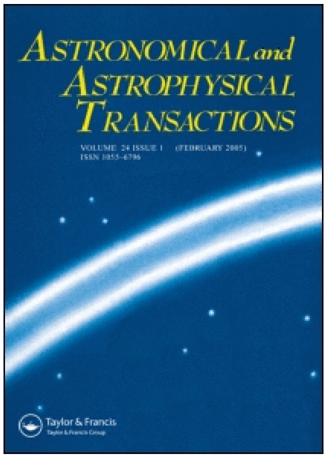

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RATAN-600 AND THE EARLY UNIVERSE

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We discuss the status of the Russian-USA "the Big Trio" project, based on the steep spectra (SS) FRII RG method of the selection of old and distant galaxies. Some aspects of the integral efforts of high redshift radio galaxies (HZRG) groups and Cosmic Microwave Background (CMB) anisotropy project briefly discussed, and new generation "Sakcharov Oscillation" national project at RATAN-600 shortly mentioned.

KEY WORDS Radio galaxies: general, observations, cosmology

The only source of information about the very early Universe, from the recombination epoch to the singularity, is radio waves. Almost all HZ galaxies were found using radio preselection methods. We present here some recent results on the combined RATAN-600, VLA and 6 m SAO optical telescope efforts (the "Big Trio" project) in the detection of the most distant galaxies and a new programme of CMB anisotropy measurments.

HZ RG are now detected at redshifts of more than 4 (4.25; 4.41–1996 records), that is practically at QSO redshifts, but RG are of special interest:

(1) they are much more abundant in the Universe;

(2) the stellar population may be deeply studied and the evolution of the galaxies may be traced back to the very early, pre-QSO epoch.

We use a $100 \times 100°$ selected area (S.A.) (Experiment cold strip) and differ from other groups by the selection criteria. We extended the SS approach by the optimization of the flux density and luminosity ranges (see Kopylov *et al.*, 1995 for details). 1140 objects were found by RATAN-600 in this S.A. down to a few mJy, (RC-Catalog). Most of them have normal spectra, see Figure 1, but we preselected about 100 objects with very steep spectra, SS objects, mapped them with the VLA, selected FR II structures and identified practically all of them with 6 m telescope down to 24–25 R mag (25–27 V mag equivalent for the gE population).

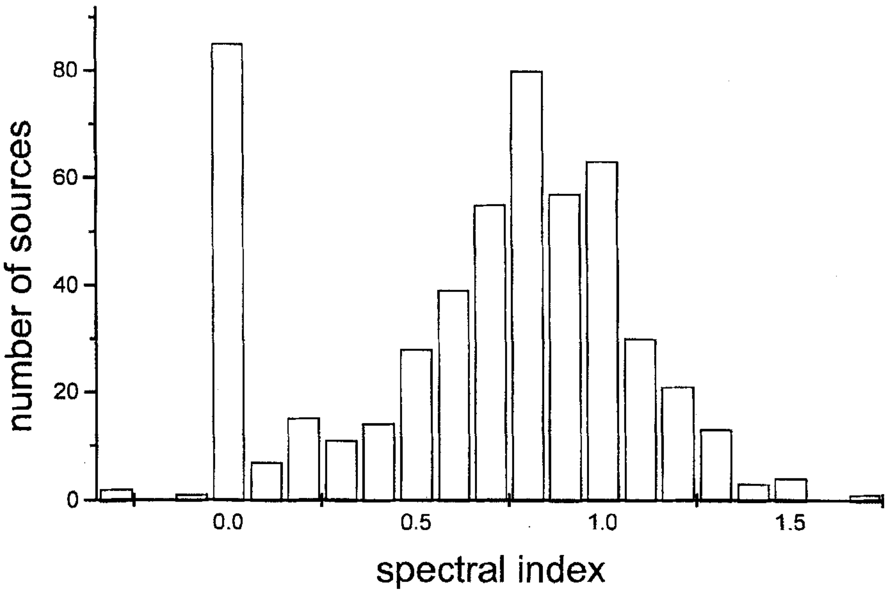

Figure 1 Spectral index distribution for all RC objects with known spectra (about 500 sources, see Bursov *et al.*, 1996).

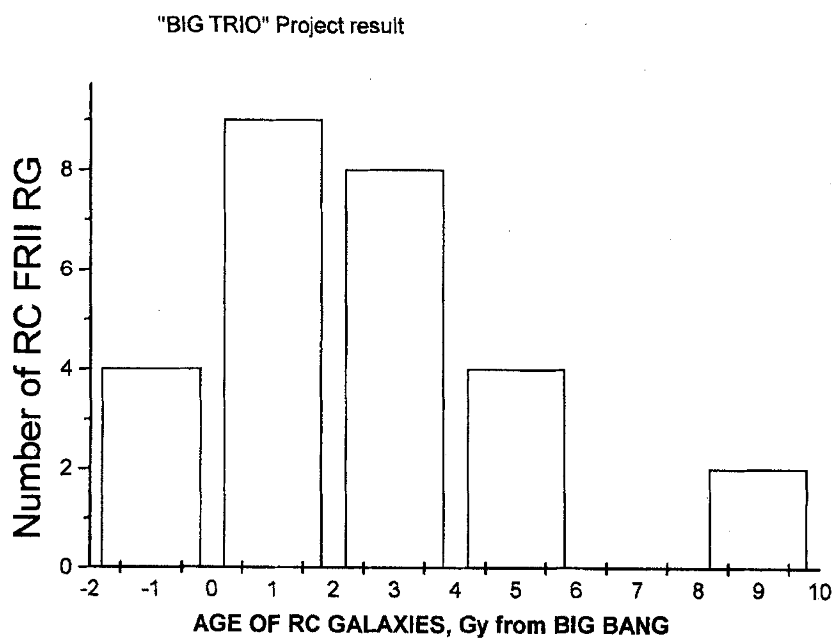

Figure 2 Determination of the colour redshifts and ages of the stellar populations of the parent galaxies using 6 m multi-colour BVIR photometry and the Charlot–Chambers evolution models for gE.

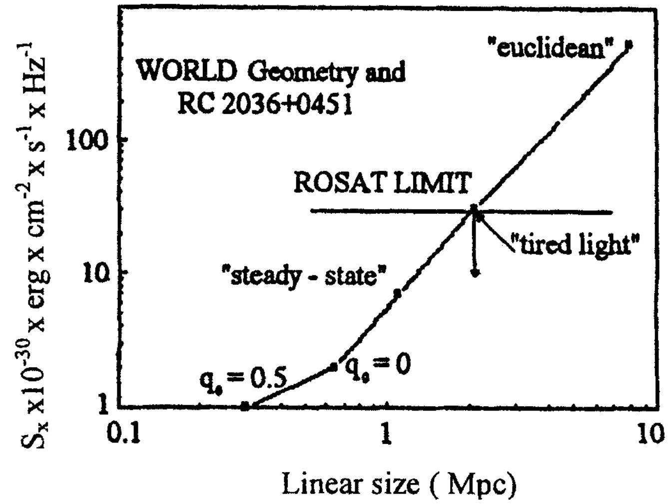

Figure 3 Distant giant radio structure and geometry of the Universe. ROSAT X-ray flux is shown for the biggest radio structure available up to now in the early Universe, RC object 2036+0456 with measured z at 6 m telescope by S. Dodonov.

Using the best calibration curves, we estimated photometric redshifts for all identified objects. For $z > 1$ RATAN-600 is among the most efficient instruments in picking up distant radio objects.

In 1994 we started multi-colour observations at the 6 m telescope and using most popular colour evolution models found colour redshifts and ages for the first subgroup of our SS FR II RG. We demonstrate this process in Figure 2. It is interesting to note that the colour method, which uses a classical HD approach, now strongly competes with the old radio (not realized!) suggestion to use IGM H I absorption for redshift estimates. For $z \gg 1$ objects the L-alpha forest and Lc-forest act as IGM very efficiently. The practically infinite optical depth of H I at wavelengths shorter than 912Å may be easily used to detect objects at $z > 4$. The HST group demonstrated this recently. We prepared the first list of candidates for extremely high redshift objects, $z > 4$–6. A "negative test" in optics (complete absence of emission in short wavelength filters) may be checked by a "positive test" using the best mm-submm facilities to identify IR peaks of the galaxies redshifted to the radio domain (Parijskij and Korolkov, 1986).

In some cases even single object can be used as a "test particle" for cosmology. Serendipitously, we found a distant QSR with an unusually big radio structure ($z = 2.95$, a size of a few Mpc) for the early Universe. We used it to test the geometry of the Universe. It is easy to show that the inverse Compton (IC) X-ray luminosity (CMB photons, scattered by relativistic gas in RG bubbles) strongly depends on the geometry of the Universe. The ROSAT group gave us an upper limit on the X-ray flux and it is certainly smaller than our prediction for the case of a Euclidean Universe, see Figure 3. It is interesting to show that all extended FR II

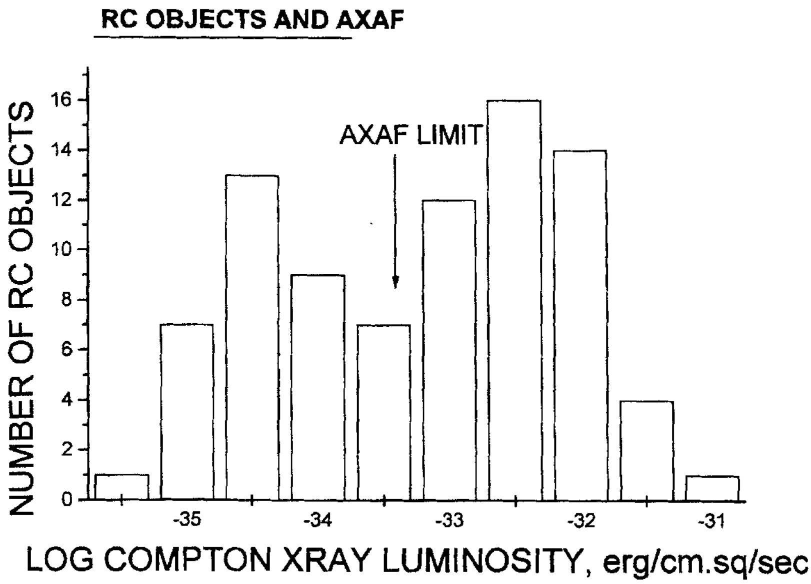

Figure 4 RC objects and IC X-ray fluxes. About 10 000 objects of that type should appear in the AXAF X-ray sky.

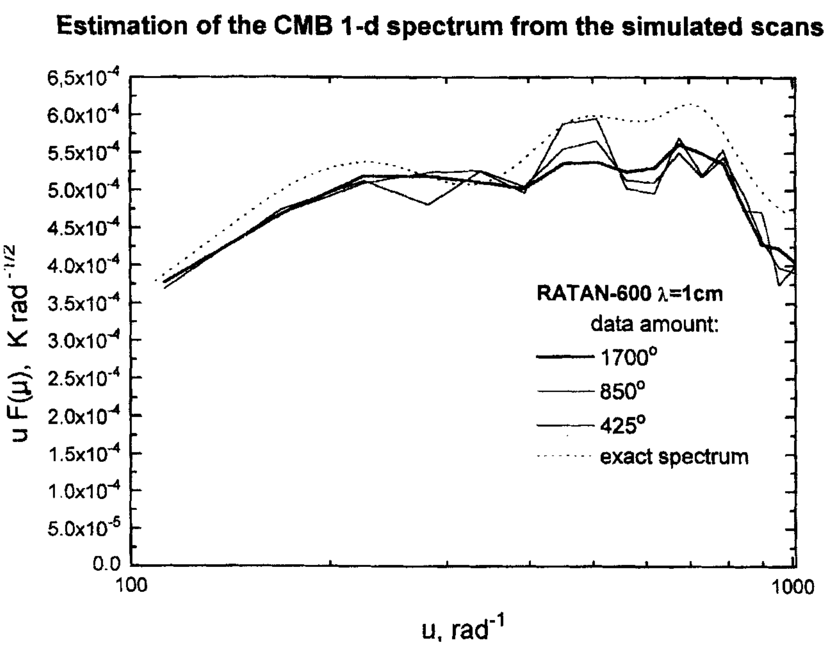

Figure 5 Computer simulation of the next generation RATAN-600 CMB anisotropy experiment. At least three peaks of "Sakharov Oscillations" are clearly visible after decomposition of all the screening radiations and background sources and may be used for particle physics and cosmology; see text.

RG at high redshifts should be visible with the new generation of X-ray telescopes, such as AXAF, see Figure 4.

Distant FR II RG should have giant black holes (BH) in the parent gE galaxy and there are some problems in making them early enough in standard evolution scenarios. We have some indication of the multiple merging process from our Finland partners (see Parijskij *et al.*, 1996), but it is always better to escape from the merging process for that class of objects, as well as to have giant BH much earlier than in the classical way (Hills, 1975). Very early active objects (being even sparsely populated) can play an important role in the ionization status of IGM (UV, IC UV, etc.) and in the process of formation of large structures in the Universe.

The possibility of the existence of very rare but extremely early objects has to be taken into account in the next generation of CMB anisotropy experiments, and we suggest a new programme for the RATAN-600. In principle, such rare objects may be formed from Gaussian type noise at the recombination epoch, where normal galaxies are from the rms (1-sigma) density fluctuations, RG from 2–3 sigma variations, and QSO from 3–5 sigma variations, in agreement with the relative space densities of these populations.

RATAN-600 can help greatly in the joint effort to detect "Sakharov oscillations", which should select the correct high energy physics, select the right cosmology, find with an accuracy of 1–3% the main parameters of the acting cosmology and construct the real scenario of the evolution of the Universe (see e.g., the COBRAS/SAMBA project for the details of this approach). We have just performed the computer simulation of the RATAN-600 COBRAS/SAMBA combined ground and space based next generation experiment connected with the "Sakharov Oscilation" programme and the results are shown in Figure 5.

Acknowledgement

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