40 New Quasars identified within the SDSS-DR16 Quasar Superset and pipeline data

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Abstract

The SDSS-DR16 Quasar Superset and pipeline catalogues are searched for undeclared quasars which were concealed by or confused with other objects, with their redshifts available in the data. Forty such quasars are found and herewith presented. Also, 57 entries in the SDSS-DR16Q main quasar catalogue are shown to be non-quasars.

Keywords: catalogs — quasars: general

1 INTRODUCTION

The Sloan Digital Sky Survey (SDSS) Quasar Catalogue 16th Data Release (DR16Q: Lyke et al. 2020) consists of two files, being the quasar-only main catalogue of 750,414 quasars which includes earlier SDSS-I/II/III visually confirmed quasars, and a 1,440,615 row “superset” of SDSS-IV/eBOSS quasar target classifications. The SDSS-DR16 pipeline catalogue (DR16: Ahumada et al. 2020) gives pipeline-processed details of 5,789,200 spectra taken over the life of the SDSS project, including multiple spectra for some targets. Data is taken from each of these for this work.

The DR16Q uses quite a different methodological approach to data processing & presentation compared with its predecessor DR14Q (Paris et al. 2018): it emphasizes data uniformity and rule-based classifications whereas DR14Q (and its predecessors) had a more heuristic approach. This rigour produces quantifiably reliable data for onwards research but can overlook data anomalies which evade the data-gathering rules. I found such anomalous data which yielded 40 evident quasars in the overall SDSS data which had not heretofore been identified as quasars. Such identifications need redshifts to be useful, and those redshifts are available as well: the DR16Q catalogues present multiple redshifts per object as are available, including the neural automated QuasarNET (Busca & Ballard 2018) redshift for which is claimed $>99\%$ efficiency and $>99\%$ accuracy within 0.05z. I report QuasarNET redshifts and DR16 pipeline redshifts in this work.

The 40 new quasars come in groups depending on the method to collect them, plus some history of how one group led to another, so I present them in groups accordingly. At the outset, I show some anomalous DR16Q data to introduce the topic of things not always being what they seem, and document the “2 arcsecond rule” which can confuse quasars with their neighbours on the sky. Other quasars were concealed in the merged photometry of close doublets or by the glare of bright stars. And a technique of swapping out “unplugged” objects is detailed, with 7 quasars added by that. There are 16 figures in this paper, some quite reduced in size, but just zoom in to see them clearly.

At the end, I present 57 DR16Q “quasars” which are clearly not quasars, such as, for example, if they should be star spikes. In such a large 750K data pool there is no great significance in these 57 non-quasars except to reify previous SDSS-given caveats which were stated only statistically, and to introduce the topic of “line poaching” which can cause non-quasars to be visually classified as quasars.

2 ANOMALOUS DATA AND THE 2-ARCSECOND RULE

The DR16Q paper abstract states an expectation of “0.3%-1.3% contamination” in the quasar-only catalogue. Figure 1 shows 3 such contaminants, star spikes in this instance.

What is instructive about those 3 examples is that they were visually inspected (so flagged) and assigned
redshifts \( > 2 \) with medium or high confidence. This shows us that “visual inspection” consists of inspection of the spectrum but not of the image. This lack of the image as a resource opens the door to artefacts of what can be called “the 2-arcsecond rule” which is given as:

\[
\text{Any group of spectra which are within 2 arcsec of each other are considered to be of the same object, and only one of them is designated as ‘sciencePrimary’}. \]

Therefore two objects within 2 arcsec had their spectra collected together with just one spectrum as the “primary” one, even if both objects were targeted separately; this plus spectral deblending limitations and the absence of the image could cause the two objects to become confused. But we can use the images to un-scramble them throughout this paper.

As an example of this, Figure 2 shows SDSS-DR16 finding charts\(^2\) for both objects of a red-blue doublet separated by 1.27 arcseconds, thus within the “2 arcsecond rule”. The blue object (J103745.85+061301.5) is a QSO of \( z = 0.809 \). The red object (J103745.92+061302.3) has always been classified as a star by the pipeline, dating back to the legacy SDSS-DR7 (Abazajian et al. 2009). However, the SDSS-DR7Q (Schneider et al. 2010) visual inspector classified it as a QSO due to the emission lines contributed by the blue object – the DR7 spectrum (on the left of Figure 2) was actually of the joint object. Separation between them is 1.270 arcsec.

and that objects within a 2-arcsec separation of each other can become confused, now we can move on to cases where such issues caused mis-identification of the quasars or concealed the quasars altogether.

3 THREE QUASARS FOUND BY SWAPPING WITH FALSE IDENTIFICATIONS

Figure 3 shows a star-QSO doublet with separation of 1.527 arcsec. The red object (J154316.78+402634.9) has 2 spectra assigned to it and has photometry of \( ugriz = (24.63, 22.45, 20.67, 19.86, 19.33) \); the blue object (J154316.72+402636.3) has no spectrum assigned and has flat photometry \( ugriz = 21.07, 21.04, 21.49, 21.07, 22.83 \) typical of a QSO of \( z < 2 \). The red object was originally targeted by DR7 as a high-redshift \((i.e., z > 3)\) QSO target but its DR7 spectrum (bottom right of figure) revealed a QSO of \( z = 1.345 \) and the DR7 Finding Chart\(^3\) zWarning flag warned “LOC NOT _QSO”. The primary BOSS spectrum (bottom left of figure) shows it to be an M1 star, but broad emission lines are seen as well. Clearly, the spectra combine the emissions of the red star and the blue QSO, and the DR7 spectrum captured more of the QSO emission than did the BOSS spectrum, probably due to pointing. This shows that a spectrum of close objects can combine their emissions, even after efforts at deblending, and a star-QSO doublet can show a spectrum of broad QSO lines superposed

\(^1\)at http://www.sdss.org/dr16/spectro/catalogs.php
\(^2\)at http://skyserver.sdss.org/dr16/en/tools/chart/chartinfo.aspx
\(^3\)at http://cas.sdss.org/dr7/en/tools/chart/chart.asp
onto a stellar continuum such that the continuum causes the DR16 pipeline to declare a star rather than a QSO, thus concealing the QSO. This happens especially if the star is red or bright as is profiled by the 25 doublets reported in Section 4.

As the blue object of Figure 3 was never identified as the QSO, it is here presented as the first new QSO of this paper. A complete listing of the 40 newly discovered quasars is given in Table 1.

Two more close doublets are shown in Figure 4, each of which replaces a false DR16Q quasar with the true quasar. J093859.26+020924.4 is the blue end of a doublet with the red J093859.23+020925.8 at a separation of 1.675 arcsec. The DR7 pipeline, DR7Q, and DR16Q classify the red object as a quasar with $z=1.410$, but the DR16 pipeline reports it as an M1 star. The red object photometry is, from DR7:

\[ ugriz = 22.27, 21.55, 20.31, 19.21, 18.49 \]

None classify the blue object. The spectrum clearly shows a BAL quasar with a bold Ly$\alpha$ line near the 4000 Å mark – incompatible with the red object photometry (\[ ugriz = 22.44, 20.72, 19.55, 18.26, 17.32 \]) which is faint in $u$. The blue object is the quasar, newly reported here.

\[ J101012.77+560520.0 \]

is the blue end of a doublet with the red J101012.65+560520.5 at a separation of 1.036 arcsec. DR7/DR7Q/DR16Q all report the red object as a quasar with $z=2.130$. The blue object was evidently never sighted, it has photometry (\[ ugriz = 19.37, 18.87, 18.64, 18.47, 18.41 \]) befitting a quasar. The spectrum clearly shows a BAL quasar with a bold Ly$\alpha$ line near the 4000 Å mark – incompatible with the red object photometry (\[ ugriz = 22.44, 20.72, 19.55, 18.26, 17.32 \]) which is faint in $u$. The blue object is the quasar, newly reported here.
neighbours on the sky, and I show 25 examples of that now, but on the other side of the coin, non-quasars can be classified as quasars when their spectra are contaminated by stray light from neighbouring quasars on the sky; I’ll give 6 examples of that later in this paper.

The DR16Q Superset presents all classifications of SDSS-IV/eBOSS quasar targets. I searched its classified stars for star/QSO doublets which were photometrically dominated by the star, thus causing the pipeline to classify them as stars, but without visual inspection of the spectrum, and which showed quasar lines sufficient for the QuasarNET algorithm to classify them as quasars and give the redshift. The rules used in the extraction were CLASS_PERSON=0 (i.e., not visually inspected), AUTOCLASS_PQN="STAR" (i.e., classified as a star), and IS_QSO_QN=1 (i.e., the QuasarNET algorithm classifies it as a quasar). This yielded 1286 objects of which about half match to known quasars or pipeline quasars which are not new objects, with the remaining 634 being apparent stars. I inspected the images & spectra of those 634 and found 25 to be QSOs concealed within star/QSO doublets, and 5 others described in the next section. These are new QSOs, herewith presented.

Figure 5 shows the 25 new quasars and Figure 6 shows their respective spectra. All spectra were classified by DR16/DR16Q as stars but show quasar emission lines superposed onto stellar continua contributed by stray light from the neighbouring star. QuasarNET redshifts for these are given by the DR16Q Superset and are shown on Figure 5 and listed in Table 1.

5 FIVE QUASARS CONCEALED IN THE GLARE OF BRIGHT STARS

The largest doublet separation of Figure 5 is 5.088 arcsec for the 2nd image, which suggests that bright stars can submerge quasar spectra at large offsets. I have found 5 such new quasars, also from the DR16Q Superset extraction described in the previous section, see Figure 7 which shows images & spectra. The first one is a mag-18 quasar in the glare of 89 Pisces, a 5th magnitude star. Table 1 gives their QuasarNET redshifts.

6 SEVEN QUASARS SALVAGED FROM “UNPLUGGED” OBJECTS.

The DR16 pipeline file gives a complete record of the optical observations made throughout the life of the SDSS project, which were 6826 plates taken with a total of 5789200 plugged CCD observations – the first 2880 SDSS plates had 640 fibred plugs per plate, then 3946 later plates had 1000 plugs per plate. Sometimes the fibres were not firmly plugged in, or even got their wires mixed up as to which CCD-plugholes they connected to, thus yielding a spectrum obviously incompatible with the photometry (such as a bright bluish spectrum for a faint reddish object). SDSS documents such mix-ups with this caveat:4

With some frequency, the fiber mapping failed which identifies which fiber has been plugged into which hole. There are around 7200 such cases in DR10, which are marked as UNPLUGGED in the ZWARNING bitmask. The vast majority of these cases occur because the fiber was actually not plugged or was broken. In around 200 cases, there is measurable signal down the fiber. In cases where there is more than one such fiber on plate, there is a possibility that the fiber location associated with the spectrum is incorrect (and thus that the photometric and spectroscopic information is mismatched).

That caveat isn’t general enough, though. Over 90% of UNPLUGGED fibres have no signal at all, and certainly a mixed-up fibre-with-signal can match to a no-signal one, so it’s sufficient for there to be just one UNPLUGGED fiber-with-signal for it to be matchable to any other UNPLUGGED fibre, whether signalled or not. There are a total of 28248 UNPLUGGED fibres over all plates, thus an average of about 5 per plate for the 1000-plughole plates. In the case of an UNPLUGGED but fully-signalled quasar spectrum, it would be desir-
able to determine which plughole sent that quasar signal. However, SDSS production did not encompass such a deductive process – the observation had to be done right for the data to be usable. But given the data, sometimes it is clear which was the true source plughole. Figure 8 shows a most obvious example, a plate which has only 2 fibres UNPLUGGED, with the left one being a yellowish galaxy showing an incompatible blue quasar spectrum, and the other being a blue object with the right $ugriz$ profile for a $z=2.4$ quasar. Therefore it is immediate that the blue object is the source of the quasar spectrum, and that quasar is one of the seven new quasars presented in this section.

Usually a plate has more UNPLUGGED objects than just 2, a typical example is plate 4092, MJD (modified Julian date) 55477, which has 5 UNPLUGGED objects one of which shows a quasar spectrum, see Figure 9 and its caption. Only one of those objects has suitable photometry, so it is selected as being the true source of the quasar spectrum. In this case we have a confirmation from LAMOST-DR5\(^5\) which targeted our selected object and presents a spectrum which matches our spectrum, see lower right corner of Figure 9. This confirmation supports the validity of our technique, although this quasar is thus not newly-discovered.

While this may sound straightforward, in fact very few quasars can be identified in this way. Only 562 UNPLUGGED objects have a quasar-classified spectrum and only about 100 of those are good-quality (2+ lines) spectra AND misplaced plugholes. In many cases there are many candidate objects for the spectrum with no basis to choose one; sometimes one candidate looks much the best but that still is not good enough. Sometimes a plate-MJD combo has multiple UNPLUGGED quasar spectra with which nothing can be done. Only when there is just one good-quality UNPLUGGED quasar spectrum and just one viable candidate for it, can this method be used. In the end I could make only 8 identifications, one of which was previously identified as shown

\(^5\)http://dr5.lamost.org/v3
Figure 7. 5 new quasars in the glare of bright stars. Spectra show quasar lines superposed onto the stellar continua broadcast by the stars, causing these quasars to be classified as stars by DR16/DR16Q. These quasars are listed respectively as rows 29-33 of Table 1.

Figure 8. The only two UNPLUGGED fibres for plate 6471, MJD 56309. Left side shows a quasar spectrum allocated to an unsuitable object, right side shows an object with photometry well-matched to the quasar spectrum, and so adjudged to be the true source of that spectrum, and thus a quasar.

Figure 9. UNPLUGGED fibres for plate 4092, MJD 55477. Left side shows the UNPLUGGED object wrongly allocated with the quasar spectrum, the band of 5 images superposed across the middle shows all 5 UNPLUGGED objects for this plate on which it is seen that only the left-most object has the right photometry for the quasar spectrum, the right side identifies that object, and at bottom right is superposed a LAMOST-DR5 spectrum of that object which is seen to match the spectrum on the left, thus confirming the chosen object to be the quasar.

in Figure 9. Therefore 7 new quasars are included in Table 1 from this method, one of which was shown in Figure 8. Figure 10 shows the remaining 6 new quasars, flagged as UNPLUGGED, discovered from swapping out the spectrum with another UNPLUGGED object (identified in Table 1) from the same plate-MJD combo. In every case this bluish object was the only eligible photometric match to a solo available quasar spectrum. A notable point about these 7 swappers is that in 3 cases (1st, 4th, & 5th spectra of Figure 10) the swapped
Figure 10. 6 new quasars from UNPLUGGED swap-outs. Each quasar has its spectrum on its upper-right, obtained from a fellow UNPLUGGED object (identified in Table 1) of the same plate-MJD combo.

Table 1 shows the full set of 40 new quasars presented in this paper. The left column shows the method used to detect the quasar as described above: 3 replacements where a blue QSO replaces a red star as the identified QSO in a red/blue doublet, 25 doublets where the quasar was hidden by the stellar continuum contributed by its neighbour, 5 QSOs previously washed out in the glare of bright nearby stars, and 7 UNPLUGGED quasars "replugged" by identifying the correct optical objects for those spectra. The SDSS name (and thus J2000) is given, redshift and provenance, some photometry and doublet separation where applicable, and a relevant comment.

7 DR16Q QUASARS WHICH ARE NOT QUASARS

It’s not news that some DR16Q objects classified as quasars are not in fact quasars, especially as the DR16Q paper abstract states an expectation of “0.3%-1.3% contamination” over its 750K quasars which thus indicates ≈ 7K non-quasars. However, the bulk of those are expected to be within the low signal-to-noise faint objects where the spectra become more difficult to classify, that class of objects being retained for completeness.

What the DR16Q proprietors would not have intended to keep, though, would be contaminants like star spikes and asteroids. Even so, a few could be expected to slip through given that visual inspection of the images was not usually done. Well, I have a few such to present here, maybe even the most of them, and the count is quite small given the very large 750K data pool, so for the record here are 3 asteroids mistaken for quasars, 34 star spikes mistaken by the target reduction pipeline and subsequently accepted into DR16Q, 5 star glow similarly accepted, 6 “line poachers” (as I call them) which show quasar emission lines only because of emission bleed-over from a neighbouring quasar, the 3 supplanted objects from Section 3, and 2 processing mis-identifications & 2 processing duplicates. Most of these are visually obvious so can be presented without elaboration, but I’ll give brief descriptions of the processing anomalies, and the line poachers will require detailed justification. Table 2 lists all the non-quasars. Figure 11 shows 3 asteroids, Figure 12 shows 34 star spikes, and Figure 13 shows 5 star glow. All are annotated with J2000 positions.

The two processing mis-identifications: a red-blue
doublet at J214325.74+244941.1 has a separation of 1.825 arcsec, thus within the "2 arcsecond rule".

Table 1 The 40 new quasars

| g | finding |
|---|---------|
| | method | ID & DR16 | DR7Q | DR14Q | DR15Q | DR16Q | DR17Q |
| 1 | doublet | 2.237 | 19.89 | 21.01 | 1.036 | 4 |
| 2 | doublet | 2.699 | 21.04 | 21.14 | 0.589 | 0 |
| 3 | doublet | 1.903 | 22.02 | 22.14 | 0.198 | 1 |
| 4 | doublet | 1.903 | 22.02 | 22.14 | 0.198 | 1 |
| 5 | doublet | 2.587 | 22.02 | 22.14 | 0.198 | 1 |
| 6 | doublet | 2.587 | 22.02 | 22.14 | 0.198 | 1 |

Line poachers are objects wrongly identified as quasars because their spectra are contaminated by stray light from nearby true quasars. This problem may be worse for visual classifiers finely-tuned to recognizing quasar lines than for the pipeline; indeed, 5 of the following 6 line poachers were visually classified with high confidence (so flagged) and their assessment of the redshift was fully correct, but not for that object. Figure 14 shows the most obvious example of a line poacher.

In Figure 14, the prominent emission lines of the bright quasar on the right are echoed in the spectrum of the faint star on the left. Looking at the image of the star, it is seen to be a typical member of a faint yellow star cluster there. Its spectral flux increases at the blueward end, entirely incompatible with its faint u and g photometry, so clearly that blue flux is further contamination from the nearby quasar. So the left object, presented as a quasar in DR16Q, is seen to be not a quasar. This example shows that "line poaching" needs to be considered when classifying objects. Now I give another example in Figure 15.

Figure 15 shows the copy-over of the quasar emission lines from the white quasar to the yellow star, similar to Figure 14. The quasar is a legacy (DR7Q) object and the star was visually inspected as part of the subsequent BOSS project and classified as a QSO with z=0.341 with high confidence (so flagged). The classifier, working without the image, would not have been aware of the very close QSO. Note that this doublet has a separation of 1.825 arcsec, thus within the "2 arcsecond rule"
Figure 12. 34 star spikes in DR16Q, images have 1 arcmin edges. Annotated DR16Q location is at exact centre of image, crossed by a star spike there with no background object present.

discussed in Section 2, and has left this quasar with no primary spectrum. This would have prevented its uptake into DR16Q which uses only primary spectra (see their Section 3.5 end) except that as a DR7Q quasar it was thus included into DR16Q as well.

Figure 16 shows a line poacher of an unusual grey colour, the spectrum of which includes the emission lines of its quasar neighbour. Note these are once again within 2 arcsec of each other, thus the 2-arcsecond rule applies, and the left object has no primary spectrum as before, so the method described in Section 2 must be used by the user to access that spectrum.

There are 3 other line poachers in Table 2: rows 53 and 55 show “bonus” targets taken when a fibre had no particular target allocated, so the operators selected something available; if that something was near to a known quasar then, well, it might end up as a line poacher. Table 2 row 56 shows a line poacher 4.166 arcseconds from the quasar 2SLAQ J212112.04-003304.1 of z=0.460, an object not targeted by SDSS.

If a whole-sky redshift database is searched for close stellar-PSF doublets, the results will comprise 4 types: (1) lenses, (2) NIQs (nearly identical quasars), (3) projected QSOs (of different redshifts), and (4) QSO / line poacher pairings. Very little attention has been paid to the last of these. Hopefully it will be more attended in future.

8 CONCLUSION

40 new quasars, not previously published, are found in a search through the extensive SDSS-DR16 pipeline and SDSS-DR16Q Superset data, and are presented here. Also 57 SDSS-DR16Q quasars are shown to be not quasars.
Figure 15. Line poacher: at left, a yellow star showing emission lines of a $z=0.341$ quasar; at right, the true quasar with redshift 0.341. Separation between them is 1.825 arcsec. Emission lines of the right object have contaminated the spectrum of the left object.

Figure 16. Line poacher: a close grey-blue doublet. The grey object spectrum echoes the emission lines of the blue quasar. Separation between them is 1.674 arcsec.

9 ACKNOWLEDGEMENTS

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REFERENCES

[Abazajian et al. 2009] Abazajian, K., N., Adelman-McCarthy, J. K., Agueros, M., A., et al. 2009, ApJS, 182, 543-558, SDSS DR7 pipeline
[Abolfathi et al. 2018] Abolfathi, B., Aguado, D. S., Aguilar, G., et al. 2018, ApJS, 235, 42, SDSS DR14 pipeline
[Almada et al. 2020] Almada, R., Allende Prieto, C., Almeida, A., et al. 2020, ApJS, 249, 3, SDSS DR16 pipeline
[Busca & Ballard 2018] Busca, N., G., & Ballard, C., 2018, [arXiv:1808.09955], QuasarNET
[Lyke et al. 2020] Lyke, B. W., Higley, A. N., McLane, J. N., et al. 2020, A&A, 613A, 51, SDSS DR16 Quasar
[Pâris et al. 2018] Pâris, I., Petitjean, P., Aubourg, E., et al. 2018, A&A, 613A, 51, SDSS DR14 Quasar
[Schneider et al. 2010] Schneider, D. P., Richards, G. T., Hall, P. B., et al. 2010, AJ, 139, 2360, SDSS DR7 Quasar
| #  | Type of ref | ID & J2000 | DR16Q ref | r | s | g | r | doublet | sep | asec | ZWARN | ING | comment |
|----|------------|------------|-----------|----|---|---|---|--------|-----|------|-------|-----|--------|
| 1  | Section 2  | SDSS J103745.92+064302.1 | 0.809 | 24.63 | 25.11 | 20.46 | 1.270 | J103745.85+064301.5 is the QSO, see Sec.2 |
| 2  | Section 3  | SDSS J023859.25+085224.8 | 1.411 | 20.74 | 20.53 | 19.91 | 1.675 | 0 |
| 3  | Section 3  | SDSS J154316.78+402634.9 | 1.328 | 24.63 | 22.64 | 20.87 | 1.527 | J154316.72+402634.3 is the QSO, see Sec.3 |
| 4  | Section 3  | SDSS J101012.65+560520.4 | 2.131 | 22.40 | 20.81 | 19.71 | 1.036 | 0 |
| 5  | confused   | SDSS J135507.59+450854.1 | 3.055 | 23.70 | 22.24 | 21.18 | 1.843 | J135507.43+450853.6 is the QSO |
| 6  | duplicate  | SDSS J224430.44+233932.5 | 2.705 | 24.07 | 21.90 | 21.60 | 1.993 | 0 |
| 7  | duplicate  | SDSS J020501.30-074249.5 | 2.079 | 19.37 | 19.25 | 20.95 | 0 |
| 8  | duplicate  | SDSS J003024.32-525524.7 | 2.919 | 20.59 | 21.19 | 20.69 | 0 |
| 9  | asteriod   | SDSS J101048.45+541942.7 | 0.609 | 22.86 | 21.34 | 21.54 | 4 |
| 10 | asteriod   | SDSS J112023.04+444053.5 | 0.677 | 23.25 | 21.22 | 21.60 | 4 |
| 11 | asteroid   | SDSS J154316.78+402634.9 | 1.411 | 20.74 | 20.53 | 19.91 | 1.675 | 0 |
| 12 | star spike | SDSS J000242.70+055035.7 | 1.796 | 24.63 | 23.94 | 21.11 | 0 |
| 13 | star spike | SDSS J001243.07+340053.5 | 0.552 | 24.63 | 23.25 | 21.12 | 0 |
| 14 | star spike | SDSS J004611.72+015954.8 | 1.518 | 24.63 | 23.25 | 21.12 | 0 |
| 15 | star spike | SDSS J010800.09+210417.0 | 0.675 | 24.63 | 23.25 | 21.12 | 0 |
| 16 | star spike | SDSS J011048.45+541942.7 | 0.609 | 22.86 | 21.34 | 21.54 | 4 |
| 17 | star spike | SDSS J011118.84+541942.7 | 0.609 | 22.86 | 21.34 | 21.54 | 4 |
| 18 | star spike | SDSS J012023.04+444053.5 | 0.677 | 23.25 | 21.22 | 21.60 | 4 |

Table 2 57 non-quasars in the DR16Q Quasar catalogue

40 New Quasars

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