# Faint Radio Galaxies on the Planck Mission Maps

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We investigate the distribution of emission on the multifrequency Planck maps toward radio sources of several samples separated by spectral index, redshift, morphology.

The "Cold" surveys were conducted at the RATAN-600 radio telescope in the centimeter and decimeter wavelength ranges. The RC (RATAN-Cold) catalog [1] contains multifrequency flux density measurements. The limiting sensitivity of the RCR (RC Refined) catalog is 10 mJy at 1.4 GHz. We investigated the regions with a radius of 1.5 beam widths at the Planck high frequencies for occurrence of a positive signal at the level of the signal-to-noise ratio $1 < S/N < 3$. We prepared the catalog of 117 radio sources with the measurement data and corresponding continuous spectra from the radio to submm range [2, 3]. Independent flux density estimations of the investigated radio sources, which are presented in the Planck catalog (there are 16 such objects in our list), give evidence of the satisfactory accuracy of flux estimation in the introduced method. Energy distribution in radio source spectra is marked by a rise in the submillimeter range and shows evidence of a dust component which present in AGN. The presence of such sources, difficult to clear out from the CMB maps, complicates the statistical analysis of the Planck CMB maps at scales $<7'$. Statistics of CMB peaks in the region of the investigated RCR radio sources show distinction for objects of different types: 1) on average, the flat-spectrum sources (i.e., from the spectral range $-0.5 < \alpha \leq 0.5$) fall into the positive peaks region 1.2 times more often than the steep-spectrum objects if the $1\sigma$ detection level is set; 2) the average number of cold spots in the range of $S/N > 2.0$ in the $7'$ vicinity of the RCR sources is very small in comparison both with the data on hot spots and with the models. This fact can prove that the selection of the sources in the microwave range is not random.

The stacked images of the Planck CMB maps for different object populations are shown on Fig. 1. Some topological features, e.g. minima and maxima, are visible in the objects areas. We can conclude that the CMB maps contain signal from radio galaxies and/or their parent galaxy, probably, due to a dust

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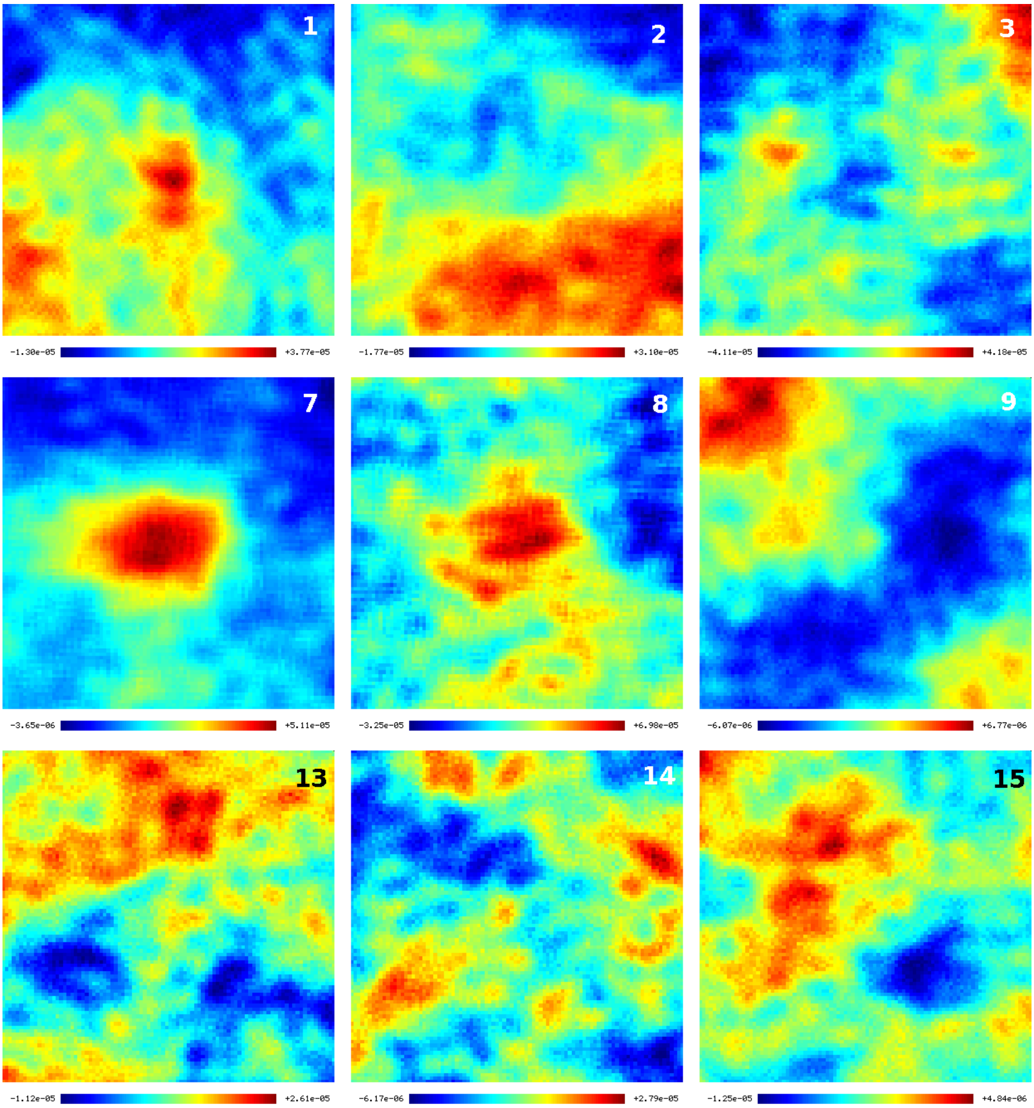
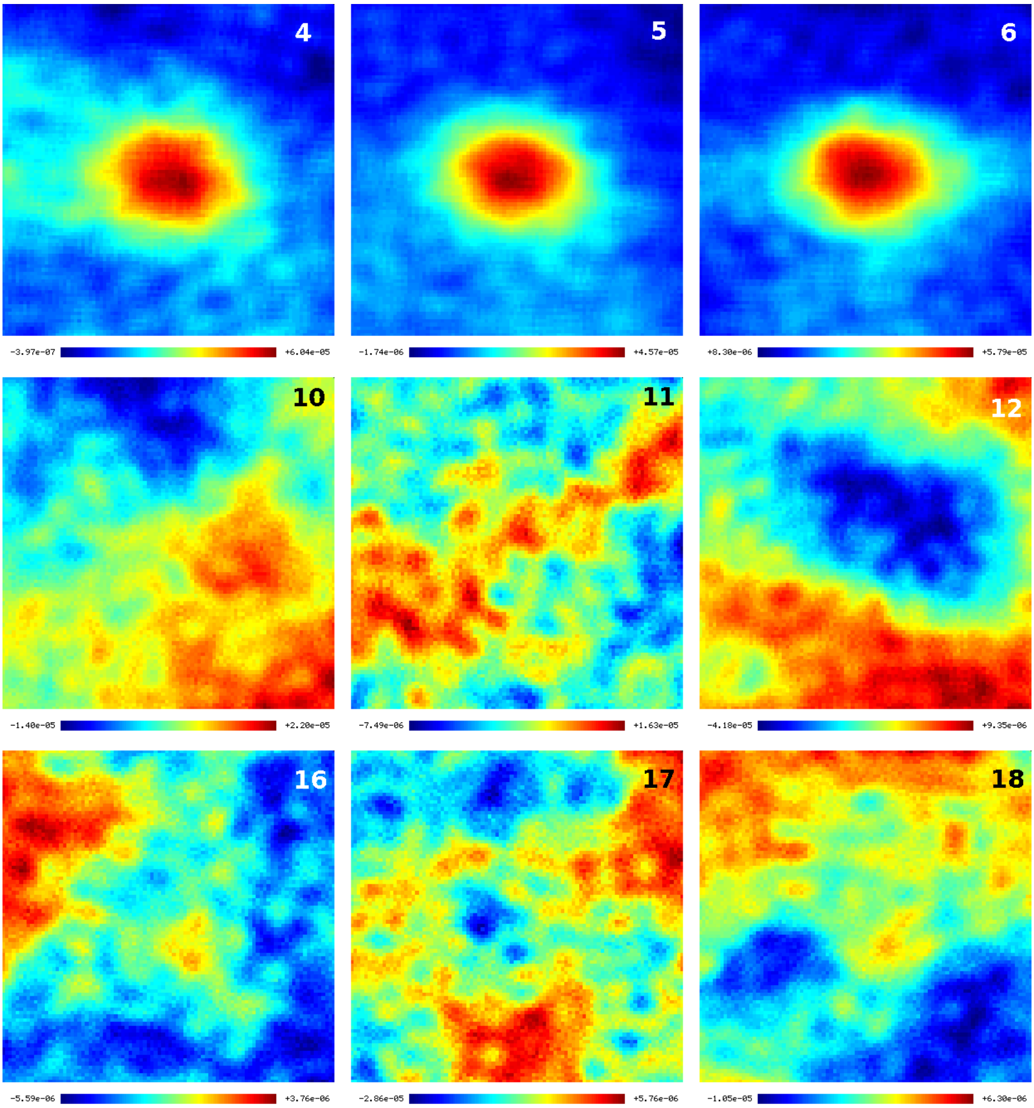



Figure 1: A response from stacking areas from the Planck 2.02 CMB maps around: **(1)** RCR-objects (117 stacked objects); **(2)** giant radio galaxies larger $\theta > 4'$ and 1 Mpc (89 obj.); **(3)** gE and CD galaxies (25 obj.); **(4)** WENSS radio sources (RS) with the radio spectral index $\alpha < -1.1$ (224 obj.); **(5)** WENSS RS, $-1.1 \le \alpha < -0.75$ (661 obj.); **(6)** WENSS RS, $-0.75 \le \alpha < -0.5$ (497 obj.); **(7)** WENSS RS, $-0.5 \le \alpha < 0$ (238 obj.); **(8)** WENSS RS, $\alpha \ge 0$ (19 obj.); **(9)** distant RG, $0.3 \le z < 0.7$ (1797 obj); **(10)** HZRG, $0.7 \le z < 1.0$ (205 obj.); **(11)** HZRG, $1.0 \le z < 1.5$ (149 obj.); **(12)** HZRG, $1.5 \le z < 2.0$ (103 obj.); **(13)** HZRG, $2.0 \le z < 2.5$ (77 obj.); **(14)** HZRG, $z \ge 2.5$ (81 obj.); **(15)** BATSE events with $t$ <2s (495 obj.); **(16)** BATSE, $t$ >2s (1540 obj.); **(17)** BeppoSAX, $t$ <2s (87 obj.); **(18)** BeppoSAX, $t$ >2s (694 obj.).


4
-3.97e-07
+6.04e-05
5
-1.74e-06
+4.57e-05
6
+8.30e-06
+5.79e-05
10
-1.40e-05
+2.20e-05
11
-7.49e-06
+1.63e-05
12
-4.18e-05
+9.35e-06
16
-5.59e-06
+3.76e-06
17
-2.86e-05
+5.76e-06
18
-1.05e-05
+6.30e-06

component. This signal contaminates the resulting CMB maps [4]. Objects of different population in the stacked area on CMB maps demonstrate different map topology. Some average zones are connected with response similar to Zeldovich–Sunyaev effect observing like minima on the CMB map. Other ones are gE-galaxies often being a center of clusters, distant RGs with $1.5 \leq z < 2$ in the epoch of active cluster formation. Short BATSE events, probably, connected with neutron stars merging in elliptical galaxies, and giant radio galaxies demonstrate inverse Compton scattering of CMB photons with the RG radio lobes electrons.

## References

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* The color figures are available online in the Proceedings at *http://www.astro.spbu.ru/sobolev100/*.