PEAKS AND PERIODICITIES IN THE REDSHIFT DISTRIBUTION OF QUASI-STELLAR OBJECT

D. DUARI, P. DASGUPTA AND J. V. NARLIKAR
Inter-University Centre for Astronomy and Astrophysics
PB-4, Pune-411 007, India.

1. Introduction

There have been claims from time to time that there are periodicities in the redshift distribution of QSOs. These claims are examined from various statistical angles for a sample of 2164 QSO redshifts, with redshifts lying in the range 0.025 – 4.43 taken from the latest compilation (1993) by Hewitt & Burbidge. We have not included QSOs whose redshifts were obtained by 'grism' technique, because of a possible selection effect (Scott 1991). For our analysis we use several staistical techniques, including the Burbidge - O'Dell type Power spectrum analysis (1972), the Rayleigh test, the Kolmogorov-Smirnov test, and the so called 'Comb-tooth' template test. the tests are not inter related and have the advantage of checking the claim for nonuniformity of the distribution from various independent angles. We have also carried out Monte Carlo simulations of the redshift distribution of QSOs to check for any systematic effect that can give rise to a spurious periodic effect.

2. Tests and Results

The Power spectrum analysis gives two peaks of the spectral power function that exceeds 90 % confidence levels. The two peaks corresponds to a periodicity value of $\xi = 0.0565$ and 0.0129 with confidence level of 90.21% and 98.28% respectively.

The generalized Rayleigh test involves the analysisi of phases in the signal (i.e., the number counts of the QSOs against their redshifts) and helps to fine tune the value of the periods obtained by power spectrum analysis. The result of this test showed the presence of the periodicity of 0.0565 with confidence level exceeding 99%. The test showed two other

M. Kafatos and Y. Kondo (eds.), Examining the Big Bang and Diffuse Background Radiations, 555–557.

https://doi.org/10.1017/S007418090011068X Published online by Cambridge University Press

periods, that of 0.0121 and 0.0127 for two different degrees of freedom for which the test was carried out.

The Kolmogorov-Smirnov test yielded a result in favour of the claim of presence of a periodicity in the data and showed a strong rejection of the null hypothesis of an expected uniform distribution of QSO redshifts.

The Comb-Template test was constructed keeping in mind our requirement of checking the presence if any, of a periodic signal in the observed redshift distribution. It is especially suited to detect periodicity. We consider a comblike template with "teeth" at regular intervals, which is made to slide across the redshift histogram. If the period of the comb matches the underlying periodicity of the histogram, then we expect to see peaks arising when and only when there is a tooth for tooth matching between the two distributions. The test showed the presence of a periodicity of $\xi = 0.0565$ with a 4.1σ level of significance.

The question of redshift periodicity, its validity and cause can be put to tougher challenge if one takes into account all the factors that can creep into the observational data due to the solar system's position and motion in the Milky way galaxy. Using the value of the circular speed of Local Standard of Rest (LSR) with respect to the Galactic Centre(220 ± 19 km s^{-1}; Fich et al, 1989) and the solar system velocity with respect to the LSR (20 km s^{-1} towards $\alpha = 18^h$ and $\delta = 30°$; Kerr and Lynden-Bell, 1986), redshift reduction to the Galactocentric frame was carried out for all the QSOs under investigation. It should be emphasized that with the reduction to the Galactocentric frame, the statistical significance of $\xi = 0.0565$ actually increases. These results lend a greater confidence to the reality of the effect. Moreover, even after considering the error in determining the solar velocity, the effect persists, and in all the cases the confidence level for both $\xi =$ 0.0565 and 0.0129 increases.

We next considered the hypothesis of periodicity in $\ln(1+z)$, especially to test the claim that a periodicity of $\Delta\ln(1+z) = 0.206$ is present in the QSO redshift distribution (Arp et al, 1990), but failed to detect any significant periodic signal in the $ln(1+z)$ distribution.

To check whether the periodicity obtained is an artifact due to the statistical tests and to look for any systematic bias in the chosen sample which can produce a periodic effect, we took help of large number of Monte Carlo simulations. From these simulations it was found that there seems to be no systematic effect in the sample we have chosen that can give rise to a spurious periodic signal not present in the actual data; and moreover, our statistical tests are not biased towards picking up periodic signals around the $\xi = 0.0565$ value.

3. Conclusion

Our various statistical tests and Monte Carlo simulations confirm an underlying spiky nature of the redshift distribution of QSOs. There is considerable evidence to support the claim of periodicity of $\xi = 0.0565$ and also perhaps of a periodicity in the range 0.0121–0.0129. The former periodicity, which survives with greater confidence level when the redshifts are transformed into Galactocentric frame, is close to that observed by Burbidge (1968) in a much smaller sample. It is extremely difficult to draw any deeper conclusion from the results, beyond stating the fact that the peaks and periodicities have withstood the challenge of various researchers, and have remained for more than two decades despite the enormous increase of the data.

References

Arp, H. , Bi, H. G., Chu, Y., Zhu, X. 1990, *A & A*, **239**, 33
Burbidge, G. R. 1967, *ApJ*, **147**, 851
Burbidge, G. R. 1968, *ApJ. Lett.***154**, L41
Burbidge, G. R., and O'Dell, S. L. 1972, *ApJ*, **178**, 583
Fang, L. Z., Chu, Y., Liu, Y. and Cao, C. 1982, *A& A*,**106**, 287
Fich, M., Blitz, L., and Stark, A., 1989, *ApJ*, **342**, 272
Hewitt, A. and Burbidge, G.R. 1993, *ApJS*, **87**, 451
Kerr, F.J., and Lynden-Bell, D., 1986, *M.N.R.A.S.*, **221**, 1023
Scott, D. 1991 *A&A*, **242**, 1

https://doi.org/10.1017/S007418090011068X Published online by Cambridge University Press