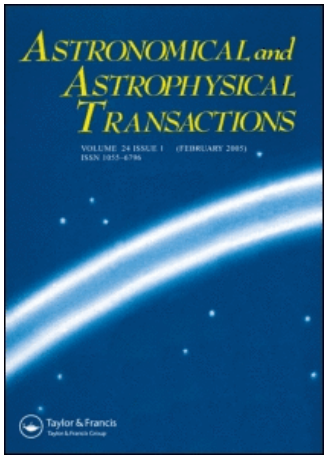

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Once again, what does it mean? (On the analytical representation of the observed log **N**-log **S** relation for radio sources)

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ONCE AGAIN, WHAT DOES IT MEAN? (ON THE ANALYTICAL REPRESENTATION OF THE OBSERVED log N–log S RELATION FOR RADIO SOURCES)

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The observed log N–log S relation for radio sources is well represented by a log-normal law.

KEY WORDS Radio source statistics

20 years ago I wrote a short paper entitled "What does it mean?" (Gershberg, 1974) where noted that the distribution of radio sources according to the observed flux at 408 MHz was well represented by a log-normal law. This result is shown in Figure 1a: vertical lines are the data from Pooley and Ryle (1968) and the solid line is the function

$$p(U) = (2\pi)^{-1/2} \int_U^\infty \exp(-U^2/2)\, dU \qquad (1)$$

where $U = (\log S_{408} + 28.6)/0.925$. Comparing the scales of $\log p$ and $\log N$, one finds that

$$N(S > S_0) = 2.9 \times 10^5 p(U). \qquad (2)$$

Later the radio source counts in the centimetre wavelength range were carried out, to a flux level less than 1 mJy. Results of such counts with RATAN-600 at 3.95 GHz are shown by dark circles in Figure 1b, and those with the Effelsberg telescope at 4.85 GHz are presented by open circles in the same plot, both from Parijsky and Korol'kov (1984). The solid line is the same one as in Figure 1a but shifted by 0.6 along the $\log S$ axis. Such a shift corresponds to a spectral index of radio sources $\alpha = \Delta \log S/\Delta \log \nu = 0.6$. This value is in agreement with its direct determination for the wavelength range under consideration (Pauliny-Toth and Kellermann, 1978).

As known, for the homogeneous Euclidean world a relation

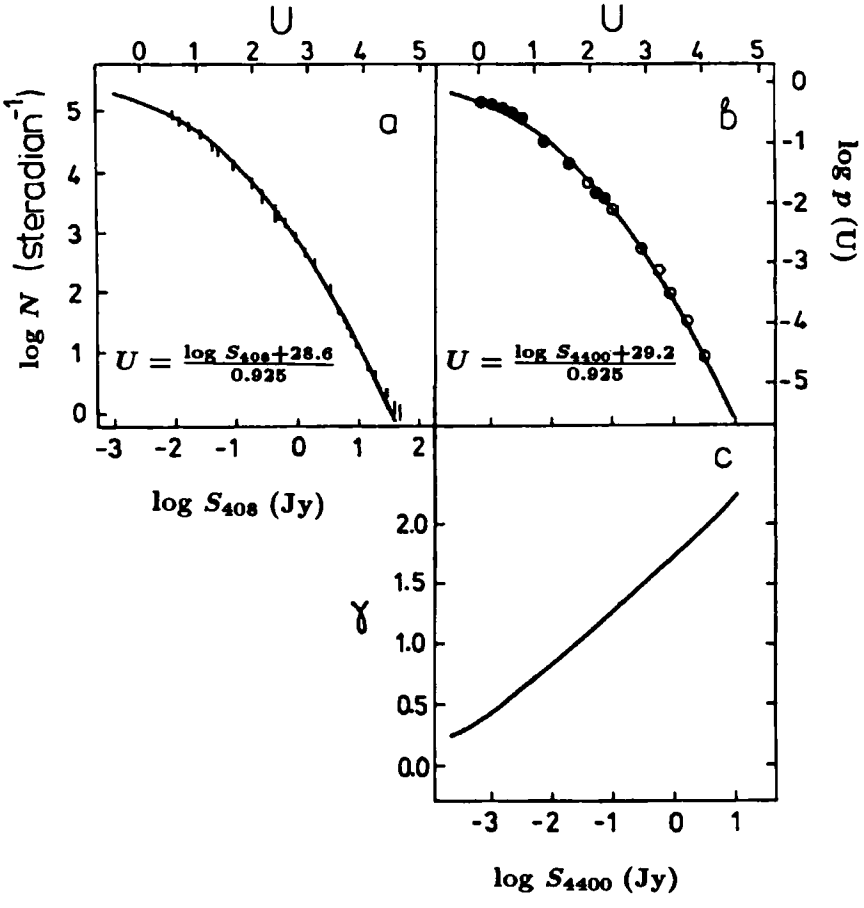

Figure 1

$$N(S > S_0) \propto S_0^{-3/2} \tag{3}$$

holds, and differences between the exponent 3/2 in (3) and those obtained from source counts are used in discussions of the source evolution and/or the Universe models. Approximating observations by the relation

$$N(S > S_0) \propto S_0^{-\gamma}, \tag{4}$$

one finds from (1), (2) and (4) a formula for "observed" γ:

$$\gamma = 0.187 \exp(-U^2/2)/p(U). \tag{5}$$

This relation is plotted in Figure 1c. We see that the exponent γ varies monotonously within the wide range, from 2.2 for the brightest sources to 0.25 for the faintest ones.

Source counts at centimetre wavelengths already reached the top of the Gaussian curve at $U = 0$. If this symmetrical curve is also valid to represent the distribution of still fainter sources with $U < 0$, their total number should be

$$N_{\text{tot}} = 4\pi N(S_0 = 0) = 3.6 \times 10^6. \tag{6}$$

In such a case, the faintest dozen of sources should correspond to $N = 1$, which occurs when $p(U) = (2.9 \times 10^5)^{-1}$, that is $U = -4.50$ and $S_{4400} = 1/25$ μJy. This level is several orders of magnitude below that presently reached.

Addition. The above notes were written in 1984 but not published. During the last decade, in spite of a lot of new observations, the interpretation of the observed log N–log S relation did not achieve noticeable success – see Zhuravlev and Larionov (1994). It makes reasonable to publish my formal finding. Although I do not know what does it mean and I do not insist on a finiteness of the radio source number and on reality of the Gaussian distribution of these sources by radio magnitudes, an analytical representation of observations seems to be useful in discussing these problems. The "observed" behavior of $\gamma(U)$ for $U > 0$ requires a clear explanation independent of the behavior of $N(U)$ for $U < 0$ in general and on correctness of the hypothesis on symmetry of $N(U)$ in particular.

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