Intergalactic UV Background Radiation Field

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Running Title: Intergalactic UV Background Radiation Field
Abstract

We have performed proximity effect analysis of low and high resolution data, considering detailed frequency and redshift dependence of the AGN spectra processed through galactic and intergalactic material. We show that such a background flux, calculated using the observed distribution of AGNs, falls short of the value required by the proximity effect analysis by a factor of $\geq 2.7$. We have studied the uncertainty in the value of the required flux due to its dependence on the resolution, description of column density distribution, systemic redshifts of QSOs etc. We conclude that in view of these uncertainties the proximity effect is consistent with the background contributed by the observed AGNs and that the hypothesized presence of an additional, dust extinct, population of AGNs may not be necessary.

Key Words: QSO–absorption lines–Ly $\alpha$–proximity effect, intergalactic ultraviolet background radiation
1. Introduction

In recent years quasar absorption lines have yielded unique information about the physical conditions at high redshifts. The proximity effect, which is the decrease in the number of Ly $\alpha$ forest lines having neutral hydrogen column density above a certain minimum value, per unit redshift interval, near the QSO, has been used to determine the intensity of the intergalactic ultraviolet background radiation (IGUVBR) at high redshifts (Bajtlik, Duncan & Ostriker, 1988). With a large sample of QSOs observed at intermediate resolution Bechtold (1994) confirmed the presence of proximity effect at a high significance level. Bechtold (1994, 1995) also considered several sources of uncertainty in the value of the flux obtained from the analysis of the proximity effect. Espey (1993) considered the possibility of a higher systemic redshifts of QSOs, while Loeb & Eisenstein (1995) considered the possibility of quasars residing in clusters of galaxies. These two possibilities were also considered by Srianand & Khare (1996, hereafter SK96) for a large, homogeneous sample. In addition SK96 showed that the study of proximity effect in a sample of QSOs having damped Ly $\alpha$ absorbers along their lines of sight provides an indirect proof of the presence of dust in such absorbers. All these studies used intermediate resolution data. Proximity effect calculations using such data suffer from curve of growth effects and the assumptions of the I model (Bajtlik et al 1988) used in these calculations may not be strictly valid. Also line blending is inherent in the low resolution data and therefore the column density distribution implied by the equivalent width distribution may be considerably different from the actual distribution (SK96). It is therefore worthwhile exploring these effects using high resolution data.

Bechtold (1994) obtained the value of the intensity of the IGUVBR at the Lyman limit, $J_{\nu LL}$, to be $3 \ J_{21}$ ($J_{21} = 10^{-21}$ ergs cm$^{-2}$ s$^{-1}$ Hz$^{-1}$ sr$^{-1}$), assuming $J_{\nu LL}$ to be independent of redshift. From an analysis of high resolution data Giallongo et al (1996) and Cooke,
Espey & Carswell (1996) found no evidence for the redshift dependence of IGUVBR over the redshift range of 1.7 to 4.5 and obtained $J_{\nu_{LL}} \simeq 0.5 \pm 0.1$ J$_{21}$ and $1^{0.5}_{-0.3}$ J$_{21}$ respectively. Values of $J_{\nu_{LL}}$ obtained by Bechtold (1994) and Cooke et al (1996) are considerably higher than the value expected from the distribution of visible QSOs. It has been suggested (Fall & Pei 1993) that the actual number of QSOs may be larger than their observed number and that several QSOs may be rendered invisible due to dust extinction in the intervening absorbers. It is also possible that the IGUVBR gets a significant contribution from star forming galaxies (Madau & Shull 1996, Giroux & Shapiro 1996). The shape of the IGUVBR in almost all the studies of proximity effect has been assumed to be a power law having the same slope as the UV spectra of the QSOs. This assumption is, however, not valid due to the absorption and re-radiation of the UV photons by galaxies and intergalactic material. Also if the IGUVBR gets significant contribution from stellar sources then also its shape is likely to be considerably different from a power law.

In this paper we first study, using a large sample, of QSOs observed at intermediate resolution as well as a sample of QSOs observed at high resolution (section 2), the effect of assuming a more realistic shape and redshift dependence of the IGUVBR on the value of $J_{\nu_{LL}}$ obtained from the proximity effect analysis (section 3). We then study (section 4) the uncertainties in the value of $J_{\nu_{LL}}$ due to various possibilities mentioned above using the sample of Ly $\alpha$ lines with measured column densities in the spectra of QSOs observed at high resolution.

2. Data sample

Our low resolution sample (LRS) is same as that used by SK96 for proximity effect analysis. It consists of 54 QSOs observed at a resolution between 60 to 100 km s$^{-1}$. 
The minimum equivalent width limit used for this sample is 0.3 Å which is above the completeness limit for the sample. The high resolution sample (HRS) consists of lines observed towards 9 QSOs. The details of the sample are given in Table 1, which lists the emission redshift, \( z_{\text{em}} \), corrected emission redshift, \( z_{\text{em}}^c \), minimum observed redshift, \( z_{\text{min}} \), maximum observed redshift, \( z_{\text{max}} \), quasar flux \( f_\nu \) and references for all the 9 QSOs. \( z_{\text{em}}^c \) are the average values of corrected redshifts of all available emission lines, calculated as described by Tytler & Fan (1992) to obtain the systemic redshifts. \( z_{\text{min}} \) is the larger of the observed minimum and the redshift corresponding to the Ly \( \beta \) emission. \( f_\nu \) is the QSO continuum flux at the Lyman limit, in units of microjanskies. The values are calculated by extrapolating the continuum flux at the rest wavelength of \( \lambda (1450) \) to the Lyman limit. The minimum neutral hydrogen column density cutoff for the sample is taken to be \( 10^{13} \) cm\(^{-2}\).

3. Shape of IGUVBR

Shape of the IGUVBR due to AGNs and young galaxies is affected considerably by the absorption by galaxies and intergalactic matter (Bechtold et al 1987; Miralda-Escude & Ostriker 1990). Recently Haardt & Madau (1996, hereafter HM96) have shown that radiation from re-combination within the clumpy intergalactic gas contributes significantly to the IGUVBR. They have determined the spectrum of IGUVBR due to AGNs at several redshifts taking into account the absorption as well as re-radiation due to intervening material. The ionization rate of H I due to this background is roughly 1.5 times the rate if the recombination radiation is omitted.

We have used the shape and redshift dependence of the IGUVBR of HM96 to calculate the expected number of Ly \( \alpha \) lines near the QSOs, having equivalent width greater than 0.3 Å for LRS and having column density greater than \( 10^{13} \) cm\(^{-2}\) for HRS. This calculation is
similar to the I model calculation of Bajtlik et al (1988) except that we explicitly calculate
the ionization rate of neutral hydrogen at different distances from each of the QSOs in
the sample using the shape and intensity of the IGUVBR at that redshift obtained by
interpolating between the spectra given by HM96 in their Fig. 5. The expected number of
Ly $\alpha$ lines per unit redshift interval, having neutral hydrogen column density above $N_{HI}^{min}$,
at a redshift $z$ in the spectra of a QSO having emission redshift $z_e$ is then given by

$$\frac{dN}{dz} = N_0 (1+z)^\gamma R^{1-\beta}$$

where $\gamma$ and $\beta$ describe the distribution of Ly $\alpha$ lines away from the QSOs w.r.t. redshift
and column density respectively, the number of lines per unit redshift interval per unit
column density interval being proportional to $(1+z)^\gamma N_{HI}^{-\beta}$. $N_0$ is the value of $dN/dz$ at $z=0$
and $R$ is given by

$$R = \frac{\int_{\nu_L}^{\nu_U} \sigma_\nu \left( J_\nu(z) + \frac{f_\nu(z_e,z)}{4\pi} \right) dz}{\int_{\nu_L}^{\nu_U} \sigma_\nu J_\nu(z) dz},$$

being the ratio of neutral hydrogen column density in a given cloud at redshift $z$ if it is
ionized both by QSO radiation and IGUVBR to the column density if it is ionized by
IGUVBR alone. This factor replaces $(1+\omega)$ factor used in the earlier analysis of I model,
where $\omega$ is defined as

$$\omega = \frac{f_\nu(z_e,z)}{4\pi J_\nu(z)}.$$ 

Here $\sigma_\nu$ is the ionization crosssection of H I and $f_\nu(z_e,z)$ is the flux from QSO at the redshift
$z$. Values of $N_0$ (6.73 for LRS & 23.8997 for HRS), $\gamma$ (1.810 for LRS & 1.903 for HRS)
and $\beta$ (1.5453 for HRS) for the sample are obtained by performing a maximum likelihood
analysis of the sample of lines at distances larger than 8 Mpc from the respective QSOs,
which is presumed to be free of the effects of ionization by the QSO flux. The total number
of expected lines in the spectra of all QSOs in the sample as a function of relative velocity
w.r.t. the QSOs is shown in Fig.1 for HRS. The figure also includes the histogramme for
the observed number of lines with different relative velocities.
As seen from the figure, the expected numbers of lines in the region close to the QSO are much smaller than the observed values. This is because the background flux is small and QSO flux is much stronger than the background thereby making R large. The $\chi^2$ probability that the observed number of lines with relative velocity w.r.t. the QSOs, smaller than 12000 km s$^{-1}$ are consistent with the expected values is $\sim 10^{-6}$ for LRS & $10^{-4}$ for HRS. As mentioned above, higher background flux can be obtained by assuming either that large number of QSOs are obscured due to dust extinction in intervening absorbers or that the flux from galaxies contributes significantly to the background. In the first case we can uniformly scale up the flux of HM96 keeping the redshift and frequency dependence same and keeping in mind the possibility that the true redshift and luminosity distribution of QSOs may be different from the observed distribution and the actual redshift and frequency dependence of the IGUVBR may be different from that of HM96. Good fit between the expected and observed distribution ( $\chi^2$ probability = 0.236 for LRS & 0.822 for HRS) is obtained for a scaling up factor $\sim 6.3^{+6.4}_{-2.3}$ for LRS and $5.0^{+8.0}_{-2.3}$ for HRS. Errors are 1σ values assuming a Gaussian $\chi^2$ probability distribution and give the range of values for which the $\chi^2$ probability is $\geq 1/\sqrt{e}$ of its maximum value. The expected distribution is shown in Fig.1. The IGUVBR of HM96 thus falls short of the value required by the proximity effect by a factor of at least 2.7.

We have explored the possibility that additional flux may be contributed by galaxies. Madau & Shull (1996) have estimated that at $z \sim 3$, galaxies which may be responsible for the generation of metals seen in Ly $\alpha$ clouds at that redshift, can contribute a flux of $J_{\nu,L} \sim 0.5 J_{-21}$ to the IGUVBR provided the escape fraction of Lyman continuum photons from the galaxies is $\geq 0.25$. It thus seems unlikely that the background flux due to galaxies will be sufficient to explain the proximity effect. It is however, possible that as the Lyman alpha clouds are possibly associated with galaxies (Lanzetta et al 1995; Boksenberg 1995) the radiation from local stellar sources contributes significantly to the radiation incident on
the clouds. We have explored this possibility and have calculated the expected distribution for the case when radiation from local stellar sources contributes to the flux incident on the clouds. Steidel (1995) from his study of a large sample of galaxies associated with QSO absorption lines of heavy elements at \( z \leq 1 \) finds these galaxies to be normal in the sense of their star formation rates. Recently Steidel et al (1996) have found a substantial population of normal star forming galaxies at redshifts \( >3 \). We have therefore taken the shape of the local radiation field to be that given by Bruzual (1983) and assumed it to be independent of the redshift. We added this galactic flux to the background of HM96 and varied the absolute value of the galactic flux at 1 Ryd. The best fit was obtained for \( J_{\nu,1\text{LL}}(\text{galaxy})=1.9^{+2.4}_{-0.5} J_{-21} \) for LRS and \( 1.5^{+2.7}_{-0.9} J_{-21} \) for HRS. The best fit is also shown in Fig.1. These values are very large and can be achieved only if the clouds lie at distances \(< 90 \) kpc of the galactic centre (Giroux & Shull 1997). The observed distances of the clouds are almost an order of magnitude larger than this value (Lanzetta et al 1995). We thus conclude that the HM96 spectra falls short of the proximity effect estimates by a factor of \( \geq 2.7 \) and the additional flux needed is unlikely to be contributed by galaxies. Proximity effect calculations, assuming a pure power law IGUVBR, leads to \( J_{\nu,1\text{LL}} \sim 2.5 J_{-21} \) for LRS and \( 2.0 J_{-21} \) for HRS. The expected number of lines for this case are also shown in Fig.1. Same values are obtained for pure galactic spectra, and are therefore highly insensitive to the detailed shape of the flux.

4. Column density distribution

The I model used by Bajtlik et al (1988) assumes a single power law distribution for the neutral hydrogen column density. Bechtold (1994) pointed out the dependence of the derived value of the flux on the value of \( \beta \), the required value of flux decreasing with decrease in \( \beta \). Chernomordik & Ozernoy (1993) showed that the observed equivalent width
distribution can be explained from an assumed power law distribution of column density only if the power law index is 1.4 instead of the observed value. SK96 argued that as the lines are often blended in low resolution data, an effective column density distribution (of blended lines) describing the equivalent width distribution should be used in model calculations for low resolution data. High resolution data have revealed a paucity of high column density lines and it seems likely that the column density distribution is described by a double power law (Petitjean et al 1993, Khare et al 1997). The double power law may, however, be a result of the incompleteness of the sample at low column density end caused by the loss of such lines due to blending. This has been shown to be the case through the analysis of simulated spectra (Hu et al 1995, Lu et al 1997), the real redshift distribution being a single power law of index \( \sim -1.5 \) (however, see Giallongo et al 1996). As the observed distribution is a double power law, it should be used in the proximity effect calculations rather than a single power law. Giallongo et al (1996) using the observed double power law obtained a value of \( J_{21 LL} \sim 0.6 J_{21} \) for their high resolution sample, which further reduced to 0.5 \( J_{21} \) when the blending effect was accounted for. Double power law fit to our sample of lines farther than 8 Mpc from the QSOs is given by

\[
 f_{N_{HI}} dN_{HI} \propto N_{HI}^{-\beta_1} \text{ for } N_{HI} < N_b
 \]
\[
 \propto N_{HI}^{-\beta_2} \text{ for } N_{HI} > N_b
\]

with \( \beta_1 = 0.936, \beta_2 = 2.1727 \) and \( N_b = 9.54 \times 10^{13} \text{ cm}^{-2} \), the distribution being continuous at \( N_b \). Near the QSOs the column density distribution retains its shape except that the value of the column density at the break changes with distance from the QSO as \( N_{b \text{near}}(z) = N_b (1 + \omega)^{-1} \). The expected number of lines within a given column density range, per unit redshift interval, at a given redshift (near the QSO) can be obtained by integrating the distribution given in the above equation w.r.t. the column density, using appropriate values of \( N_{b \text{near}}(z) \). The best fit for HM96 is obtained for a scaling up factor
of $2.0^{+1.3}_{-0.5}$. The distribution is shown in Fig 1. The fit is not as good as that with a single power law, the $\chi^2$ probability being 0.197. The best fit for pure galaxy spectra and power law is obtained for $J_{\nu LL} \sim 0.8^{+0.3}_{-0.3} J_{-21}$ and $0.8^{+0.3}_{-0.2} J_{-21}$, the $\chi^2$ probability being 0.266 and 0.267 respectively. The required value of galactic flux is, within the allowed range, consistent with that expected from the starburst galaxies. We therefore conclude that the HM96 spectra falls short of the proximity effect requirements by a factor of $\geq 1.5$. The required extra flux may possibly be contributed by starburst galaxies.

In the following section we study the uncertainties in the background flux calculations as a result of various factors mentioned in the introduction. As we are interested in estimating the relative change in the background flux we assume a power law background with slope $= -1.5$, assume single power law column density distribution and use only the HRS for the analysis.

5. Sources of Uncertainty in the value of $J_{\nu LL}$

5.1. Resolution

Cooke et al (1996) have argued that line blending in general makes detection of lines less likely, however, as the lines near the QSOs are sparse detection is easier and effect is to increase the number of lines near the QSOs. This effect will, however, be countered by the increase in blending near the QSOs due to the fact that the number of lines per unit redshift interval increases with $z$ and therefore the intrinsic line density near the QSOs is higher than that away from it. One way to judge the effect of blending is to compare the results obtained from observations with different resolutions. As noted before, comparison with results of low resolution sample is not appropriate as these samples (with measured
equivalent widths rather than column densities) may suffer from curve of growth effects and due to the effective column density distribution being different than that observed for the HRS (SK96). Note that using $\beta = 1.4$ for LRS reduces the value of $J_{\nu L L}$ by a factor of 2, which is larger than the difference between the values of $J_{\nu L L}$ obtained from the proximity effect analysis of the HRS and LRS. The values for LRS are higher by a factor of $\sim 1.25$. It is, therefore, more appropriate to compare results of analysis of column density measured samples observed at different resolutions. Our data has two QSOs, Q1100 - 264 and Q2206 - 199 observed with very high resolution $\leq 8 \text{ km s}^{-1}$, while the rest of the QSOs have a resolution of between 14 and 35 km s$^{-1}$. We have performed the analysis for the sample excluding the lines observed towards Q1100-264 and Q2206-199 which yields $J_{\nu L L} = 2.5 J_{-21}$ which is $25\%$ higher than the value for the whole sample. The value of $J_{\nu L L}$ is thus likely to be overestimated due to line blending.

Cooke et al (1996) have estimated the effect of blending on the estimated value of $J_{\nu L L}$ by performing proximity effect calculations for two different values of $N_{\text{H I}}^{\text{min}}$, differing by $\Delta \log (N_{\text{H I}}) = 0.5$. They find little change in the lowest reasonable flux though the best fit value of $J_{\nu L L}$ increases with increase in $N_{\text{H I}}$, specially for $z < 3.5$, by up to 2 orders of magnitude. Based on the lowest reasonable flux they conclude that the change in $J_{\nu L L}$ values due to the change in completeness limits ($N_{\text{H I}}^{\text{min}}$) and therefore due to line blending is less than 0.1 dex, the flux being underestimated due to blending. It is, however, not very clear if the difference between the two $J_{\nu L L}$ values is due to the effect of blending alone. The $\gamma$ value increases with increase in $N_{\text{H I}}^{\text{min}}$ (Acharya and Khare 1993; Cooke et al 1996) which means relatively more lines near the QSO for the sample with higher value of $N_{\text{H I}}^{\text{min}}$ which may overestimate $J_{\nu L L}$ value for that sample (Cooke et al 1996). Also as pointed out by Cooke et al (1996) taking a sample of stronger (more saturated) lines may overestimate the effect of QSO flux as the strong lines are relatively less sensitive to the flux. It is therefore not very clear if the $J_{\nu L L}$ value for the sample with increased completeness limit is the value
for lower blending. The effect of blending found here is stronger and in an opposite sense. We have estimated the effect by a direct comparison of flux values obtained by including and excluding QSOs observed with a resolution which is considerably higher than that for the rest of the QSOs. We feel that our approach may give a direct estimate of the effect of resolution and therefore blending. Our conclusions are based on best fit values and are at lower redshifts. The two QSOs observed with higher resolution are at redshifts of 2.15 and 2.55 while the average redshift of the rest of the QSOs is 3.07. Thus part of the difference between the flux values obtained for the two samples may be contributed by the redshift dependence of $J_{\nu LL}$ and it may be necessary to perform a more detailed study on a larger sample in order to understand the effect of blending.

5.2. Dust in damped Ly $\alpha$ systems

Presence of dust in damped Ly $\alpha$ systems has been indicated by the redder colours of QSOs having these systems along their line of sight (Fall, Pei & McMahan 1989; Pei, Fall & Bechtold 1991). Pettini et al (1994) have independently confirmed the presence of dust in these systems through the measurement of abundance of the refractory element Cr which appears to be depleted compared to its solar abundance. SK96 obtained yet another independent proof for the existence of dust in the damped Ly $\alpha$ systems. They argued that the observed flux of the QSOs having such absorbers in their lines of sight must be smaller than the actual value as a result of which the IGUVBR flux obtained from the proximity effect analysis of a sample of these QSOs should be lower than that obtained from the whole sample. They confirmed this with their sample of 54 QSOs, 16 of which had damped Ly $\alpha$ lines in their spectra. 5 QSOs in our sample have damped Ly $\alpha$ systems along their lines of sight. Proximity effect analysis for these yields $J_{\nu LL} \simeq 1.5^{+3.3}_{-0.8} \, J_{-21}$ which is only marginally smaller than the value of $2.0^{+2.64}_{-1.01} \, J_{-21}$ for the entire sample. The decrease in
the value of $J_{\nu LL}$ is much smaller than that found by SK96 and may be due to the fact that our sample is much smaller and the QSOs with damped Ly $\alpha$ systems form more than half of the sample. Large samples will be needed to verify the presence of and estimate the amount of dust in these systems.

5.3. Peculiar velocities of Quasars and/or Ly $\alpha$ clouds

For several QSOs, some of the lines observed on the long wavelength side of the Ly $\alpha$ emission line can not be identified as heavy element lines. It is possible that these are Ly $\alpha$ forest lines with a redshift larger than the emission redshift of the QSO. The higher redshift of the Ly $\alpha$ forest line can occur due to either the QSO having a peculiar velocity due to its presence in a cluster and/or the Ly $\alpha$ forest clouds infalling towards the QSO or the cluster (Loeb & Eisenstein 1995) or having peculiar velocities (SK96). The last possibility is rendered viable by the observed clustering of Ly $\alpha$ forest clouds on velocity scales of $\leq$300 km s$^{-1}$ (Srianand & Khare 1994, Chernomordik 1995) and is also expected if Ly $\alpha$ clouds are associated with galaxies or clusters of galaxies as mentioned above. The modification in the expected number of lines near the QSOs taking into account some of these effects was evaluated by Loeb & Eisenstein (1995) and SK96. Here we follow the approach of SK96 and assume that the Ly $\alpha$ clouds have a Gaussian peculiar velocity distribution with a velocity dispersion $v_d$. The result will also be valid for the case of the QSO having a peculiar velocity instead of the Ly $\alpha$ clouds. Good fit between the observed and expected values is obtained only for $v_d >$1000 km s$^{-1}$. The best fit values of $J_{\nu LL}$ for $v_d = 1500$ & 2000 km s$^{-1}$ are 2.5 $J_{-21}$ & $J_{-21}$ respectively. These velocities are too large to be due to peculiar velocities of Ly $\alpha$ clouds and could only reflect the peculiar velocities of QSOs. However, such high velocities, even for QSOs, can not be obtained for realistic values of cluster masses containing QSOs (Loeb & Eisenstein 1995). It thus appears that
the absorption lines with redshift larger than the emission redshifts may not be caused by the peculiar velocities of Ly α clouds and/or QSOs.

5.4. Higher systemic QSO redshifts

Following Espey (1993) and SK96 we also considered the possibility that the systemic redshifts of QSOs are higher than the values used here (Table 1). Note that we have actually used the emission redshifts corrected for the difference in redshifts of lines of the low and high ions, as per the prescription of Tytler & Fan (1992). The dependence of $J_{\nu L}$ on the shift in systemic redshifts (assumed to be same for all QSOs in the sample) is shown in Fig.2. A shift by 250 km/s will reduce the necessary value of $J_{\nu L}$ by a factor $\simeq 1.4$, which is roughly the discrepancy between the flux of HM96 and that required by the proximity effect.

6. Conclusions

We have performed the proximity effect calculations for low resolution as well as high resolution data assuming different shapes and redshift dependence of the IGUVBR. We find that the required intensity of the background flux is highly sensitive to the shape of the column density distribution used in the analysis. The use of a double power law reduces the intensity by a factor of 2.2 from the value obtained by using a single power law distribution. It is therefore important to have a large sample of lines observed at high resolution in order to accurately determine the column density distribution. Higher systemic redshifts of the QSOs by only $\sim 250$ km s$^{-1}$ reduce the required intensity by
a factor of 1.4. The presence of dust in damped Lyman $\alpha$ systems on the other hand may be responsible for an underestimate by more than 25% of the required value of the flux. A similar effect may also be present due to the limitation in resolution used for observing the QSOs. Pure AGN background, processed through galaxies and intergalactic matter falls short of the proximity effect requirements by a factor of $\geq 1.5$. However, considering the uncertainties in the required intensity due to its dependence on several other factors mentioned above, this may not be a serious discrepancy. The required value of the flux is highly insensitive to the shape of the background. In view of these uncertainties the proximity effect may also be entirely accounted for by the radiation from the galaxies responsible for producing heavy elements observed in the Lyman alpha clouds. Note that we have not taken into account the additional uncertainties in the value of $J_{\nu,LL}$ due to the uncertainties in the values of $\gamma, \beta, \text{QSO flux}$ etc (Cooke et al 96). Thus we conclude that at present there is no compulsive evidence from proximity effect for a larger, dust extinct, QSO population or a substantial contribution from galactic sources and pure AGN flux may be adequate to explain the proximity effect.

Acknowledgment

This work was partially supported by a grant (No. SP/S2/013/93) by the Department of Science and Technology, Government of India.
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Figure Captions

Fig.1: The expected and observed number of Ly $\alpha$ lines near the QSOs as a function of relative velocity w.r.t. the QSOs. The histogramme shows the observed number. Long dashed dotted line is for HM96, solid line is for scaled HM96, dotted line is for power law background and dashed line is for pure galactic background assuming single power law column density distribution. Long and short dashed line is for scaled HM96, long dashed line is for pure galactic background and dash dotted line is for power law background assuming double power law column density distribution.

Fig.2: $\chi^2$ probability as a function of the background flux for higher systemic redshifts of the QSOs. The curves from right to left are for systemic redshift higher by 0, 500, 1000, 1500 and 2000 km s$^{-1}$. 
