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PHYSICAL PROPERTIES OF QUASARS CLUSTERING FROM SDSS: DR10 AT REDSHIFT $0 < Z \leq 6$

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ABSTRACT: *Using a sample of 1000 quasars from SDSS Data Release ten quasar catalog of redshifts $0< z \leq 6$, we study the physical properties of quasars at this redshift range. We have studied the number density of quasars, colors changes at low and high redshifts, the scattering in the color as a function of the redshift of quasars, and calculated the median of the colors. Our results investigated that the majority of quasars were found at low redshifts due to the massive black holes. We also conclude that quasars at low redshifts are outliers from the ugri stellar locus, and the high redshift quasars are outliers from griz stellar locus.*

KEYWORDS: Quasars - Catalog: General, Redshift, Methods: Statistical

INTRODUCTION

Most of the important luminous objects in astrophysics are quasars. Due to accretion of the material upon a supermassive black hole quasars are driven by an active galactic nucleus. [1,2]Feeding a black hole should affect the formation of galaxies in proximity to quasars [3].The large number of quasars has been discovered in two large spectroscopic surveys, the Two-Degree Fields quasar survey and the Sloan Digital Survey. [4] .The data from SDSS are adopted a multi-band optical color and has identified more than 120000 quasars. [5]SDSS photometric data are observed through five filters (u, g, r, i, and z) at a wavelength interval of (3000-9500) A° up to magnitude of r ~ 22. A visualization of the range of these five filters is shown in Figure 1.

The spectral energy density of quasars is characterized by strong emission lines and featureless blue continua.At low redshift, the quasars will be separated from the hot star due to the lack of a Balmer jump in the quasars. Color of quasars becomes increasingly redder at high redshift because of the presence of a strong emission and absorption lines by the Lyα which forest the results in the broad – band color of the quasars to be redder with redshift. This is the reason that makes the quasars to be distinguished by the stars when we are looking at their position in the color – space diagram in abroad – band photometric system.

Quasars have colors varies significantly as a function of redshifts, but locally distribution of the colors is narrow and degenerate.Density of the absorption lines in the spectral energy distribution of quasars will be increased at high redshift, causing the quasars to move away from the region of the color-space occupied by Galactic stars. [6]

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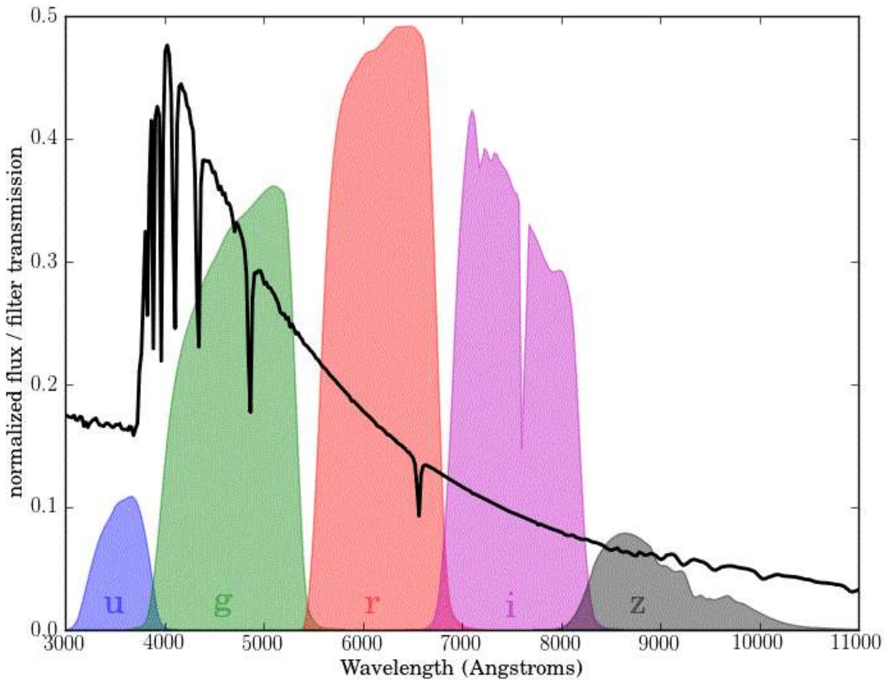

Figure 1. SDSS filters and references spectrum

In this work we focus on a new sample of quasars from SDSS: DR10 and study the color of quasars at redshift range $0 < z \leq 6$

SAMPLE SELECTION

Our photometric data have been accessed using SQL – query to the SDSS Catalog Archive Server (CAS). We depends the DR10 catalog and downloaded redshifts, luminosities Mu and Mr. We also downloaded magnitude of quasars at five broad-band filters (u, g, r, and z).
Our current sample includes 1000 quasars with limiting luminosity range $17 \leq Mu < 27$, and $16 < Mr < 23.5$ at redshift $0 < z \leq 6$. The flux of quasars are limited to $i > 16.5$ at low redshift $z \leq 1$ and $i = 23.3$ at high redshift $z \geq 2$.
Analysis of the data was done using MATLAB. The data set has a.csv file extension.
We have extracted magnitudes of quasars in u, g, r, i, and z band and measured the color of quasars as u-g, g-r, r-i, and i-z.
The low redshift objects are carried out in ugri color space, while the high redshift objects are carried out in griz color space.
We divided the sample into 20 redshift bins to study the number distribution of quasars at each bin, We further studied the distribution of the quasars according to their luminosity and colors.

DATA ANALYSIS AND RESULTS

In the following sections we will analyze and discuss the different properties of quasars through the redshift distribution, color-color relation, and color - redshift relation for our photometric data of 1000 quasars from SDSS: DR10.

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We depends the statistical methods in calculating the different variables and comparing the results with each other.

REDSHIFT DISTRIBUTION OF QUASARS

The redshift and colors distribution of quasars in our sample illustrates in Figure 2.
In the upper panel of this figure we divided the 1000 SDSS into 20 redshift bins at range $0 < z \leq 6$. The normal distribution of the quasars at the selected range of the redshift as shown in the upper panel of Figure 2 looks more Gaussian with mean values of z, $\mu_z = 2.2216$ and standard deviation $\sigma = 0.8044$. There is a noticeable lack of quasars at $z > 3.2$, since the numbers of quasars are declining at this range of the redshift. Nearly quasars of the $z < 3.2$ cover a larger area of the sky, that is mean that the low redshift quasars introduces a significant feature.
Using the absolute U and R magnitude of quasars we measured their colors as U-R. Red companion are defined as those with color U-R > 2.2, whereas others which have U – R < 2.2 are blue companion. It is clear that most of the objects in the sample are blue companion at redshift $z < 3$, and the more luminous blue companion are slightly redder, having high metallicity and are somewhat older. While the few other objects that have large scattering and seems to be red companion at high redshift $z > 3$.

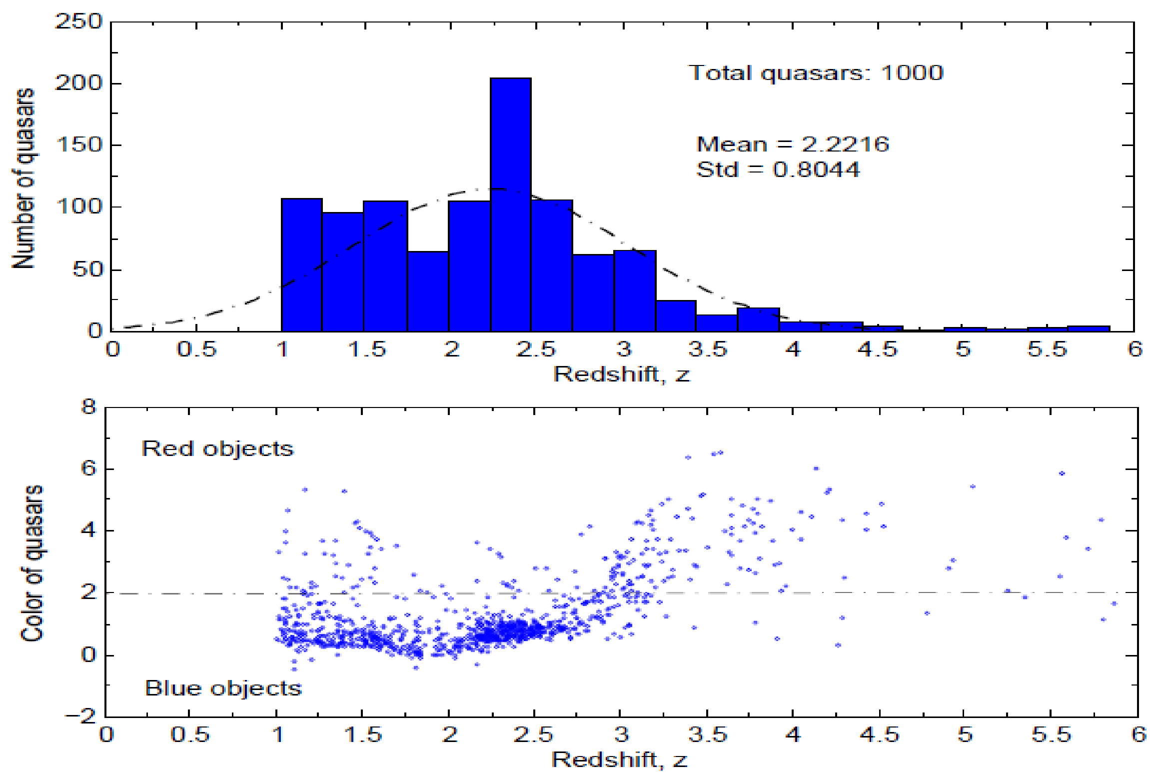

Figure 2. The upper panel shows the redshift distribution of quasars from SDSS: DR10. Lower panel shows the color distribution of quasars as a function of redshift.

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COLOR – COLOR RELATION OF QUASARS

Distribution of the quasars in ugriz color-color space is shown in Figure 3. In this figure we defined the color of quasars into two cubes, one for ugri-color cube, and one for griz-color cube. Color selection of quasars inbetween these two cubes depends on the redshift range of the target. Most of the quasars in the three plats of Figure 3 are entwired and can't be discriminated. The quasars targets in ugri are limited to objects fainter than i = 16, while the bright objects are targeted of i=22.4. Quasars of g-r colors are somewhat redder than most other color of quasars. The upper left panel of Figure 3 shows most color of the quasars at redshift z < 2.2 are placed inside stellar locus region due to the magnitude uncertainties in the u and g bands. These quasars have the lowest redshift in the sample and look redder than targets in other colors. Targets in ugr plot with color u-g > 0 are at redshift larger z > 3. While the most of the objects on the right panel of Figure 3 in gri plot will be distributed in the mid redshift range at 3.5 < z < 4, while the low redshifted objects at 0 < z < 1 are consistent with the stellar locui. Target objects in griz color – cube are classified as high redshift targets z > 4.5, and they are fainter than i = 17.2 and brighter than i = 23.4. The majority of the quasars at high redshift are consistent to the stellar locus and have colors concentrated at -0.8 < r-i < 1 and -0.8 < i-z < 1. Therefore the targets objects in griz color – cube can be classified as stellar objects. However some of the quasars in griz color cube are fainter than others in ugri color – cube. As a result we can say that in ugri color diagram, we can distinguish targets objects at low redshift, in the same time it can be found quasars of high redshift in griz color – diagram.

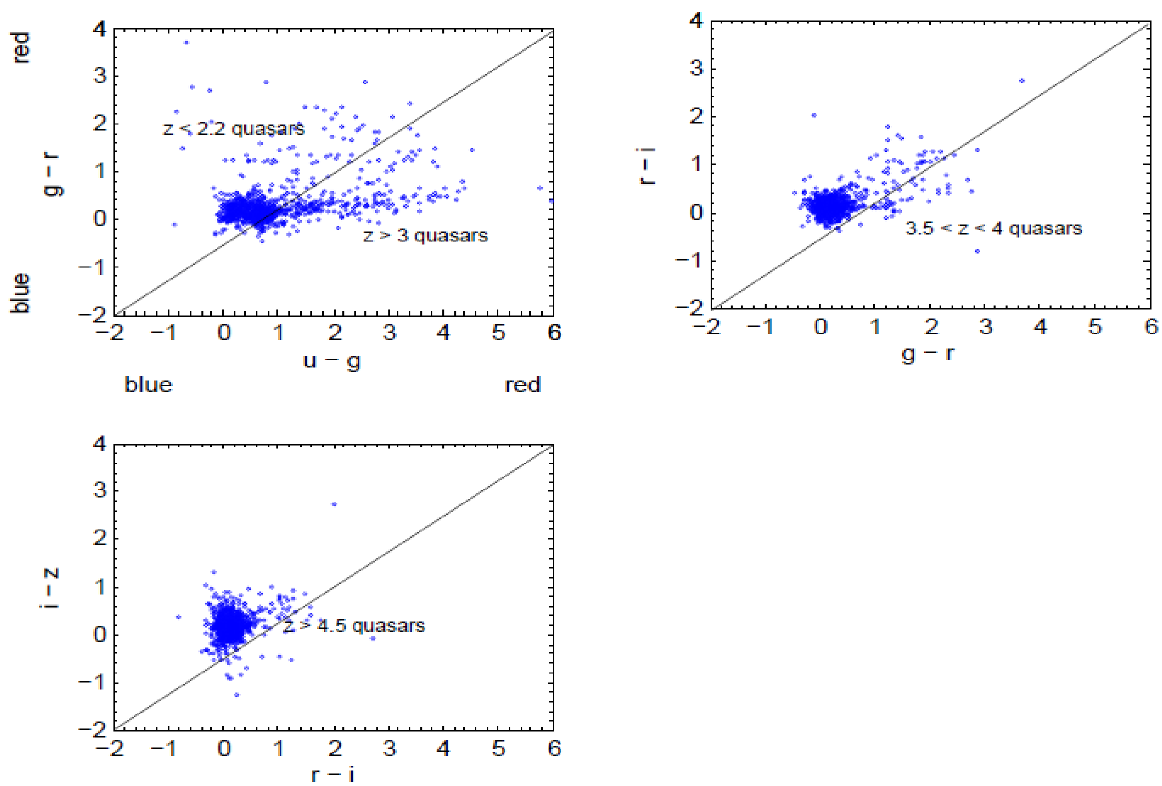

Figure 3. Color – color diagram of 1000 quasars from SDSS: DR10

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COLOR – REDSHIFT OF QUASARS

We present SDSS color of quasars as a function of redshift for DR10 catalog in Figure 4. The colors are variation due to the emission lines that enter and exit each band wavelength windows. The figure explains the dependence of redshift on color of the quasars, and the colors are depending on the quasar intensity.In the color – redshift relation there are many of the features are caused by one or more property in the quasar spectrum interacting with transmission curve.In (u - g) versus z plot, we see few quasars at low redshift -1 < z < 0 that are fainter than i < 17. Due to the fact that the quasars at low redshift are found by UV excess, the majority of quasars at 0 < z < 1 have color 1 < u - g < 3, and the limiting magnitude is 19 < i < 23, due to the emission lines that affect the broadband color; i.e Mg_{II} in u will cause that to be blue, and Mg_{II} in g makes the red color. When the redshift will be exceed 1, at z > 1, the color will rises slightly and shifts to the blue causing a blue dip

The u - g color rises slightly and will be little or no flux in u band, [3], therefore the number of quasars will be noticeable decrease at high redshift z ∼ 3 to z ∼ 4.5.Quasars of color g-r have approximately the same properties as in u-g color. At z < 0.4, the average color is relatively red and there is a population of redder objects as in u – g. But the difference here at z > 2, there are few quasars bluer than in u – g. For the same previous cause the number of quasars will be decreased rapidly when the redshift are increased more and more and disappears at z > 4, because of the g –r color will be little or no flux in the g band at high redshift.

As it is clear in Figure 4 the redder objects in the sample have the lowest redshift range and r – i color, and there are little or no existence of quasars at high redshift with r – i color. Whereas the quasars of i – z color are divided into blue and red colors at redshift 0 < z < 0.6, and the same as in r – i there is no quasars at high redshift range.As a result the quasars with similar redshifts tend to have the same color, and the blue and red quasars have similar clustering properties.We divided our sample into 20 redshift bins of size Δ z = 0.25 from z = 0 to z = 6. We then calculated the median color for all of the quasars that lying within each bin, and measured median of the colors for the four colors u-g, g-r, r-i, and i-z, and plot the results in Figure 5.

It is clear that the quasars of u - g are redder objects in the sample comparable with others colors at the same redshift. Quasars of r – i and i – z colors seems to have the same properties at redshift z < 3.5. As you can see there is a lack in the r – i color is disappear at z > 5, and at z > 3 for i – z color, and the reason for this is due to the rapid fall in the number of quasars in the redshift bins beyond z = 5, and z

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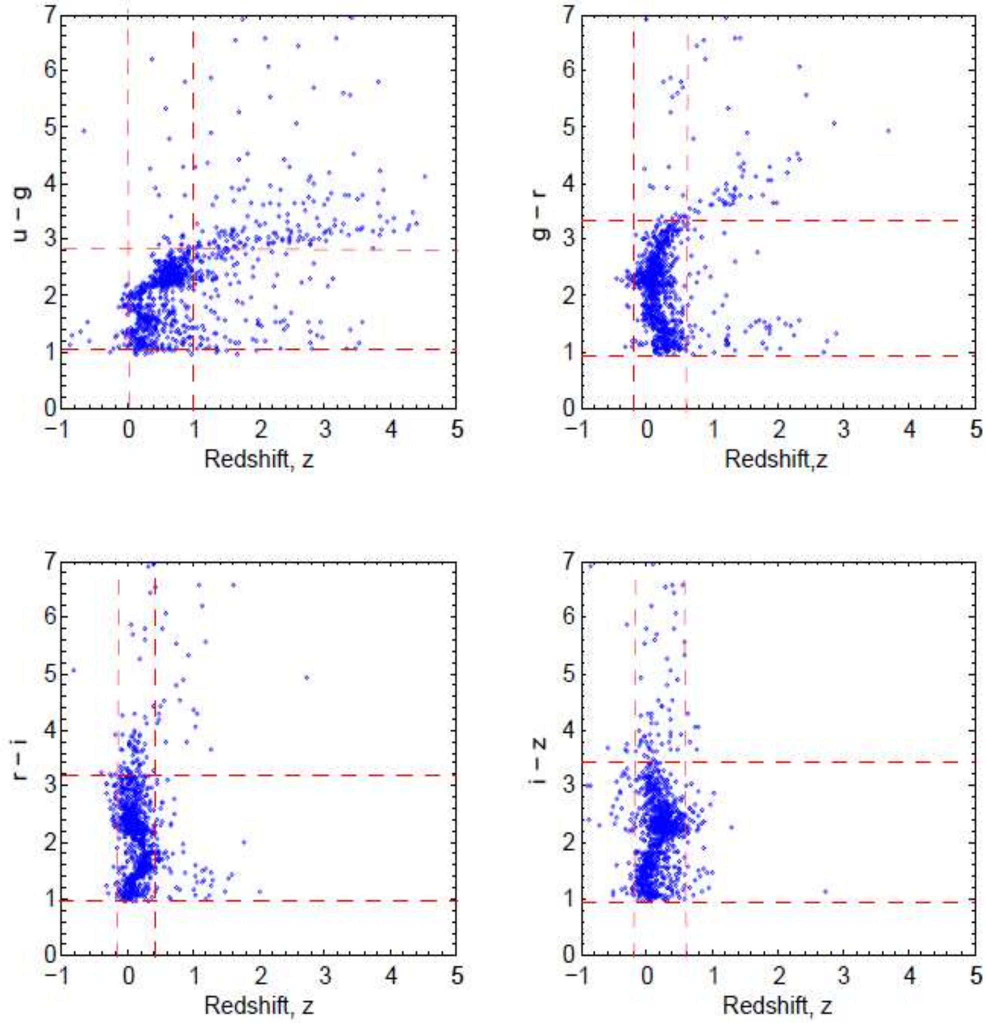

Figure 4. Color versus redshift for 1000 quasars from SDSS: DR10

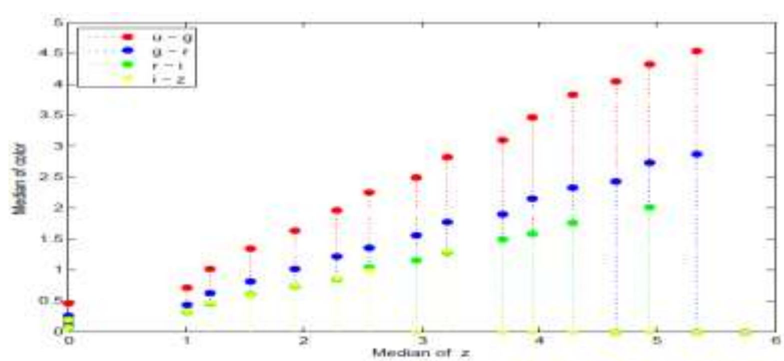

Figure 5. Median of color for 1000 quasars from SDSS: DR10

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DISCUSSION

We have studied a sample of 1000 quasars from SDSS: DR10 at redshifts $0 < z \leq 6$. We focused on the optical colors of quasars at five bands u, g, r, i, and z.

In this study we investigated the following results.

1. The number density of quasars in DR10 are much more at low redshift of $1 < z < 3$ than the high redshifts quasars. Due to the massive black halos, then the high redshift quasars are rare and live in dark matter halos.
2. Colors of quasars appear to be varied as a function of redshift and they are laying within either ugri or griz stellar loci. The quasars of low redshift are outliers from the ugri stellar locus fainter than i = 16 and brighter than i = 22.4. Whereas the high redshift quasars are outliers from griz color – cube are fainter than i = 17.2 and brighter than i = 23.4.
3. There is a scatter in the color of quasars at low redshifts due to the strong emission lines that have a significant effect upon the broadband color of the quasars. While color of the quasars have to been similar at the same redshift range. In the same time we don't found quasars of colors r – i and i – z at high redshift.
4. Median of colors is redder in u – g comparable with g – r, r – i, and i – z colors at the same redshift range. This is meaning that it can be study more properties of quasars at this color.

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