Redshift periodicity and its significance for Recent observation

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ABSTRACT

Recent observational evidence in extra galactic astronomy, the interpretation of the nature of quasar redshift continues to be a research interest. Spectrum observation of high redshift quasar is young in nature. Observational evidence discusses on physical interpretation of redshift periodicity with statistical confirmation. Karlsson observed redshift periodicity at integer multiples of 0.089 in log scale and Burbidge observed redshift periodicity integer multiple of 0.061 in linear scale. Data analysis is important in order to form correct interpretations of the observed phenomena. Since Singular value decomposition (SVD) based periodicity estimation is known to be superior for noisy data sets, especially when the data contains multiple harmonics and overtones, mainly irregular in nature, we have chosen it to be our primary tool for analysis of the quasar-galaxy pair redshift data. Kernel density estimation has been performed for estimating the bin width as proper computation of this quantity is crucial for the correctness of the analysis and prevention of over-smoothing of the data. We observed fundamental periodicity to be an integer multiple of 0.063 and 0.0604 using method1 and method2 in the transformed quasar redshift data with 95% confidence interval in linear scale. Our results clearly establish that redshift is quantized for quasar-galaxy pair data and its histogram exhibits periodic peak(s). At last briefly discussed on physical interpretation of quantized redshift for quasar and galaxy. Hoyle Narlikar theory of gravity explain the Mystery in recent observation.

Keywords: Quasar, Galaxy, Distance and Redshift, Large scale structure of universe

1. INTRODUCTION

The cosmological hypothesis defines the total observed redshift as:

\[(1 + Z) = (1 + Z_c)(1 + Z_{NC})\]  

where \(Z\) is the total observed redshift, \(Z_c\) is the redshift due to cosmological contribution and \(Z_{NC}\) is the redshift due to non cosmological origin by Bell.M.B & Fort.D.N (1973). According to standard theory, quasar redshifts are caused by expansion of the universe. If one plots quasar redshift against apparent brightness, one gets a non-linear relation which implies that linear Hubble relation is not valid for high redshift quasar by Roy et al. (2007); Roy et al. (2000).

H Arp observed the physical association of quasar and galaxy (Refs. Arp 1966). Interestingly however, it has been observed by Arp that two different objects in the universe quasi stellar object (QSO) and galaxy are close to each other but have different redshifts. An observational evidence of quasar of \(Z=2.114\) was found very close to the nucleus of the galaxy NGC7319 with \(Z=0.022\). In general, Gravitational lensing explains the association of high redshift quasar with galaxy in a few cases but Arp has observed filaments connecting the high redshift quasar with low redshift galaxy; prominent examples being NGC4319 and MK205, NGC 3067 and 3C232 etc. Some quasars exhibit jets of unknown nature (3C345 in the vicinity of NGC6212), while in some cases, moving structures were found be radio observation along with jets. Lopez observed (Refs. López-Corredoira & Gutiérrrez 2004) two emission line objects with redshift greater than 0.2 in the optical filament apparently connecting the Seyfert galaxy NGC 7603 (\(Z=0.029\), NGC 7603B (\(Z=0.057\)) to its companion, this leads to possible examples of anomalous redshift. Majority of the findings lead to the conclusion that quasars are ejected from galactic nuclei and redshift is an intrinsic parameter. This naturally raises
doubts regarding our current understanding of the significance of the redshift. There are two possible interpretations of physical association; either QSOs with different redshift are objects at different distances, or, non cosmological redshift accounts for QSOs possessing different redshifts at the same distance.

After the discovery of quasars, they were assigned great physical distances because of their high redshifts (Refs. Matthews & Sandage 1963). However, evidence started to emerge that they were ejected from nearby galaxies and their redshifts were intrinsic (Refs. Arp 1966). If purely intrinsic, it would yield a redshift –distance relation of redshift as inverse of age squared (Refs. Arp et al. 1990). Recent geometric tests of the redshift –distance relation (Refs. Anderson et al. 2012) too lend support to this theory. Another explanation provided by (Refs. Narlikar & Das 1980), (Refs. Arp et al. 1990) claim that high redshifts have an intrinsic component which might be emitting radiation from matter of an younger age. Many researchers (Refs. Narlikar & Arp 1993; Arp 2003; Napier & Burbidge 2003; Galianni et al. 2005) argue in favour of quasars ejected from galactic nuclei.

Current theories predict the evolution process, that supermassive black holes begin their lives in the dust-shrouded cores of vigorously star-forming "starburst" galaxies before expelling the surrounding gas and dust and emerging as extremely luminous quasars. Recently observed GNz7q by (Refs. Fujimoto 2022), has exactly both aspects of the dusty starburst galaxy and the quasar. This observation lacks various features that are usually observed in very luminous quasars. The central blackhole of GNz7q is still in a young and less massive phase at high redshift.

Next GN-z11 (Refs. Linhua, Jiang et al. 2021) was photometrically selected as a luminous star-forming galaxy candidate at redshift $z > 10$ is known to be "oldest galaxy". The age of GN-Z11 is estimated to be only 70 million year and moderately massive suggest that this young galaxy was born and grew rapidly, also the fact the evidence of carbon and oxygen in GN-Z11 indicates that this galaxy is not the first (metal-free) galaxy in the universe also direct that it is second generation of galaxy. The detected light of carbon and oxygen suggest special physical condition not found in present day galaxies. Its accurate redshift remained unclear.

Also observation of metallicity evolution at high redshift quasar (Refs. Juarez 2009) raise the question on evolution process. Their observation conclude that abundance of carbon relative to silicon and oxygen also does not evolve significantly.

2. METHODOLOGY

2.1. Proposed Method

H. Arp (Refs. Arp 1994; Arp et al. 2001) observed that a cluster of high redshift quasars appears to be physically connected with a lower redshift galaxy. He claimed that their redshifts do not indicate distance and furthermore, redshifts of those clusters are quantized and obey a simple formula:

$$\frac{1 + Z_{k+1}}{1 + Z_k} = 1.227$$

where $Z_k$ is the redshift of a quasar and $Z_{k+1}$ is the next higher redshift. Karlsson (Refs. Karlsson 1977) observed that the peaks of the histogram of the redshifts, form a mathematical series $Z = 0.061, 0.3, 0.6, 0.96$. Hawkins (Refs. Hawkins et al. 2002) found non existence of periodicity, but their methodology was challenged by Napier (Refs. Napier & Burbidge 2003). Next, Tang (Refs. Tang & Zhang 2005, 2008) claimed the non- existence of periodicity with a dataset that was 15 times larger than the previous one. Duari (Refs. Duari et al. 1992; Duari 1997) found redshift periodicity statistically. Fulton (Refs. Fulton et al. 2018) explains redshift periodicity using ejection velocity computations. Mal (Refs. Mal et al. 2020) have already shown the existence of periodicity of redshift for quasar as well as for galaxy; here we have analysed the data for quasar-galaxy pair datasets and try to understand the physics behind the quantization of redshift in such datasets.

We examine the existence of redshift periodicity in quasar-galaxy pair data following the procedure outlined here. After the initial selection of data in accordance with the flag values provided, selection of the bin width for formation of the histogram is optimized as in (Refs. Shimazaki & Shinomoto 2007, 2009) minimizing the cost function for the overall data set of Solan Digital Sky Survey’ sample (SDSS DR-7). Next, an SVD- based method (Refs. Kanjilal & Palit 1995) has been adapted for estimating the fundamental periodicity present in the histogram of the red shift data. (Refs. Mal et al. 2020) have established the superiority of the SVD based approach of periodicity detection over the periodogram-based approach. The periodogram is not a suitable tool for data of a quasi-periodic nature or a dataset containing multiple periodic components and a large number of overtones or a somewhat irregular periodic part. Hence,
periodicity detection for the quasar-galaxy pair data examined in this article has been performed using the SVD based method.

2.2. Description of dataset

The SDSS DR7 database contains information pertaining to galaxies with low redshift -quasar pair, where the quasars are projected within 100 Kpc of the galaxy. A total of 97489 galaxy/ quasar pairs are reported from a sample of 105783 spectroscopic quasars and 798948 spectroscopic galaxies. This database contains spectroscopically observed galaxy/quasar projections that can be used to study quasar absorption-line systems arising from known galaxies with redshifts between 0 < Z < 0.6 and quasar redshifts 0 < Z < 3.5.

2.3. Data selection

The quasar and galaxy redshift data was collected from SDSS DR-7 (Refs. Cherinka & Schulte-Ladbeck 2011 )and redshifts corresponding to Ca-II and Na-I flags showing warning were rejected. Narlikar (Refs. Narlikar & Arp 1993) explain that if quasars are physically connected with a parent galaxy, the redshift of each quasar must be transformed to reference frame of the putative parent as:

\[ 1 + Z_0 = \frac{1 + Z_c}{1 + Z_p} \]  

(3)

where \( Z_0 \) is the transformed quasar redshift, \( Z_c \) is the observed companion quasar redshift and \( Z_p \) is the observed redshift of the object. The data was transformed to rest frame as proposed by (Refs. Narlikar & Das 1980) according to equation (3). The transformed quasar redshift data \( Z_0 \) with values greater than 0.8 were selected for further processing, in order to avoid the possibility of mistakenly including galaxy redshift data.

2.4. The procedure for analysis

As proposed by Mal (Refs. Mal et al. 2020), the two main stages of the approach consist of the formation of an appropriate histogram after determining the optimal bin width and application of SVD for periodicity determination. For the convenience, the procedure is briefly outlined here.

**Determination of optimal bin width and histogram formation:** The optimal bin width is obtained by minimizing the mean integrated square error (Refs. Shimazaki & Shinomoto 2007, 2009) for the entire data set. optimum binwidth is 0.0029 for the Analysis of transformed quasar redshift data.

**Matrix formulation & application of SVD:** In order to examine the existence of a periodic component, candidate period lengths are selected and the input matrix for application of SVD, formed accordingly. For a candidate period length of say, \( L \), the corresponding data matrix \( A \) is formed by partitioning the data into contiguous segments of length each and placing each segment (aligned in phase) as a row of \( A \). This matrix is used for singular value decomposition. We follow two approaches outlined below: Our first method (SVR1) is defined as the ratio of the first two singular values. A plot of this ratio versus row length is called the SVR1 plot which shows the presence of multiple peaks at integer multiples of the value of the fundamental red shift. The second method (SVR2) for measuring periodicity is defined as the ratio of residual energy to the energy content of the aperiodic signal. The plot of this quantity versus row length is called the SVR2 plot which shows repeated peaks at integral multiples of the value of the fundamental red shift.

3. RESULTS OF SIMULATIONS

The fundamental period of the periodic component present is determined as the product of the peak location of the histogram and the optimal bin width. A peak location is selected as the base period if peaks are also observed at integral multiples of that peak location. The 95% confidence interval of the base period was determined using resampling of the transformed redshift values \( Z_0 \). A Monte Carlo type simulation was conducted over 1000 iterations to compute the confidence interval. The simulations confirm that the reported periodicity of 0.063 has a 95% confidence interval of [0.0402, 0.0891] using the first method SVR1 and 0.0604 using the second method SVR2 in the interval of [0.0604, 0.0661]. The SVR spectrum exhibits the periodic peak as shown in Figure 1 and Figure 2. The redshift periodicity of quasar has been observed without transformation in the redshift range \( z > 0.03 \). The quasar redshift periodicities having the values 0.0906 and 0.1533 has been detected within the 95% confidence intervals of [0.0744, 0.1114] (using method1) and [0.1259, 0.1811] (using method2). Moreover, the redshift periodicity of galaxies have also been observed in this dataset within the redshift range of (0.03 < z < 0.1) of base periodicity 0.0015 and 0.0032 using method1 and
method2 corresponding to 95% confidence interval of [0.0018, 0.0045] and [0.0029, 0.0085], respectively. Apart from that, galaxy redshift periodicity of 0.0032 and 0.0044 has been observed using the method1 and method2 corresponding to 95% confidence interval of [0.0024, 0.0149] and [0.004, 0.0162] in the range of (0.1 < z < 0.2) respectively.

Some salient observations are as follows. Firstly, the existence of at least one periodic component is observed for several ranges of redshifts of quasars and galaxies, secondly observation may be made regarding the presence of additional periodic components which are noticed in Fig.1 (identified as red and pink vertical marker). This is confirmed by a secondary strong peak and a peak occurring at a location, which is a multiple of the location of the secondary peak 0.077 identified in pink colour, whereas primary peak at integer multiple of 0.0603 identified in Red colour. The redshift periodicity of quasars and galaxies may indicate that evolution of quasars into galaxies have occurred over time.

![Figure 1. Quasar Galaxy pairs SVR Spectrum : SVR1](image1.png)

![Figure 2. Quasar Galaxy pairs SVR Spectrum : SVR2](image2.png)

4. PHYSICAL INTERPRETATION AND DISCUSSION:

4.1. Interpretation of the result

Physical interpretation of redshift periodicity confirm the objects which have same redshift are physical members of same clusters, or evolution of quasar is concentrated about epochs spaced in this way, i.e it must have some sort of "periodic "structure / "crystalline" structure or It can be interpreted that non cosmological origin is more stronger than other components of redshift as discussed in equation 1.
4.2. Discussion

There are two conventional alternatives to account for the discretization of redshift or anomalous redshift of QSO, one is Doppler shift and another one is gravitational redshift, but they cannot explain physical association of low redshift galaxy with multiple QSOs and evolution process.

The extremely active field of gravitational lensing has also made rapid strides in locating and imaging of a variety of lensed quasars at various wavelengths. High resolution radio imaging was used by Kratzer (Refs. Kratzer et al. 2011) to resolve a large separation lensed quasar at \( Z = 2.197 \). Zimmer (Refs. Zimmer et al. 2010) used archival Chandra data to construct an x-ray light curve of all four images of the quadruply lensed quasar at \( Z = 1.695 \). High energy gamma rays were used for gravitational lensing for the first time by Barnacka (Refs. Barnacka, A. et al. 2011). Corredoira (Refs. López-Corredoira & Gutiérrez 2006) propose weak gravitational lensing by dark matter as the cause of the statistical correlation between low and high redshift object. However,Scranton (Refs. Scranton et al. 2005) have contradicted them and claimed that the correlation found was an ad-hoc fit of the halo distribution function to an angular cross correlation with very small amplitude of the galaxy selected photometrically. Even to this day, standard cosmology is unable to provide an explanation for the correlation of galaxies and QSOs. Gravitational lensing explains the association of a high redshift galaxy with a single quasar using the standard cosmological model but fails to explain multiple gravitational lensing within the galaxy.

The generally accepted idea is that a galaxy is surrounded by background QSOs. However the question of statistical analysis of the background /foreground object probability in a small area distributed according to its position and average density in any line of sight, raises much controversy in the astrophysical community. The main approach here is to demonstrate that two extragalactic objects with very different redshifts may be physically neighbors in reality. The physical association of quasar and galaxy is an example of the two cosmological objects being neighbors of each other.

Physical association of quasar and galaxy also explain using super massive black hole(SMBH) and Active galactic Nuclei(AGN). SMBH can grow in size up to billions of solar masses from “seed”, the grow process depend on feeding mechanism from surrounding gas, Astronomer think that every galaxy have extremely bright centre region called Active galactic Nuclei(AGN) and think that they are powered by SMBH in their centre. The most luminous of all the AGN are quasars. Recent discovery of J0313-1806 discovery leads to a question of formation of it. J0313-1806 is thought to sit inside a galaxy with a very active region, the host galaxy produces 200 solar masses worth of star per year. The SMBH that powers this quasar formed just 670 million year after Big-Bang, which ask question on how “seed” grew from to form and how this black hole stellar !. Next researchers propose alternative mechanism called ‘direct collapse’, but truth is unknown.

One of the outstanding mysteries in astronomy today is: How did supermassive black holes, weighing millions to billions of times the mass of the Sun, get to be so huge so fast at the edge of universe.

Recent observations of extra-galactic objects that do not appear to be consistent with the cosmological hypothesis that their redshifts arise from the expansion of the universe.

Our statistical analysis of redshift data clearly establishes the existence of discrete redshift using quasar galaxy/ pair red shift dataset. In the view of the above difficulties with the conventional model, we look for alternative models which can explain the periodicity of redshifts. One such model is proposed as by Hoyle-Narlikar (Refs. Narlikar & Das 1980; Hoyle & Narlikar 1964, 1966) which tries to explain the periodicity of redshifts based on Variable Mass Hypothesis(VMH). According to this, the inertia of matter arises due to interaction of other matter in the universe, the matter created from zero mass surface based on quantum principle. The excess redshift does not Aries from high speed of ejection but from the low mass of the newly created matter. Narlikar (Refs. Narlikar & Das 1980)explain that the ejected QSO can be bound to the parent galaxy with typical separation of the order of 100-200kpc.Hoyle (Refs. Burbidge et al. 1999) explain redshift periodicity using variable mass hypotheses. Redshift periodicity is a direct confirmation of the fact that quantization in redshift implies quantization in mass.VMH theory predict that the age of an object usually measured from zero mass epoch on its world line hence higher the redshift of quasar younger it is, this is well matched with recent observation of extragalactic objects: HD1,HD2,GNZ7Q,GNZ11.

Another model proposed and elaborated upon by Roy et al. (Refs. Roy et al. 2007; Roy et al. 2000) based on Wolf mechanism is known as Dynamic Multiple Scattering (DMS) theory. It is shown in a recent paper that DMS can explain the redshift for Galaxy-Quasar association. This depends on the property of the environments around galaxies as well as that of quasars. This mechanism mimics Doppler shift even in the absence of relative motion of the observer and the source.
Wolf (Refs. Wolf 1986) explains correlation induced spectral shift as well as the broadening and shifts of the spectral line. Roy et al. (Refs. Roy et al. 2007; Roy et al. 2000) analyzed statistically the Veron-Cetty (V-C) quasar catalogue (2006) and SDSS DR3 data set and concluded that the Hubble law is linear up to small redshifts less than 0.3 (\( z < 0.3 \)) but nonlinear for higher redshift, which adds fuel to the cosmological debate. Roy et al. (Refs. Roy et al. 2000) explain the broadening of the spectral line using dynamic multiple scattering. They also found a critical source frequency below which no spectrum can be observed for a particular medium. The broadening due to multiple scattering is more than the shift due to cosmological effect. In our future works we will discuss the possible explanation of periodicity of redshifts within DMS framework.

There are two fundamental objection against the ejection hypotheses. First, in the ejection model, ejection is always away from us means redshifted. second, The apparent velocity difference is a large fraction of the speed of light. Many researchers has explained the 1st problem using different selection mechanism, also this is well explained using wolf effect based method. The spectral shift of quasar depend on the surrounding scattering medium of quasar and ejection angle. Peter M (Refs. PeterM 2006) explain apparent redshift components of quasar-galaxy association using parametric model in the wolf framework. The second problem does not exist in the relativistic slingshot process by Saslaw (Refs. Saslaw 1974) of ejecting black-hole.

5. CONCLUSIONS AND FUTURE WORK

We have observed the existence of redshift periodicity in quasar / galaxy pair redshift data without transformation, also the existence of periodicity in this data can be clearly perceived upon analyzing it after transformation to rest frame. Since data binning has been performed using kernel density estimation method and not in a heuristic fashion, our results directly contradict the proposition reported by some papers that redshift periodicity observed is actually due to selection effect of the data binning by Basu (Refs. Basu 1978). other kind of noise in the data may be influence to redshift periodicity due to that fundamental periodicity may be within the band. The most significant contribution of the present work is the analysis of the paired redshift data and its periodicity detection and estimation using an SVD based approach rather than the conventional Periodogram/FFT based approaches. The applicability of this approach, also used in Mal et al. (Refs. Mal et al. 2020) is further vindicated by the present results. It thus proves to be invaluable for astronomical data analysis since it is able to reveal hidden periodicities better than traditional approaches hence leading to correct interpretation of the data. Fulton (Refs. Fulton et al. 2018) has proved the existence of Karlsson peaks using the ejection velocity constraint but it may be noted that the proposed work gives a direct way of estimation of redshift periodicity. This article confirms the existence of redshift quantization in quasar-galaxy associated dataset and supports the Hoyle-Narlikar model (Refs. Hoyle & Narlikar 1964, 1966) and Narlikar–Das cosmological model (Refs. Narlikar & Das 1980) and (Refs. Burbidge et al. 1999) that quasars are ejected from galactic nuclei and explain the process of evolution.

Recent observational result should be mentioned that most distance quasar are most metal deficient, but surprinsigly high metal abundances were found in high redshift quasar. The question are how metal produced by rapidly evolved stellar population around quasar, so soon after the bigbang. The only way to produce heavy elements are known nuclear process at large stage of their evolution. Satndard theory can not explain the above observation, if redshift is not intrinsic parameter.

Also if quasar are at cosmological distances, the velocities of these moving structure should be super luminous on the otherhand if it is local origin the ” super luminous” velocities will be reduced below the velocity of light.

Presently cosmologists are greatly interested in understanding the source of Lyα forest and environment surrounding the galaxy. In order to answer the question of how the forest arises, the variable mass hypotheses explains that lower redshift quasar implies larger and older mass whereas a higher redshift quasar is younger and possesses smaller mass. In contrast to the standard model, the absorption feature in Lyα forest should exhibit peaks at multiples of base periodic component (Refs. Karlsson 1971, 1973, 1990) and (Refs. Burbidge 1968). This paper also confirm the periodicity of redshift of quasar and galaxy. Further experimentation is required for detail understanding of quasar ejected from galactic nuclei using 3D imaging.
The authors express their thanks to Prof. J.V.Narlikar of IUCCA for excellent guidance and suggestions provided during the research time. Authors want to express their special thanks to Christopher C. Fulton and Martín López Corredoira for providing suggestions during discussion. The authors would like to express their gratitude to Dr. Debiprasad Duari for his interest in this work. Authors also acknowledge Prof. Debasis Sengupta from ISI, Kolkata for his help in designing simulations and Ms. Susmita Nandi for her assistance in carrying out some simulations. They would also like to acknowledge H.S.Ravindra of LEOS, Tapan Misra and Atul Shukla of SAC, ISRO for their encouragement.

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