THE NUCLEI ACTIVITY RECURRENCE AND THE LUMINOSITY PERIODICITY OF QUASARS AND GALAXIES

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We made the assumption about the cosmological periodicity of quasar and galaxy luminosities from own studies of object samples in the decametric and optical ranges. The corresponding space and time scales of cosmological periodicity were estimated.

INTRODUCTION

We received from our previous studies of the quasar and galaxy luminosity functions in the decametric and optical ranges that the object luminosity changes with cosmological epoch as:

$$L_\nu(z) \sim (1+z)^4. \tag{1}$$

We use this dependence for the estimation of the characteristic luminosity function evolution time $\tau_L = \dfrac{L}{dL/dt}$, taking into account that $dz/dt = H_0(1+z)^2(1+2q_0z)^{1/2}$. Then the τ_L is:

$$\tau_L = \frac{1}{4H_0(1+z)(1+2q_0z)^{1/2}}. \tag{2}$$

The value τ_L is found three times smaller in comparison with the characteristic cosmological evolution time t passed from the beginning of the Universe expanding until given epoch z.

On the basis of own results we assume that nuclei activity may undergo the cyclic changes, that is the quasar and galaxy nuclei activity recurrence may exist. Therefore, the periodicity of the object luminosity distribution should be observed. We assume that the redshift distribution periodicities determined formerly by many authors for quasars and galaxies are caused not only the cell universe structure, but the nuclei activity recurrence too.

SPECTRAL ANALYSIS OF THE QUASAR AND GALAXY LUMINOSITY DISTRIBUTIONS

It is known that the spectral analysis is a good research method of periodicity in the physical value distribution given as the time series. We used this method to two not large, but statistically complete, samples of 114 galaxies and 69 quasars, identificated in the declination zone $\delta = -13^\circ \ldots +20^\circ$ from the UTR-2 catalogue at 25 MHz with optical data. The sample volumes were defined by the object selection criteria: $S_{25} \geq 20$ Jy, $m_v \leq 18.5$, where S_{25} is the flux density at 25 MHz, m_v is the visual magnitude. The UTR-2 sensibility at the regime of the discrete sources 25 MHz measurements is 10 Jy. The sample galaxies occupy the redshift range $z = 0.002 \ldots 0.881$, and the sample quasars occupy the range $z = 0.129 \ldots 2.975$ with mean value $<z>\sim 0.1$ for galaxies and $<z>\sim 1.0$ for quasars.

We derived power spectra (periodograms) P_ν to find periods in the sample quasar and galaxy luminosity distributions upon the redshift:

$$P_\nu = N^{-2}\left|\sum_{n=1}^{N} \Delta B_n \exp(-i2\pi\nu z_n)\right|^2, \tag{3}$$

where $\Delta B_n = B_n - \overline{B}, \overline{B} = N^{-1}\sum_{n=1}^{N} B_n; B_n$ are the observed values ($\log L_{25}$, $\log L_{opt}$ are the object luminosities in decametric and optical ranges), N is the number of observed data intervals, z_n are the object redshifts, ν is the frequency of series counts.

We received the power spectra of the luminosity distributions for total galaxy sample and for separated $FRII$-type (with $\log L_{25} > 25.5$, where values L_{25} are in $\mathrm{W\,Hz^{-1}}$) galaxy subsample, and for the quasar sample in the decametric and optical ranges (for example, see Fig. 1, Fig. 2). Our periodogram analysis revealed the significant peaks (significance level $Q = 97$–99%) for the quasar luminosity distribution at redshifts $z_p = 2.222$; 1.124 in both decametric and optical ranges and at redshift $z_p = 0.448$ in optics. Besides, we found the periodicity peak of optical luminosity at $z_p = 0.224$ ($Q = 93.5\%$).

The galaxy sample luminosity peaks were determined at $z_p = 0.200$ ($Q = 98\%$) in the decametric range and at $z_p = 0.0125$ ($Q = 90.5\%$) in optics.

The subsample of powerful radio galaxies ($FRII$-type) revealed peaks at $z_p = 0.192$ ($Q = 91\%$) in the decametric range, and at $z_p = 0.048$ ($Q = 99\%$) in optics.

The peak significance in the power spectra is estimated with assumption on absence of the periodic component and that the peak ordinate distribution satisfies to exponential law. The probability for given peak amplitude to be random is determined as $q_1(y) = \exp(-y)$, where $y = \dfrac{P}{\overline{P}}$, P is the peak amplitude, $\overline{P}$ is the mean peak amplitude in the power spectrum. So far as m peaks are observed at periodogram, the probability of the random overcoming of y is:

$$q_m(y) = 1 - (1 - \exp(-y))^m. \tag{4}$$

The number of independent peaks m is estimated as: $m = \dfrac{\Delta\nu}{\delta\nu} = N/2$, where $\Delta\nu$ is the total interval of the series count frequency ($\Delta\nu = \dfrac{1}{2\Delta z}$); $\delta\nu$ is the minimum interval of the series count frequency ($\delta\nu = \dfrac{1}{N\Delta z}$); N is the observed number of data intervals, Δz is the step of the redshift interval in the object luminosity distribution.

The redshift values corresponding to significant peaks in the sample quasar and galaxy luminosity distribution are in agreement with other data on the redshift periodicities. The value $z_p = 0.048$ agrees with result by Broadhurst *et al.* [3] for the galaxy redshifts, the value $z_p = 0.0125$, determined in our galaxy luminosity distribution, is close to the value shown by Duari, Gupta, Narlikar [4] for quasar redshifts ($z_p = 0.0127$). The peak value at $z_p = 0.200$ in the decametric galaxy luminosity distribution corresponds to quasar redshift periodicity shown by Karlsson [7], Barnothy and Barnothy [2], Khodyachyh [8]. The peak position at $z_p = 2.222$ for the quasar luminosity distribution is in agreement with result by Gwyn and Hartwick [5] for the galaxy redshift distribution.

One can see that peak positions in quasar and (or) galaxy luminosity distributions in both decametric and optical ranges may coincide with peak positions in the quasar and (or) galaxy redshift distributions. It is interesting that the peak position at $z_p = 0.200$ for galaxy luminosities is close to the peak position $z_p = 0.224$ for quasar luminosities, and, simultaneously, is close to analogous peak position in quasar redshift distribution. This fact point to the same nature of galaxy and quasar nuclei. In this way, we can suppose about a unique evolution process and the same characteristic evolution scales (in space and in time) for these objects.

The redshift values corresponding to periodicity peaks in the quasar and galaxy luminosity distributions in the decametric and optical ranges are from $z_p = 0.0125$ to $z_p = 2.222$. Let us determine the corresponding space and time scales for luminosity cosmological periodicity on the assumption that values z_p are multiple to smaller value from those ($z_p = 0.0125$). Then, the characteristic size in the object space distribution for $z_p = 0.0125$ is $r_p = 40$ Mpc as the distance r in a comoving volume:

$$r = c\frac{q_0 z + (q_0 - 1)[(1 + 2q_0 z)^{1/2} - 1]}{H_0 q_0^2 (1 + z)}. \tag{5}$$

Note that our value $r_p = 40$ Mpc corresponds to typical size of the galaxy superclusters. Besides, the new fractal analysis [1, 6] of the redshift surveys reveals that the galaxy clustering is described well by the fractal distribution by size $D = 2$ on scale 20–30 Mpc. So, our estimation of the characteristic size r_p in the object space distribution is close to data of other authors.

Also, we determine the characteristic time, connected with peaks of the luminosity periodicity from the expression:

$$t - t_0 = -\frac{1}{H_0}\left[z - (1.5 + 0.5q_0)z^2\right], \tag{6}$$

where t and t_0 are the values of cosmological time for the epoch z and present epoch, respectively [10]. We received that the characteristic time of the luminosity cosmological periodicity of galaxies and quasars (parameters $q_0 = 0.25$, $H_0 = 100$ km s^{-1} Mpc^{-1}) for $z_p = 0.0125$ is $t - t_0 = 1.2\times10^8$ years. This estimation of the periodicity time scale is close to our earlier analogous estimation derived by another method [9].

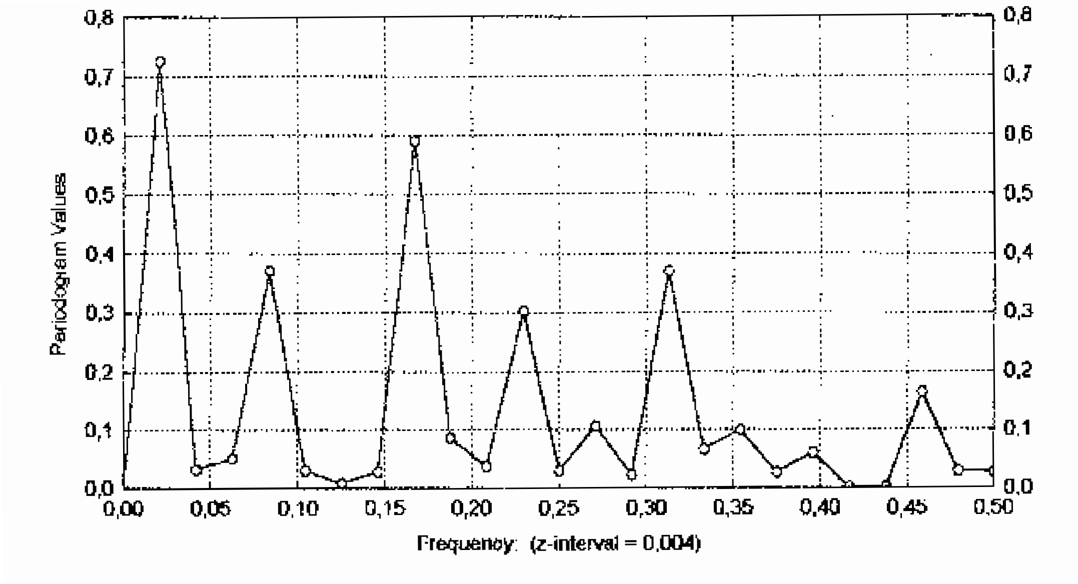

Figure 1: The power spectrum of luminosity distribution for subsample of powerful (FRII type) galaxies at 25 MHz

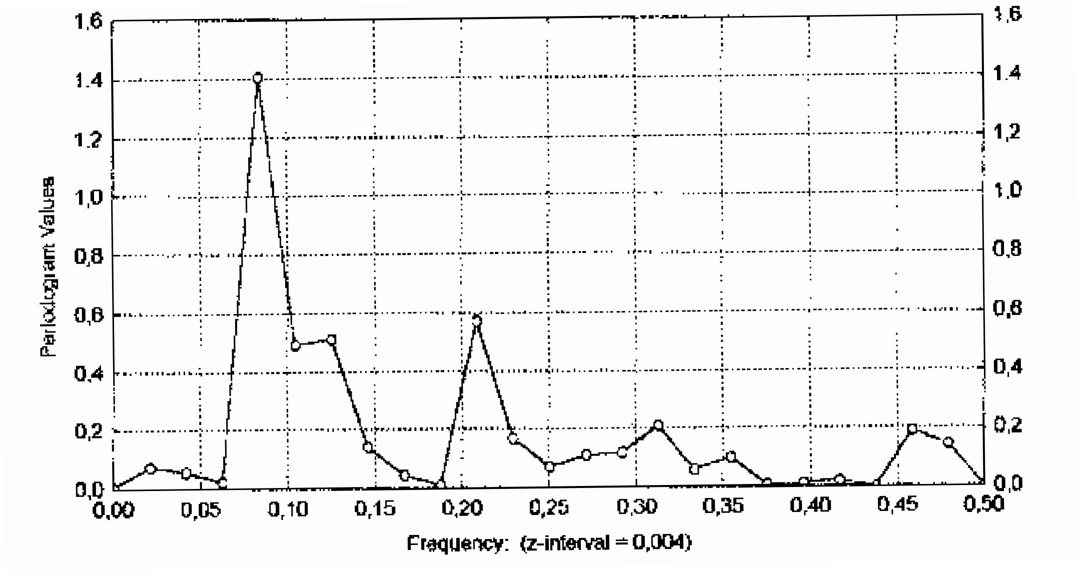

Figure 2: The power spectrum of luminosity distribution for subsample of powerful (FRII type) galaxies in optics

CONCLUSION

Our results are conformed with an assumption about the synchrotron mechanism of active nuclei radiation in wide wavelength range. It is known that time of burning down of the synchrotron radiation sources decreases with increasing of frequency. So, peak periodicity positions z_p in luminosity distributions of the same objects may not coincide in the optical and decametric ranges.

We consider the coincidence of the luminosity periodicity peak positions z_p in different frequency ranges as a manifestation of the cell Universe structure.

Distinctive peak positions z_p in the same object luminosity distributions for mutual distant frequency ranges may testify about the existence of activity recurrence for object nuclei. These nuclei have different characteristic duration of the nonthermal radiation at distant frequencies.

Thus, the cosmological periodicity in the sample luminosity distributions of galaxies and quasars may be an indicator of nuclei activity recurrence, and indicator of cell Universe structure.

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