

Ricerca di galassie radio giganti in un campione di oggetti selezionati in raggi X di alta energia

Search of giant radio galaxies in a sample of high hard X-Ray selected objects

Part 2

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Which is our aim?

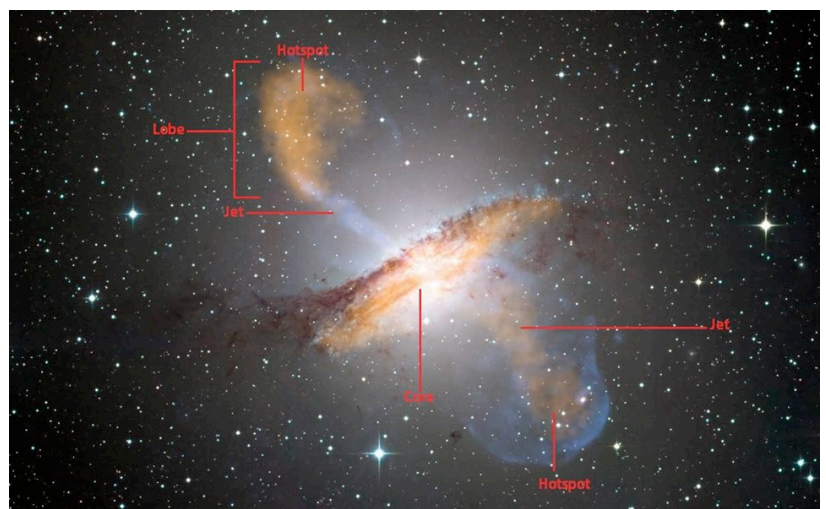
Giant radio galaxies or GRGs are a particular type of radio galaxies with big dimensions and they are thought to be very old or very powerful objects. Their number is low (~6%) in radio surveys, but recently a large number (24%) of them has been found analyzing a sample of radio galaxies selected between 20 keV and 100 keV by INTEGRAL, an ESA satellite. Aim of the present project is to search GRGs in a similar sample, using the database of Swift, a NASA satellite. The identification of a group of GRGs will allow the astronomers to study in depth their properties and to understand why they are so extended.

Who are we?

We are high school students, which attended a summer internship provided by our school. We worked at IASF/INAF of Bologna for 3 weeks: our job was to search for radio galaxies from the SWIFT 70 months survey. SWIFT is a satellite which looks for and studies gamma ray bursts (GRB) around the Universe, but one of its instruments, BAT, makes a survey of the all sky. The most recent catalogue produced with BAT data contains more than one thousand objects and we used this catalogue for our analysis. We extracted all objects associated to galaxies in the BAT catalogue and then selected those that were detectable in the radio band by the NVSS (Condon et al*), which is a radio survey of the sky above -40 degrees in declination. We, as four, had to analyze 676 sources in total which resulted in 169 objects each. Using the Swift/BAT 70 month catalogue which is available on line (swift.gsfc.nasa.gov/results/bs70mon/) we searched the NED (NASA Extragalactic Database) archive where the NVSS images are easily found and searched for objects with a specific radio structure, that of a radio galaxy.

What's a radio galaxy?

Radio galaxies are types of active galaxies or AGN (i.e. galaxies which have at their center a super massive Black Hole), which are particularly bright at radio wavelengths. The structure of radio galaxies is given by twin jets expanding in opposite directions, a core with high radio emission plus one hotspot at the end of each jet and two lobes. The host galaxies are almost always large



elliptical galaxies.

The figure on the side shows the typical structure of a bright radio galaxy (Centaurus A).

In my sample of 169 BAT galaxies I found a total of 12 radio galaxies. All of them are reported in the Table below.

This Table lists the name and coordinates of the Swift source, the name and the coordinates of the optical counterpart, the redshift which gives a measure of the distance of the source and the logarithmic value of the 14-195 keV BAT luminosity in units of erg/sec.

Swift name	RA (<i>arcmin</i>)	Dec (<i>arcmin</i>)	Counterpart name	Counterpart Coord. (RA, Dec)	Redshift (<i>z</i>)	Lum (log)
<i>SWIFT J0709.4-3559</i>	107.333	-36.029	PKS 0707-35	107.309, -36.023	0.1108	44.8
<i>SWIFT J0134.1-3625</i>	23.481	-36.504	NGC 0612	23.490, -36.493	0.0297	44.05
<i>SWIFT J2333.9-2342</i>	353.456	-23.708	PKS 2331-240	353.480, -23.728	0.0477	43.91
<i>SWIFT J0445.0-2816</i>	71.122	-28.166	PKS 0442-28	71.157, -28.165	0.1470	45.03
<i>SWIFT J1919.4-2958</i>	289.839	-29.965	PKS 1916-300	289.867, -29.969	0.1668	45.07
<i>SWIFT J0021.2-1909</i>	5.305	-19.151	2MASX J00210753 -1910056	5.281, -19.168	0.0955	44.6
<i>SWIFT J1436.8-1615</i>	219.198	-16.266	2MASX J14364961 -1613410	219.207, -16.228	0.1445	45.02
<i>SWIFT J0215.6-1301</i>	33.903	-13.011	3C 062	33.906, -12.992	0.1470	44.91
<i>SWIFT J2137.8-1433</i>	324.449	-14.554	HB892135-147	324.438, -14.549	0.2005	45.24
<i>SWIFT J2303.1-1837</i>	345.783	-18.675	PKS 2300-18	345.762, -18.690	0.1289	44.62
<i>SWIFT J0839.6-1213</i>	129.946	-12.258	3C 206	129.961, -12.243	0.1978	45.44
<i>SWIFT J0923.6-2136</i>	140.91	-21.600	PKS 0921-213	140.910, -21.600	0.0500	44

The NVSS image of each source in the Table is displayed in the Appendix

What was our final purpose and what did we find out?

As a second step of our research we had to find how many of the radio galaxies uncovered could be classified as giants. Giant radio galaxies are defined by their size, which has to be more or equal to 700 kpc; this is a conventional number adopted when the following cosmology is used: $H_0 = 69.6 \text{ km s}^{-1} \text{ Mpc}^{-1}$, $\Omega_m = 0.286$, $\Omega_\Lambda = 0.714$.

The specific purpose of our project was to show the real percentage of giant radio galaxies, which is normally set to a 6 % in radio surveys, but was found to be higher (24%) among radio galaxies selected in hard X-rays, the energy band used by Swift/BAT. To look for giant objects among my set of radio galaxies I first searched the literature to find the source size and then measured myself its dimension using the NVSS image shown in the Appendix.

My results are listed in the second Table of this report, where I report the name, the conversion factor to convert arcsec to kpc scale, the largest angular scale (LAS, in arcsec) and the size (in kpc) measured by myself and found in the literature for each source.

Counterpart name	CF	Our LAS (kpc/'')	Our Size (kpc)	Literature's LAS	Literature's Size
PKS 0707-35	2.032	546	1109.472	492 (1)	999.744 (1)
NGC 0612	0.600	1056	633.6	812 (2)	487.2 (2)
PKS 2331-240	0.941	1248	1174.368	--	--
PKS 0442-28	2.589	168	434.952	105 (3)	271.845 (3)
PKS 1916-300	2.875	222	638.25	--	--
2MASX J00210753 - 1910056	1.784	372	663.648	252 (2)	449.568 (2)
2MASX J14364961 - 1613410	2.553	714	1822.842	720 (5)	1838.16 (5)
3C 062	2.589	156	403.884	--	--
HB89 2135-147	3.332	228	759.696	150 (2)	499.8 (2)
PKS 2300-18	2.317	270	625.59	300 (4)	695.1 (4)
3C 206	3.298	228	751.944	169 (2)	557.362(2)
PKS 0921-213	0.99	1140	1123	--	--

Giant radio galaxies:

Possible Giant:

Notes

- 1: Ishwara-Chandra and Saikia (1999)
- 2: Nilsson et al. (1993)
- 3: Morganti et al. (1999)
- 4: R.W. Hunstead et al. (1983)
- 5: G. Letawe et al. (2004)

Conclusions

7% of the 169 galaxies analyzed by me have been identified as radio galaxies, this number is similar to the expectations. The percentage of giant radio galaxies among the 12 radio galaxies I found was fairly high, 41.5%, which, compared to the 6 % found in radio surveys, indicates a significant difference. All together the 4 students of my stage found 51 radio galaxies (7.5% of the sample of 676 Swift/BAT analyzed) and 17 giant radio galaxies (33.3% of all radio galaxies). These numbers are similar to what found previously by our tutors using INTEGRAL data.

References

Ishwara-Chandra, C. H., Saikia, D. J., 1999, MNRAS, 309, 100

*Condon, J. J., Cotton, W. D., Greisen, E. W., Yin, Q. F., Perley, R. A., Taylor, G. B., & Broderick, J. J., 1998, AJ, 115, 1693

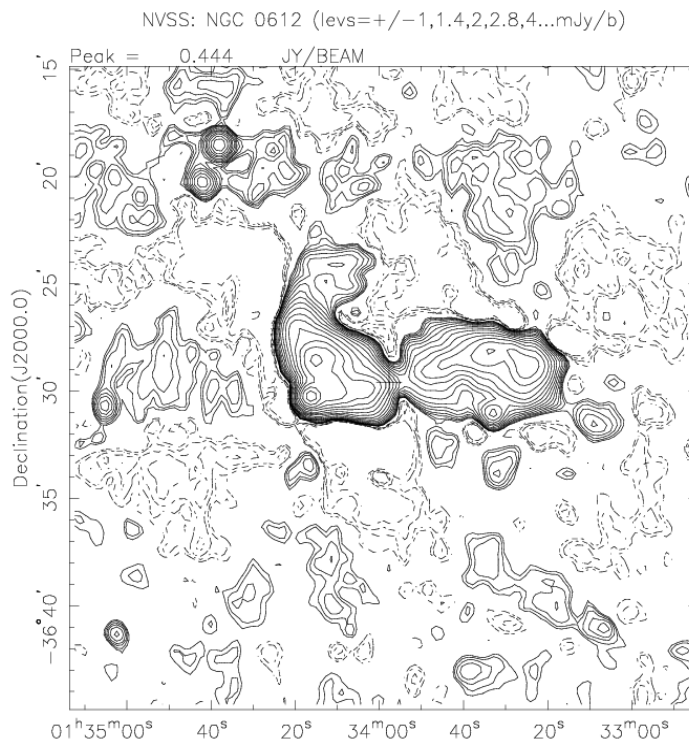
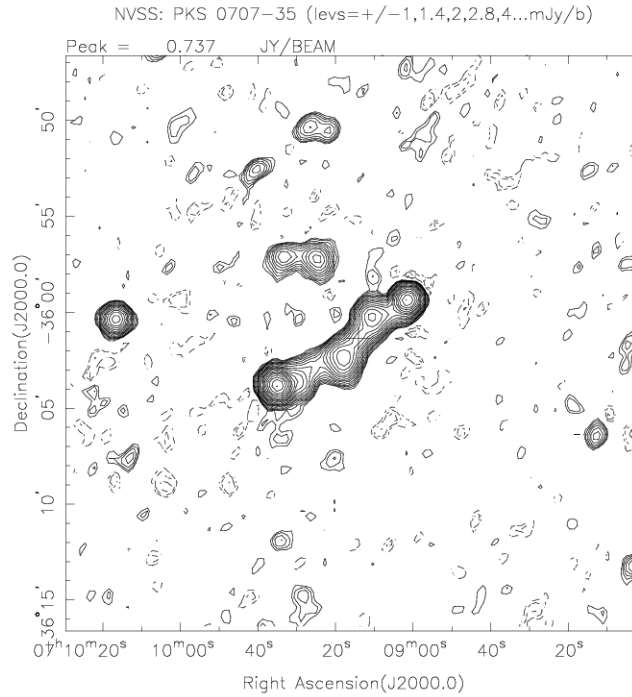
Nilsson, K., Valtonen, M. J., Kotilainen, J., Jaakkola, T., 1993, Ap.J., 413, 453

R.Morganti, T. Oostreloo, C. N. Tadhunter, R. Aiudi, P. Jones, and M. Villar-Martin

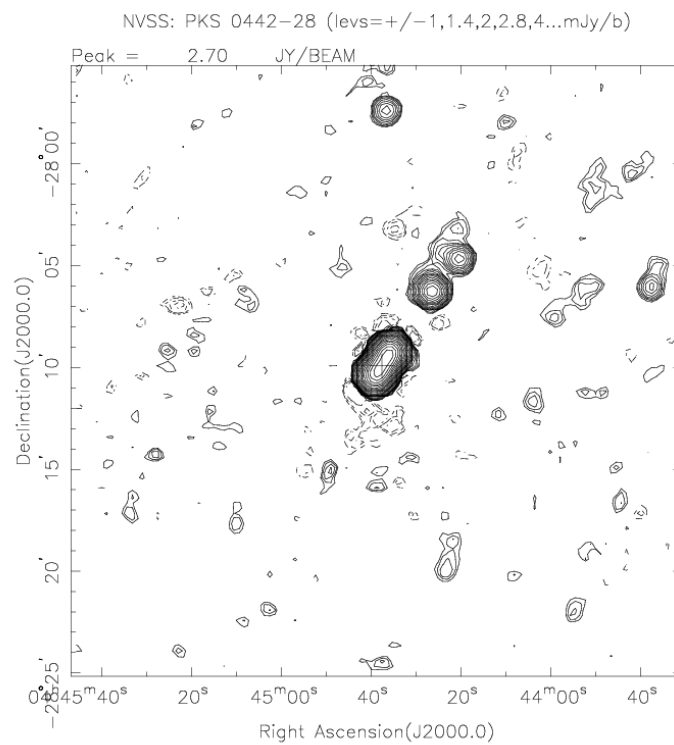
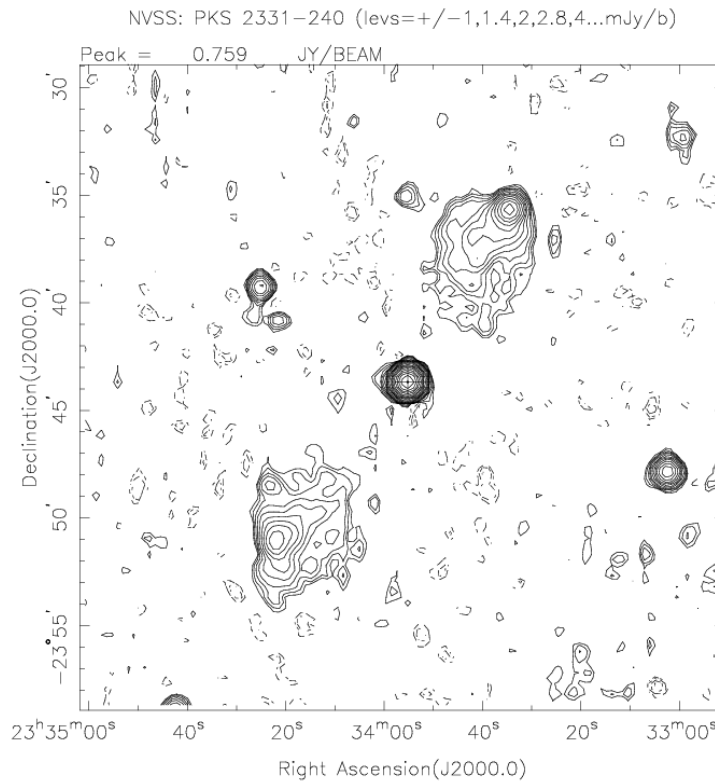
R.W. Hunstead and H.S. Murdoch, J. J. Condon, M. M. Phillips

G. Letawe, F. Courbin, P. Magain, M. Hilker, P. Jablonka, K. Jahnke, and L. Wisotzki

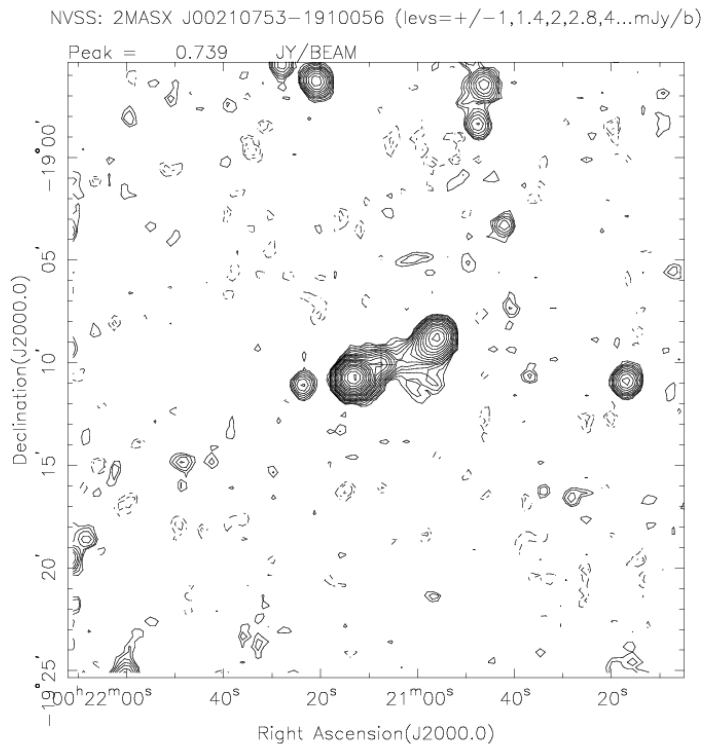
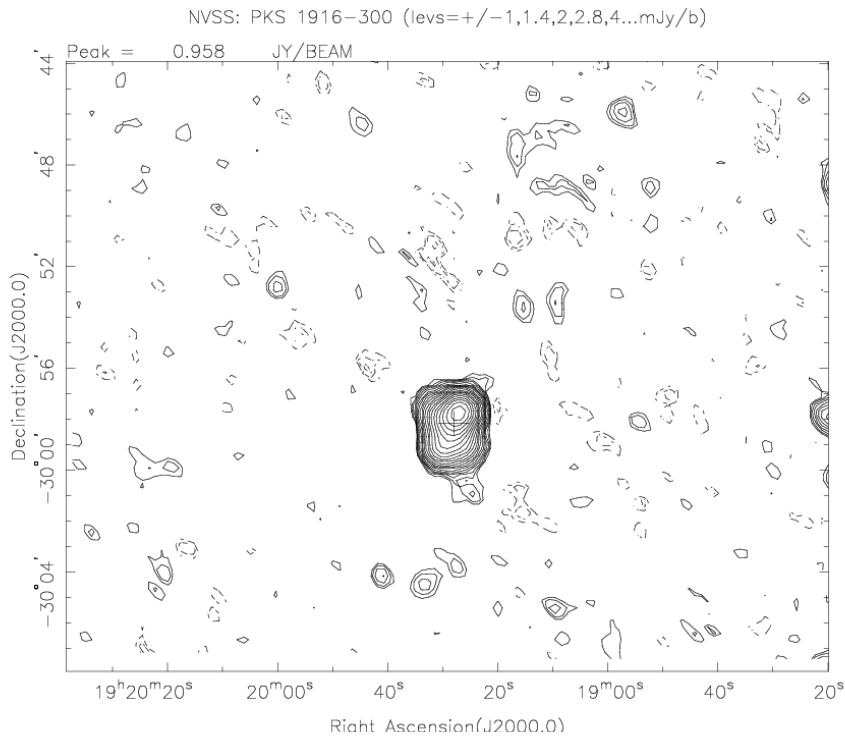
Appendix: All images of radio galaxies are showed in the next pages.



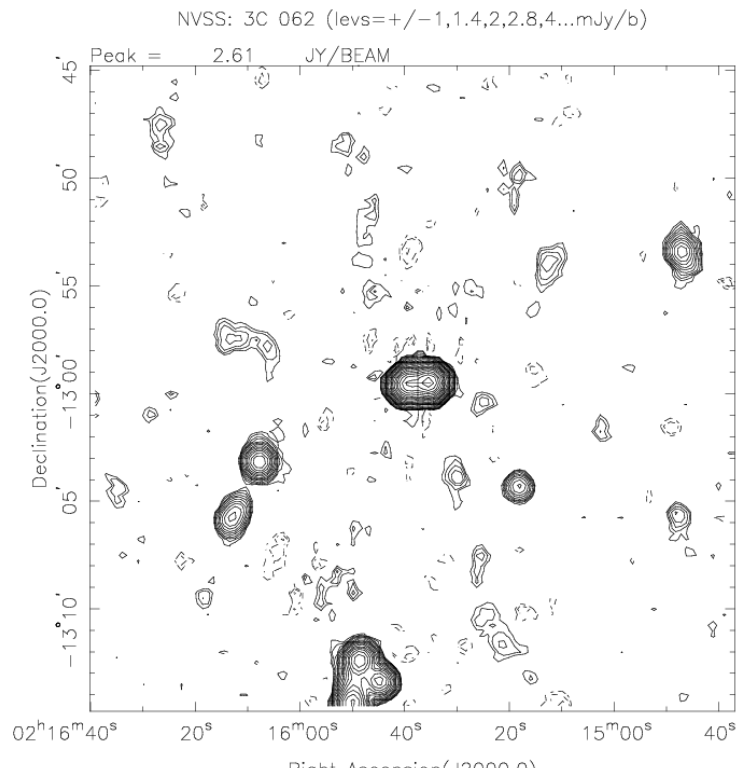
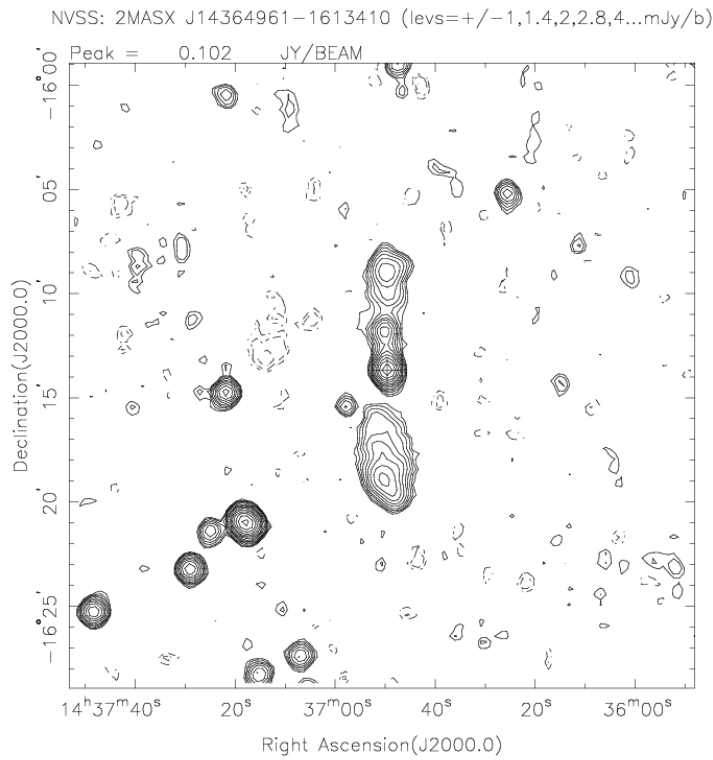
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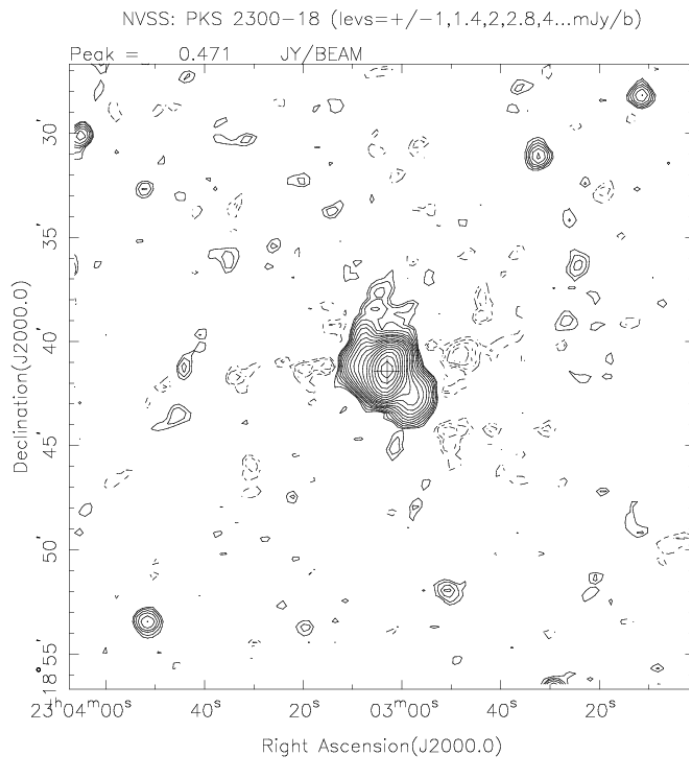
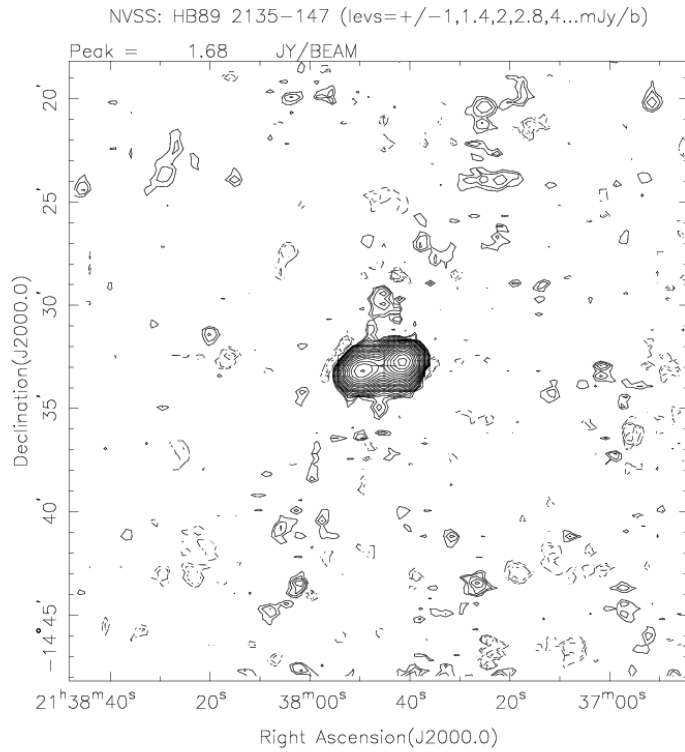


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