PERIODICITY OF LUMINOSITY OF QUASARS AND GALAXIES AT COSMOLOGICAL SCALE

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ABSTRACT. We found the cosmological luminosity periodicity in decametric and optical ranges on basis of spectral analysis of luminosity distribution in quasar and galaxy samples. Comparison with known redshift periodicity for quasars and galaxies is made. Characteristic scales of luminosity periodicity are conformable to cell structure of the Universe and to activity recurrence of object nuclei.

Key words: quasar, galaxy, luminosity distribution, decametric range, cosmological luminosity periodicity, cell Universe structure, activity recurrence, synchrotron mechanism of radiation.

1. Introduction

G. Burbidge (1968) revealed the periodicity in redshift distribution of quasars. In following years number of authors confirmed the redshift periodicity of quasars, for example (Cowan 1969, Karlsson 1977). The periodicity of galaxy redshifts was found in 1990 (Broadhurst et al. 1990). Then the conclusion about connection of peaks in redshift distribution with cell Universe structure was made (Cohen et al.1996).

In this paper the periodicity of luminosity distribution of quasars and galaxies is determined in decametric and optical ranges. The calculations are carried out within the framework of Friedmann world model with parameters $q_0 = 0.25$, $H_0 = 100 km/sMpc$. We assume the synchrotron mechanism of radiation of object active nuclei in decametric and in optical ranges. Obtained estimations of characteristic parameters suppose connection of the cosmological luminosity periodicity both with cell large-scale structure of the Universe, and with recurrence of activity of galaxy nuclei and quasars.

2. Periodicity peaks of luminosity in decametric and optical ranges

During the lifetime of cosmic object an activity of its nucleus may display the cyclic changes (activity recurrence). In this case the cosmological periodicity in the object luminosity distribution should be observed. For examination of our assumption we used the statistically complete samples of 114 galaxies and 69 quasars from the UTR-2 catalogue at 25 MHz with corresponding optical data (Miroshnichenko 1994). We considered luminosity distribution of quasars and galaxies upon the redshift, which indicated on possible periodicities both in decametric and in optical ranges. The subsample of powerful radiogalaxies (FRII-type) was examined separately.

We derived power spectra (periodograms) of sample luminosity distribution at 25 MHz and in optics for quasars and galaxies. Significant luminosity peaks, connected with certain values of redshifts, were revealed in this power spectra (significance levels are from 90% to 99%), as shown in Table 1.

Four from six peak values z_p, found by us for luminosity distributions in decametric and optical ranges, agree with results by other authors for object redshift distribution (Karlsson 1977, Broadhurst et al. 1990, Duari et al. 1992, Gwyn and Hartwick 1996).Moreover, positions of three peaks in the luminosity distribution in decametric range coincide with analogous values in optical range (see Table 1). Conformity of obtained values of z_p may be caused by the cell Universe structure.

3. Space and time scales of cosmological periodicity of quasar and galaxy luminosities

As follows from our data, the redshift values z_p, corresponding to periodicity peaks in luminosity distributions of quasars and galaxies in decametric and optical ranges, are from $z_p = 0.0125$ to $z_p = 2.222$. We assume, that revealed values z_p are multiple to the least from these, and determine space and time scales of the cosmological periodicity in object luminosity distribution.

The characteristic size r_p in object space distribution, associated with luminosity periodicity, is found at Friedmann Universe model with parameter q_0 = 0.25 and Hubble constant $H_0 = 100 km/sMpc$ for z_p = 0.0125 as distance (Zeldovich and Novikov 1975) in comoving volume:

$$r_p = c\frac{q_0 z_p + (q_0 - 1)[(1 + 2q_0 z_p)^{1/2} - 1]}{H_0 q_0^2 (1 + z_p)} \qquad (1)$$

It is received from (1), that r_p = 40 Mpc. This value of r_p is close to the characteristic size of galaxy supercluster. As we know, chains of these superclusters form the cell large-scale Universe structure, so the size of large-scale inhomogeneities in object distribution may be multiple to supercluster size. It should be noted, that galaxy clustering is described well by fractal distribution with dimension D = 2 at scale 20-30 Mpc (Amendola and Palladino 1999, Joyce et al. 1999). So, the estimation of value r_p conforms with data of other authors, concerning characteristic scale in space object distribution.

Let us consider, that quasar and galaxy distribution is inhomogeneous, that is fractal at the scale r_p = 40 Mpc, with the fractal dimension D = 2. Then we determine "correlation length" r_0 - the scale, at which the correlation function of object space distribution (in sphere by radius r) must be $\xi(r_0) = 1$ (Sylos Labini and Amendola 1996):

$$r_0 = [(3 - \gamma)/6]^{1/\gamma} r, \qquad (2)$$

where γ = 3 - D. Hence, at $\gamma = 1$ and $r = r_p$ it is received, that r_0 = 13.3 Mpc. It is known, that values of "correlation length" for space distribution of objects are next: r_o = 6-10 Mpc for galaxies and quasars, and r_0 = 18 Mpc for galaxy clusters (Peebles 1980). So, our estimation of value r_0 by value r_p is conformed with literature data.

We define the time scale, connected with obtained cosmological periodicity of luminosity from expression:

$$t_p = t - t_0 = -\frac{1}{H_0}\left[z - (1.5 + 0.5q_0)z^2\right], \qquad (3)$$

where t, t_0 - is the cosmological time for epochs z and $z_0 = 0$ (our epoch), respectively (Zeldovich and Novikov 1975). At parameters $q_0 = 0.25$ and $H_0 = 100 km/sMpc$ for $z = z_p = 0.0125$ it is obtained, that characteristic time of the cosmological periodicity of luminosity is equal $t_p = 1.2 \cdot 10^8$ years. This time scale allows an existense of the activity recurrence of galactic nuclei and quasars. The value t_p is close to period of galaxy rotation ($\simeq 2 \cdot 10^8$ years).

Also, the value t_p is conformed with estimations of the quasar stage duration ($10^7 - 10^8$ years) (Martini and Weinberg 2001, Haiman and Hui 2001). Besides, the obtained value t_p corresponds to the estimation of time variation in relationship of dust and gas masses for spiral galaxies ($10^7 - 10^8$ years) (Hirashita 2000). This fact may be significant evidence of the activity recurrence of objects.

According to synchrotron mechanism of the object radiation (Kardashev 1962), positions of periodicity peaks of luminosity distributions in optical and decametric ranges may not coincide due to decrease of the time of synchrotron radiation decay t_d with increase of frequency:

$$t_d \simeq 340 B^{-3/2} \nu^{-1/2}, \qquad (4)$$

where B - is magnetic field strength in source of radiation, that is, in object (μG), ν - is frequency (MHz), t_d - is in units 10^9 years. Let us estimate difference of the times of synchrotron radiation decay for the same relativistic electron ensemble in source in decametric and optical ranges. If the strength of magnetic field in the source is supposed be equal $B = 10^{-5}$ G, then the difference of corresponding times of synchrotron radiation decay (by formulae (4)) is: $\Delta t_d = 1.18 \cdot 10^8$ years at considered frequencies 25 MHz (decametric range) and $5.45 \cdot 10^8$ MHz (optical range). With assistance of expression (3) for Friedmann world model at $q_0 = 0.25$ and $H_0 = 100 km/sMpc$, we found that given difference of times of synchrotron radiation decay corresponds to the redshift difference $\Delta z_d = 0.013$. Everybody can see, the analogous difference of radiation decay times is $\Delta t_d = 3.69 \cdot 10^9$ years at strength of magnetic field $B = 10^{-6}$ G, so the corresponding redshift difference is $\Delta z_d = 0.264$.

Thus, the difference in positions of corresponding luminosity peaks upon redshift may change from $\Delta z_d \simeq 0.01$ to $\Delta z_d \simeq 0.3$ in decametric and optical ranges. Inhomogeneities of magnetic field in sources, and different values of magnetic field strength in different objects of our sample may cause additional variations of the value Δz_d, that is incoincidence of corresponding luminosity peak positions observed in two frequency ranges.

4. Conclusion

Results of our examination for luminosity distribution of quasars and galaxies in decametric and optical ranges indicate on cosmological periodicity of luminosity of these objects with the time scale $\simeq 10^8$ years and the space scale $\simeq$ 40 Mpc. We note the conformity in positions of peaks of luminosity periodicity and known redshift periodicity of quasars and galaxies. The accomplished analysis of luminosity periodicity in decametric and optical ranges allows to consider the cosmological periodicity of luminosity as evidence on cell Universe structure and on activity recurrence of objects.

Table 1: Values of redshifts z_p, corresponding to significant peaks in power spectra for luminosity distributions of galaxies and quasars.

Objects of samples	Decametric(25MHz) range	Optical range
Galaxies	0.200	0.0125
Galaxies FRII	0.192	0.048
Quasars	1.124	1.124
	2.222	2.222
		0.448
		0.224

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