NATURES ON THE FLUCTUATIONS OF THE INTENSITY OF MICROWAVE FROM TWENTY EIGHT QUASARS

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We researched on the fluctuations of the intensity of the microwave of quasars which have very active nuclei. The scale of the microwave source ranges from 10^{-1} to 10^{+3}pc. The quasars we researched into are twenty eight, distributing by redshift z from z = 0.070 to z = 2.365, or by light years from 1.26 to 17.2 billion at a condition of 50km/s/Mpc Hubble constant in Euclidean space. We analyzed the fluctuations of the microwave at the frequencies ν = 2.695GHz and 8.865GHz, which were observed daily from 2 February 1984 to 20 November 1986 for 1024 days with Green Bank interferometer by a team of Naval Research Laboratory, Washington DC, USA./1/ We used for analysis the time series of the 1024 elements for the twenty eight quasars.

We analyzed the fluctuations by three methods: (1) the power spectral density by FFT analysis in the frequency range between $f = 1\text{x}10^{-8}$Hz and $6\text{x}10^{-6}$Hz, (2) the fractal dimension by Higuchi method/2/ and (3)Hurst exponent by the R/S analysis/3/.

We found that most of the power spectral density of the fluctuations follow the power law $1/f^{\alpha}$ with the exponent α according to the frequency f ,/4/ and we calculated the exponent for all of the quasars in the range $10^{-7}\text{Hz} < f < 10^{-6}$Hz because of statistical reliability. The spectral indices α are distributed between 0.2 and 2.3 for all of the fluctuations of the microwave intensity. It attracts attention that the indice α becomes small with increase of the redshift for 8.865GHz microwave (Fig.1), but the situation of 2.695GHz microwave cannot be decisively judged in the same way other than referring that an astronomer believes that 2.695GHz microwave may be modified by the scintillation effect of our galaxy./5/

Using the same time series we calculated the fractal dimension D for all of the fluctuations. The summation amount of the absolute change in the time-series elements by interval k is averaged for the whole period and the amount is normalized by dividing by k to give $L(k)$, the averaged amount of it being $< L(k) >$ ./2/ For all of the fluctuations the amount $< L(k) >$ was proportional to k^{-D}, or $< L(k) > \propto k^{-D}$. We found that the fractal dimension D takes a value between 1.6 and 1.8 for 2.695GHz wave and between 1.7 and 1.9 for 8.865GHz wave (Fig.2(a)) both in the running-averaged value of seven fractal dimensions,

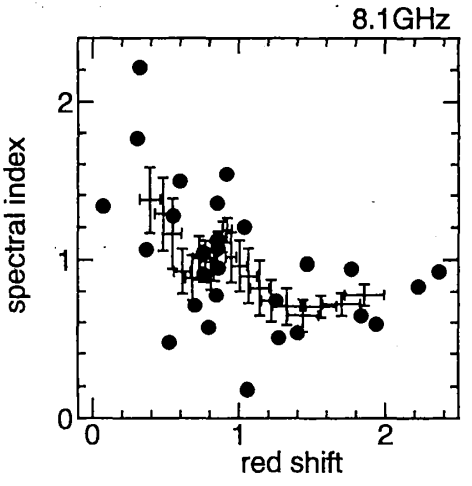

Fig.1 Redshift and spectral index.

and surprisingly, the fractal dimension increases monotonously as the redshift increases, with a saturation of D over redshift z= 1.4, for both microwaves. This shows that the randomness of the fluctuations becomes higher as the redshift increases. To make sure of it, we examined a dependence of the fractal dimension on the right ascention and declination and on the galactic longitude and galactic latitude, and compared it with a technical and artificial dependence of the redshift on the right ascention and declination and so on. As a result, we found that the dependence is entirely on the redshift, and not on the right ascention and declination and so on.

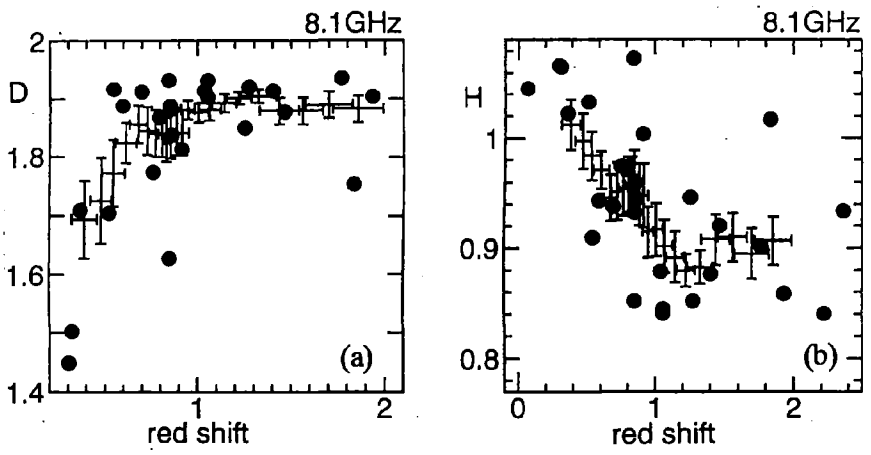

Fig.2 Redshift and (a)fractal dimension D, and (b)Hurst exponent H.

Between the dimension D and the index α, the relations $D = (5 - \alpha)/2$ for $\alpha > 1$ and $D = 1$ for $0 \leqq \alpha \leqq 1$ theoreticaly stand./2/ The calculated result qualitatively agrees with it for the both microwaves.

Using the same time series, we calculated Hurst exponent H for all of the fluctuations. Accumulating the difference of the time-series elements from the average of them in interval N, the difference between the top and bottom levels in the interval gives the range R. The ratio of the range R with the standard deviation S of the time series in the same interval N, the average of the ratio R/S by [1024/N] intervals is proportional to N^H, H being Hurst exponent, or $\langle R/S \rangle \propto N^H$./3/ Surprisingly, we found that Hurst exponent of the fluctuations is a monotone decreasing function of the redshift for the both microwaves. (Fig.2(b)) The fractal dimension and Hurst exponent have theoretically an inverse relation ($D = 1/H$)./3/ Our result agrees very well with it though it does not follow $D = 1/H$ tight.

We conclude from the analysis of the fluctuations by the three methods that the randomness of the fluctuations increases as the quasar approaches the big bang (the origin of the universe). If the fluctuations are not modulated by the medium between the quasar and our galaxy, the conclusion reflects an evolution of the structure in the quasars.

References

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