-stable ionosphere (Ryabov, 1993).

When considering the evolution of the flux of Cas A it should be taken into account: the existence of a compact source in remnant, rupture of the shell, the lifetime of individual condensations, the presence of shock waves in the remnant, modulation of the flux under the influence of changes in the state of the ionosphere. All this will help to better understand the processes that occur in the evolution flux of Cas A on the radio waves. In this regard, it is likely variability of Cyg A flux due to these effects will study in the future.

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