Photometric Selection of QSO Candidates From GALEX Sources

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ABSTRACT

We present a catalog of 36,120 QSO candidates from the GALaxy Evolution EXplorer (GALEX) GALEX Release Two (GR2) UV catalog and the USNO-A2.0 optical catalog. The selection criteria are established using known quasars from the Sloan Digital Sky Survey (SDSS). The SDSS sample is then used to assign individual probabilities to our GALEX-USNO candidates. The mean probability is $\sim 50\%$, and would rise to $\sim 65\%$ if relatively crude morphological information were available to eliminate galaxies. The sample is $\sim 40\%$ complete for $i \leq 19.1$. Candidates are cross-identified in 2MASS, FIRST, SDSS, and XMM-Newton Slewing Survey (XMMSL1), wherever such counterparts exist. The present catalog covers the 8000 deg$^2$ of GR2 lying $|b| > 25^\circ$, but can eventually be extended to all 24,000 deg$^2$ that satisfy this criterion.

Subject headings: quasars:general

1. Introduction

One of our most important observational tools is a well-determined system of coordinates against which to measure the position of any given target. QSOs provide a natural means to establish an absolute frame of reference. The major drawback of using such a system today is the strong variation in the density of known QSOs across the sky: the great majority of known QSOs [Veron-Cetty 2006] come from the Sloan Digital Sky Survey (SDSS), which
is spectroscopically identifying quasars with $i \leq 19.1$ with unprecedented completeness over the $\sim 10\,000\,\text{deg}^2$ of the north Galactic cap (Richards et al. 2002). The remaining $\sim 75\%$ of the sky has a much lower density of known quasars.

In this paper, we develop selection criteria to identify quasar candidates from a matched catalog of UV sources drawn from GALaxy Evolution eXplorer (GALEX) GALEX Release Two (GR2) and optical sources with photographic photometry from USNO-A2.0 (Monet 1998). We tune our selection criteria by comparing to known quasars in SDSS Data Release Four (DR4), and we evaluate their efficiency and completeness using this same catalog.

Bianchi et al. (2005) have previously identified QSO candidates by matching GALEX and SDSS sources over a small area of the sky. Because their fields overlap SDSS with its superior photometry and morphological information, their efficiency and completeness are much better than ours, but at the cost of restricting their sample to regions of the sky that already have the densest quasar coverage.

2. Input Catalogs

We select QSO candidates from GALEX GR2, which includes 7077 GALEX AIS pointings covering approximately 8000 square degrees on the sky. GALEX records magnitudes in two bandpasses, the Far UV (FUV) and Near UV (NUV) filters. The FUV filter is characterized by $\lambda_{\text{eff}} = 1528\,\text{Å}$, with a range of 1344 – 1786Å; the NUV filter has $\lambda_{\text{eff}} = 2271\,\text{Å}$, with a range of 1771 – 2831Å (Morrissey et al. 2005). The pointings available in GR2 are broadly distributed over the sky, except regions within $\sim 10^\circ$ of the Galactic disk. The AIS pointings, which constitute the bulk of those available, have 1σ limiting magnitudes of $FUV \approx 20$ and $NUV \approx 20.8$ in the AB magnitude system; the MIS pointings, which overlap approximately 5% of the AIS fields, have 1σ limiting magnitudes of $FUV = 22.6$ and $NUV = 22.8$ (Bianchi et al. 2005).

We match GALEX sources to the USNO-A2.0 catalog, which contains positions, and $B$ and $R$ photometry for $\sim 5 \times 10^8$ sources from the entire sky (Monet 1998). Salim & Gould (2003) find that USNO-A2.0 photometric errors are about 0.25 mag in $R$ and somewhat worse in $B$.

The GALEX team has matched their GR2 sources to SDSS DR4. We tune our selec-

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1http://galex.stsci.edu/GR2/
2ibid.
tion criteria using this GALEX-SDSS data set. We match GALEX sources to USNO-A2.0 by submitting coordinates for all GALEX sources with detections in both FUV and NUV bandpasses to the VizieR search engine, requesting the best match to the USNO sources within $3''$. We then eliminate matches with the “bad-magnitude” flag set. The resulting list of matches contains 1717057 total sources, which constitute the input used to develop our photometric selection criteria. To check the contamination of our sample by false matches, we translate 15000 of our GALEX sources south by 5' and repeat the matching procedure. We find 145 false matches, implying a 1% contamination rate.

Our catalog of matched sources initially contains numerous double-reported GALEX sources, since objects duplicated by repeated pointings at the same patch of sky have not been merged (S. Salim, 2006, private communication). We discuss the elimination of duplicated matches from our catalog in §4.

### 3. Photometric Limit Selection

We seek to develop criteria, using GALEX GR2 and USNO-A2.0 photometry, that select QSO candidates with a high probability of being real and retain as many candidates as possible. The high completeness (Richards et al. 2002) and excellent photometry of the SDSS quasars provides a superb calibration sample with which to tune these criteria.

We start by identifying the subset of GALEX-USNO sources for which SDSS DR4 is essentially complete with regard to QSO selection. First, of course, we demand that the source appear in the Siebert et al. (2005) match of GALEX to DR4. Second, we require $i \leq 19.1$, since SDSS systematically searched for quasars only up to this limit. Finally, we require that there be at least one object within $7.6''$ of the source with an SDSS DR4 spectrum. (We find by direct search that only 0.2% of spectroscopically observed targets fail this last test.)

We display all sources satisfying these three criteria on the $FUV - NUV$ vs. $NUV - R$ (GALEX-USNO) color-color diagram, using red to specify SDSS QSOs (i.e., SDSS quasars that also have point-like morphology) and black for all other objects. We then experiment with various polygons in the GALEX-USNO color-color plane to maximize the number genuine QSOs while minimizing the number of contaminants. Figure 2 shows our adopted polygon and the distributions of QSOs and non-QSOs within it, as well as in neighboring regions just outside.

We use the additional USNO $B - R$ color information in a multidimensional color-color space to isolate QSOs, in analogy to the procedure adopted by Richards et al. (2002)
for SDSS. This additional cut provides only limited discrimination between QSOs and contaminants, due to the large uncertainties in $B$ magnitudes from the USNO-A2.0 catalog (Salim & Gould 2003), but it does help eliminate some stellar outliers.

Table 1 gives our adopted color selection criteria in analytic form. In addition to these color criteria, we find that the number of GALEX-USNO matches drops rapidly for $R \geq 19.6$, and we therefore limit our catalog to $R \leq 19.5$. Finally, by comparing the Galactic-latitude distribution of our QSO candidates to QSOs found in the Veron catalog (Veron-Cetty 2006), we find that we have very little sensitivity for $|b| < 25^\circ$ and therefore do not search for quasars below this limit. We believe this low sensitivity is due to heavy extinction in the $FUV$-band.

4. QSO Candidates

After performing our photometric selection, we eliminate the duplicate candidates that entered the catalog through multiple GALEX exposures. All candidates deemed to come from the same object are examined for UV variability, and those that exhibit variability in both FUV and NUV bands at a level greater than 1σ are flagged as variable. The GALEX magnitudes recorded in the catalog are averaged over all available observations. For candidates that do not exhibit UV variability, we use the magnitudes from the first appearance in the catalog. Our initial sample of QSO candidates includes 43345 GALEX sources down to a limiting magnitude of $R = 19.5$, of which we retain 36120 after eliminating duplicates.

4.1. Candidate Probability Assessment

We assess the probability that each candidates is a QSO by assuming that the ratio of QSO to non-QSO at fixed USNO-GALEX color-colors is independent of apparent magnitude and position on the sky. In particular, we assume that it is the same for SDSS DR4 objects with $i \leq 19.1$ (for which we have substantially more data) as it is for the rest of our catalog. We observe that most SDSS quasars occupy a relatively small region in $ugr$ color-space, which we call the “SDSS QSO Selection Area”⁢. See Figure 2. Taking advantage of this correlation,

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3The use of this name does not indicate any specific correlation with the SDSS spectroscopic target selection algorithm; it is simply a term of convenience. For details on the procedure SDSS uses to select quasar candidates for spectroscopy, see Richards et al. (2002).
we scale the probability according to the $R$-magnitude of the candidate by accounting for the number of candidates that fall into the “SDSS QSO Selection Area” as a function of $R$,

$$P(R, FUV, NUV) = P_0(FUV - NUV, NUV - R) \left\{ \frac{N_{\text{qso area}}}{N_{\text{all}}} \right\}_R \left\{ \frac{N_{\text{qso area}}}{N_{\text{all}}} \right\}_{i \leq 19.1}^{-1}$$

(1)

where $N_{\text{qso area}}$ is the number of sources that fall within the region defined by the black lines in Figure 2 and $P_0(FUV - NUV, NUV - R)$ is determined by dividing the number of SDSS QSOs by the total number of point sources within a radius of 0.05 mag in USNO-GALEX color-color space.

The first factor in equation (1) would give the probability that a candidate is a QSO if it were (somehow) known $a priori$ to have $i \leq 19.1$. However, for most candidates there are no SDSS data. The second factor therefore accounts for the fraction of sources at fixed $R$ that fall into the $ugr$ color-color region that includes almost all SDSS quasars. Finally, the third factor is the correction accounting for the fact that not all SDSS quasars with $i \leq 19.1$ actually fall into the “SDSS QSO Selection Area,” and that this missing fraction is already included when calculating $P_0(FUV - NUV, NUV - R)$. The dependence of the second factor on $R$, for both all sources and SDSS point sources only, is shown in Figure 3.

For the candidates in our catalog, we calculate separate probabilities that the candidate will be an extended source, and therefore not a QSO (see §3), and that a given candidate will be a QSO, assuming that it is a point source. The extended-source probabilities are computed by using the density of SDSS extended sources relative to SDSS point sources in a given area of the USNO-GALEX color-color space,

$$P_{\text{ext}} = 1 - \left[ P_{i \leq 19.1} P_{ps,i \leq 19.1} + (1 - P_{i \leq 19.1}) P_{ps,i > 19.1} \right]$$

(2)

where $P_{i \leq 19.1}$ is the probability that a candidate with a given $R$-magnitude will have $i \leq 19.1$, while $P_{ps,i \leq 19.1}$ and $P_{ps,i > 19.1}$ are the conditional probabilities that a candidate with a given color will be a point source for $i \leq 19.1$ and $i > 19.1$, respectively. The conditional probabilities employed here are calculated in the same way as $P_0(FUV - NUV, NUV - R)$ from equation (1).

The total probability that a given source is a QSO is obtained by multiplying the probability that a point source with given colors is a QSO by the probability that the candidate is a point source, i.e.,

$$P_{\text{qso}} = P_{\text{qso,ps}} (1 - P_{\text{ext}})$$

(3)

The distribution of total probabilities that we calculate is labeled “Total” in Figure 4.
Upon integrating the total probabilities, we find that \( \sim 20\,200 \) of our candidates should be genuine QSOs, yielding a selection efficiency of 52\% for our catalog as a whole. This efficiency is reasonably good in that only half the time of a spectroscopic follow-up study would be spent taking spectra of non-QSOs. The efficiency could be further improved by “pre-screening” the candidates with snapshot images to eliminate extended sources. This would require only \( \sim 1 \) minute exposures on a 1m telescope, and would improve the overall efficiency to 65\%.

It should be noted that, while we have matched many of our candidates to various existing catalogs, we have not taken any such matches into account in our probability calculation, except insomuch as we have used SDSS quasars to determine \( P_0(FUV - NUV, NUV - R) \) and SDSS photometry to determine the conditional probabilities \( P_{ps,i \leq 19.1} \) and \( P_{ps,i > 19.1} \). See §4.4 below, for further discussion of our matches with existing catalogs.

### 4.2. Comparison With Sloan Digital Sky Survey

Of the 36,120 QSO candidates selected by our algorithm, 18,284 fall within the area covered by SDSS DR4, and 5,187 are SDSS quasars. There are a total of 5,969 candidates that have SDSS spectra, so there must be at least 782 candidates in DR4 that are not quasars. Of the sources without SDSS spectra, 10,119 have SDSS \( i > 19.1 \), and so are unlikely to have been selected for SDSS spectroscopy [Richards et al. 2002]. Of the remaining candidates, 2,144 fall more than 7′6 from the nearest DR4 spectroscopic target, indicating that they lie in regions where spectroscopy has not yet been performed. (See §3.)

There are a total of 19,116 SDSS QSOs with \( i \leq 19.1 \) having counterparts in GR2, of which 4,277 are identified as candidates by our criteria. This yields a total completeness of 22\% for our selection criteria with respect to the SDSS quasars. However, the number of SDSS quasars in the input sample might provide a more appropriate basis for comparison. The input sample, restricted to GR2 sources with USNO-A2.0 matches and detections in both the FUV and NUV bands, contains 11,321 SDSS quasars, yielding a completeness of \( \sim 38\% \). Of the 7,795 “missing” sources, most (6,935) had no FUV detections.

### 4.3. Comparison With USNO-B

We determined that it should be possible to reduce the fraction of foreground stars in our catalog by extracting the measured proper motions and star-galaxy determinations in the USNO-B catalog. Eliminating candidates with proper motions greater than twice
the inherent uncertainty in the USNO-B proper motions leaves 27,752 candidates out of 36,084 with matches in the USNO-B catalog. This cut reduces the number of SDSS quasars with proper motions measured by USNO-B from 5,153 to 4,566. This is a reduction of 11%, compared to a 23% reduction in the total number of candidates, which means that it improves the fraction of genuine QSOs in the catalog. We have not eliminated the candidates with measurable proper motions from our catalog, electing instead to list the proper motions and allow individual users to decide how to apply a proper motion cut.

4.4. Comparison With Other Catalogs

In addition to SDSS, we compare our candidates to sources in 2MASS, the FIRST survey, the XMM-Newton Slewing Survey (XMMSL1) (Freyberg et al. 2006) and the most recent Veron catalog of known QSOs (Veron-Cetty 2006). We match our candidates to the Veron QSOs and 2MASS point sources via the VizieR search engine, requiring that the distance from the matched source to the candidate be less than 5". We find 5,889 candidates with counterparts in the Veron catalog, out of a total of 9,013 unique GR2 sources with Veron counterparts. This indicates a completeness of 65% with respect to Veron QSOs. It is interesting to note that only 702 of the candidates with matches in Veron fall outside the SDSS footprint. This very strongly demonstrates the need for more uniform QSO candidate selection across the sky.

We also find 4,226 candidates with 2MASS counterparts from a total of 470,992,970 objects in the 2MASS All-Sky Catalog of Point Sources (Cutri et al. 2003). In their discussion of photometric selection of obscured QSO candidates using 2MASS colors, Barkhouse & Hall (2001) indicate that $B - J < 2$ is characteristic of most optically-selected QSOs. While not necessarily reflecting whether the selected candidates are genuine, the fact that 90% of our candidates have $B - J < 2$ is reassuring. Also of use is the fact that, because these 2MASS sources are members of the point source catalog, they are less likely to be galaxies than candidates in the general population. Specifically, we find that 26.6% of candidates with SDSS counterparts exhibit extended morphology in SDSS photometry, while only 6.8% of candidates with both SDSS and 2MASS counterparts are extended. However, this strong improvement is due largely to the relatively bright limiting magnitude of the 2MASS survey. If we restrict our examination to candidates with $R \leq 17.7$, at which point the number of candidates with 2MASS counterparts flattens, we find that 6.45% of candidates with SDSS counterparts are extended, compared to 2.75% of those with both 2MASS and SDSS counterparts. Thus, bright candidates with 2MASS counterparts are somewhat less likely to exhibit extended morphology than other candidates, and would therefore yield a slight improvement.
in observational efficiency compared to the catalog as a whole.

The procedure to match our candidates with the FIRST catalog is similar, with the exception that we do not use the VizieR search engine but the web-based search tool run by the FIRST team. Again using a limiting search radius of 5″, we find that 720 of our candidates have counterparts in the FIRST catalog.

To match our candidates with the objects contained in XMMSL1, we acquire the complete catalog from the XMM-Newton Science Archive website and use the tdump routine in the IRAF tools package to extract the columns of interest. We eliminate any sources with a warning flag and search the remaining objects for positions within 2σ of our candidates. We take this approach, rather than using a fixed search radius, because of the high variation in positional uncertainty from one XMMSL1 object to the next. From the 2692 sources in XMMSL1 (Freyberg et al. 2006), we find 20 that match our QSO candidates.

See Figure 5 for Galactic positions of the candidates, including matches to the Veron, FIRST and XMMSL1 catalogs.

4.5. Catalog Description

The catalog of candidates, which is organized by Right Ascension and appears in Table 3, includes 36,120 candidates, after duplicated GALEX observations have been eliminated. It contains 17 fields, including sky coordinates and identifiers from both the USNO-A2.0 and GALEX catalogs. Also included are two flags classifying the matches we have made to other catalogs. The first is the character flag indicating matches with Veron, 2MASS, XMMSL1 and FIRST. This flag consists of one or more characters that are added for matched candidates; ‘V’ indicating a match to Veron, ‘M’ to 2MASS, ‘X’ to XMMSL1 and ‘F’ to FIRST. In addition to these character flags, there is a numeric flag indicating the nature of any SDSS counterpart. The allowed values of this flag and their meanings are summarized in Table 2.

As discussed in § 4.3, we have included proper motions from USNO-B for the great majority of candidates. These are listed in the catalog in mas yr⁻¹, as they are in the USNO-B catalog. A small number of candidates (∼30) have no identifiable counterpart in USNO-B, and so have no available proper motion. We have flagged these candidates by listing ‘−99’ in place of their proper motions.

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4http://sundog.stsci.edu/cgi-bin/searchfirst
5. Follow-Up

Following our candidate identification, we selected a group of targets that did not have SDSS spectroscopy available from DR4 and that were visible from the MDM Observatory in Tucson, Arizona during early October. Using the CCDS spectrometer on the 2.4m Hiltner Telescope, we obtained low signal-to-noise ratio spectra, sufficient for identification purposes, for seven candidates. We found three of these to be QSOs. Only one of the objects for which we obtained spectra falls into the SDSS area (0825-19933778), and while it was targeted as a QSO candidate by SDSS, our spectrum indicates that it is a galaxy. Also, it is worth noting that none of the three objects that we have identified as QSOs in Table 4 appear in the most recent Veron catalog (Veron-Cetty 2006).

From the cumulative calculated probabilities, discussed in §4.1 above, we would expect 4.3 of our targets to be quasars, so our finding three genuine QSOs is consistent with our calculated probabilities. A list of our spectroscopic targets and their identifications is given in Table 4.

In addition to taking spectra, we also examine SDSS information for a number of our candidates for spectroscopy, since more data have become available in DR5. We find SDSS information available for 81 of our potential targets, of which 19 are identified as quasars by SDSS. An additional 23 were selected by SDSS as possible quasars, and as of DR5 are awaiting follow-up spectroscopy. A list of the candidates with DR5 information, and the associated identifications, is given in Table 5. By again summing our calculated probabilities, we predict that 40.2 candidates should be QSOs, which is again consistent with the number of observed QSOs and targets for spectroscopy. In conjunction with the results of our observations, this larger sample indicates that our probability calculation is performing reasonably well.

6. Conclusions

We have developed tight photometric selection criteria, allowing us to identify a large number of QSO candidates, across $\sim 8000$ deg$^2$ of the sky. Since the GALEX AIS survey will cover the entire sky, it should be possible to apply our criteria to new data as they become available, identifying numerous additional QSO candidates, and eventually covering the entire sky with $|b| \geq 25^\circ$.

The contamination of our catalog by the presence of a significant number of galaxies, apparent from a cursory examination of Tables 4 and 5, should not come as a surprise given the purpose of the GALEX survey. The presence of a large number of galaxies means that one
significant source of contamination can be eliminated using good-quality imaging, without even the need for precise photometry. This is advantageous, since many of the point-source contaminants appear to be white dwarfs, many of which could be eliminated using their proper motions.

While the contamination of our catalog by galaxies and foreground stars is significant, and presents a challenge for follow-up observations, our algorithm selects numerous strong candidates. It is also possible that, in many cases, the contaminants (i.e., non-QSOs) in our sample may themselves be of considerable scientific interest. While we have not done extensive analysis, it appears that a combination of our selection criteria and a good proper motion catalog could allow the identification of a number of nearby hot white dwarfs.

It should be possible to select good targets for further study based on the calculated probabilities and other information available from our catalog, including the presence of matches to one or more additional catalogs and the proper motions measured in USNO-B. The effort required to follow up any significant fraction of the candidates in the catalog will be considerable, but a careful application of the available information should allow a reasonable observational efficiency.

We are grateful to Samir Salim for sharing his insights about the GALEX data products, as well as to the Space Telescope Science Institute and MAST for providing convenient access to those data. We owe tremendous thanks to the GALEX Team and the United States Naval Observatory, without whose work our analysis would not have been possible. Our work was supported by grant AST 04-52758 from the National Science Foundation (NSF).

This publication makes use of data products from the Faint Images of the Radio Sky at Twenty-cm (FIRST) survey, the Sloan Digital Sky Survey, and the Veron quasar catalog. We wish to thank the organizers of these catalogs, who have helped make the discussion in §4.4 possible. This work makes use of data products from the Two Micron All Sky Survey, which is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation. This work is partially based on observations obtained with XMM-Newton, an ESA science mission with instruments and contributions directly funded by ESA member states and NASA. We have made use of the VizieR catalog access tool, CDS, Strasbourg, France.

REFERENCES


Cutri R.M., et al. 2003, 2MASS All-Sky Catalog of Point Sources. NASA/IPAC Infrared Science Archive


Monet, D.G. 1998, AAS, 30, 1427


Table 1: The color criteria applied to GALEX-USNO merged sources to select candidates. We require that each boundary be individually satisfied, eliminating as much background as possible while still retaining a reasonable number of candidates. There are additional photometric and positional criteria applied to select candidates, as discussed in §3.
Fig. 1.— Selection criteria (bold lines) for QSO candidates on a color-color diagram derived from GALEX ($FUV$ and $NUV$) and USNO-A2.0 ($R$) photometry. SDSS quasars are in red, and other point sources with are in black. All displayed sources have $i \leq 19.1$. 

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The diagram shows a color-color plot with two axes: $NUV - R$ on the horizontal axis and $FUV - NUV$ on the vertical axis. The points are color-coded: red for SDSS quasars and black for other point sources. The selection criteria are highlighted by bold lines on the plot.
Fig. 2.— Distribution of candidates in the SDSS $ugr$ color-color space with QSOs (red), other SDSS point sources (blue), and SDSS extended sources (green). The solid line indicates the boundary of the “SDSS QSO Selection Area,” used in the calculation of QSO probabilities. This figure includes only candidates with $i \leq 19.1$; the corresponding diagram for sources with $i > 19.1$ has a similar overall shape, but there are many more extended sources and fewer SDSS quasars at fainter magnitudes.
Fig. 3.— Probability that a candidate with a given $R$ magnitude will fall inside the “SDSS QSO Selection Area” in Fig. 2, both for all sources (triangles) and SDSS point sources (squares). The probabilities shown for $R = 17.0$ include all candidates with $R \leq 17.0$. 
Fig. 4.— Distribution of calculated probabilities that candidates are actually quasars. The *long-dashed* histogram gives the distribution of total probabilities that candidates will turn out to be QSOs; the *short-dashed* histogram shows the distribution of probabilities that candidates would be identified as extended sources in a short imaging exposure, and the *solid* histogram shows the distribution of conditional probabilities assuming that all candidates were subsequently identified as point sources.
Fig. 5.— Aitoff Projection of candidates in Galactic coordinates, including 5889 known QSOs with counterparts in Veron (mostly SDSS) (red), 702 candidates with FIRST counterparts (cyan) and 20 counterparts in XMMSL1 (magenta). All remaining candidates are shown in black.
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Table 2: A summary of the allowed values of the SDSS field in the catalog and the meaning associated with each value.
Table 3. Catalog of QSO candidates. The Flags field describes any matches to other catalogs, and is coded thus: V (Veron), M (2MASS), F (FIRST) and X (XMMSL1). The columns labeled \( \mu_\alpha \) and \( \mu_\delta \) list the proper motions in the right ascension and declination directions, respectively, in units of mas yr\(^{-1}\). The \( \Delta \) values are listed in arcseconds, and \( \Delta A = A_{\text{galex}} - A_{\text{usno}} \). All sky coordinates are listed in J2000 equinox. The SDSS flags are coded as described in Table 2.

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Table 4. Targets of limited spectroscopic follow-up and resulting identifications. Candidates are listed in order of decreasing conditional probability, $P_{qso,ps}$.

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<th>$\delta_{galex}$</th>
<th>B</th>
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<th>FUV</th>
<th>NUV</th>
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<th>$P_{qso,ps}$</th>
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Table 5. Candidates for spectroscopy with additional photometric or spectroscopic information from SDSS DR5. Candidates marked ‘target’ were selected by SDSS as potential QSOs, and are awaiting SDSS spectroscopy. Candidates are listed in order of decreasing conditional probability, $P_{qso, ps}$.

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<th>UsnoA2</th>
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