ULTRAVIOLET ASTRONOMY IN THE XXI CENTURY

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JcUVa

Classification of GALEX UV sources from cross-matched GUVcat X SDSS and Gaia databases (GUVmatch)

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ABSTRACT: We have matched the ~83million ultraviolet (UV) GALEX sources from GUVcat_AIS (Bianchi et al. 2017) with Gaia data release 2 (DR2), yielding 31,925,294 Gaia DR2 counterparts to 30,024,791 GUVcat_AIS unique sources (18,588,140 matches have a parallax measurement with error less than 30%), and with SDSS DR14, yielding 23,310,532 SDSS counterparts to 22,207,563 unique GUVcat_AIS sources, 10,167,460 of which are pointlike. Gaia DR2 covers the whole GUVcat_AIS footprint, while GUVcat X SDSS has a total overlap area of ≈11,100 square degrees (Bianchi et al. 2019: AREAcat). The UV-optical colors of sources in the GUVmatch databases are used to identify classes of astrophysical objects that are prominent in UV, such as stars in different evolutionary stages, low-redshift QSOs and galaxies.

Relevant information:

Match radius: 3''. The positions agree to <1.5'' for the majority of pointlike matched sources, a 3'' match radius is used to identify sources with possible multiple matches whose UV flux could be unresolved in GALEX imaging but resolved in Gaia and SDSS. The catalog can be trimmed to a smaller match radius using tag DSTARCSEC

Multiple matches: tags are provided to identify multiple matches

Incidence of spurious matches: at 3'' similar to secondary matches

Other useful tags: INLARGEOBJ, LARGEOBJSIZE (flag GALEX sources in extended objects such as nearby galaxies or clusters)

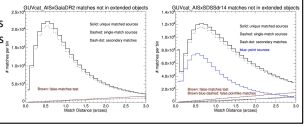


Figure: Distribution of separation between the GUVcat_AIS UV source position and the matched-source position (Gaia DR2, left panel; SDSS DR14, right panel).

Where to find GUVmatch catalogs:

Reference: Bianchi & Shiao 2020 ApJS, 250:36, arXiv:2007.03808

***Uvsky* website**: http://dolomiti.pha.jhu.edu/uvsky (.fits and .csv files, more info)
(also in the same site : AREAcat tool to compute area of sky coverage in any desired region, and GUVcat)

MAST Casjobs interface, context 'GALEX_Catalogs'
(http://mastweb.stsci.edu/gcasjobs/)

MAST HLSP (High Level Science Products) at http://archive.stsci.edu/hlsp/guvcat [doi:10.17909/t9_pyxy_kg53] - same files as in the UVsky website

Vizier: not yet, GUVmatch catalogs will be included as soon as possible

The Catalogs

GUVmatch_AISxSDSSdr14

http://dolomiti.pha.jhu.edu/uvsky/GUVcat/GUVmatch_AISxSDSSdr14.html

The matching yielded 23,310,532 counterparts to 22,207,563 unique GUVcat _AIS sources,

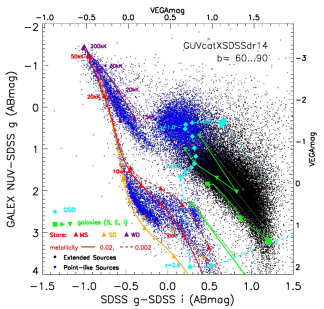
10,167,460 of which are pointlike,

over a total overlap area of ≈ 11,100 square degrees (Bianchi et al. 2019, AREAcat)

SDSS adds five optical magnitudes (*u, g, r, i, z*) to the GALEX FUV, NUV photometry and optical spectra of 860,224 matched sources

All original magnitudes are in the ABmag system

Pointlike vs Extended



For SDSS matches, we used the tag TYPE that gives a purely morphological classification of pointlike (TYPE=STAR) or extended (TYPE=GALAXY). In the color-color diagram, model colors (symbols connected by colored lines) for stars and QSOs match locus's of pointlike sources (blue) while galaxy models (green) match the extended sources locus (black data points)

Source Content

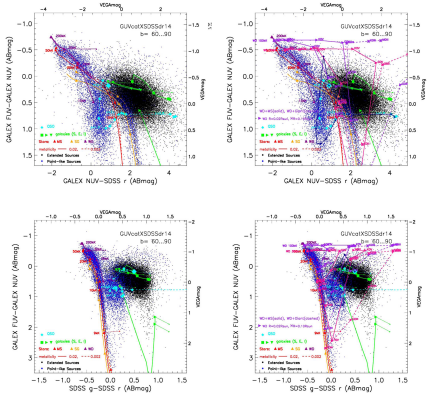
Color–color plots of GUVmatch_AISxSDSSdr14 sources, in the 60°–90° north Galactic latitude range, showing GALEX NUV-g (left) and FUV–NUV (right). In the rightmost panels, composite model colors are added for WD+main-sequence or WD+giant binaries, for WDs of Teff = 100,000 K (purple) and 30,000 K (dark pink) and radii of R_{WD} = 0.1Rsun(log g = 6) and R_{WD} = 0.02Rsun(log g = 8) with less evolved companions of representative spectral types. The model colors of a single WD with these parameters are also shown for reference. Also (right), QSO templates with enhanced Ly_alpha from Bianchi et al. (2009 AJ, 137, 3761) are shown in dark blue (right panels): Ly_alpha transits in the GALEX FUV band at redshifts between 0.1 and 0.47 and between 0.48 and 1.63 in the NUV band, causing two opposite spikes in FUV–NUV with respect to the standard template (cyan). Such QSOs (about 5% in the sample of Bianchi et al. 2009) overlap with colors of some binaries including a hot WD and a cooler star.

The lower panels (right) plot an optical color in the X-axis; note the different scale and the much reduced sensitivity to discern object types and stellar gravities, with respect to UV—optical color (top plots).

The lower plots show a wider FUV–NUV Y-range, to include cooler sources; the top plots have a narrower FUV–NUV Y-range to better show the hot-WD binaries.

Model colors: purple = WD with logg =7 and 9; red= main sequence stars, yellow= supergiants (some Teff values marked for stellar models), cyan=QSOs (redshifts labeled), green= galaxies (varying ages)

Stellar Binaries



GUVmatch_AISxGaiaDR2

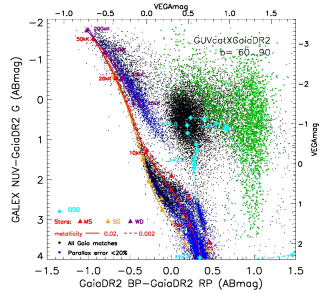
http://dolomiti.pha.jhu.edu/uvsky/GUVcat/GUVmatch_AISxGaiaDR2.html

Of the ~83million GUVcat_AIS_FOV055 sources, we found:

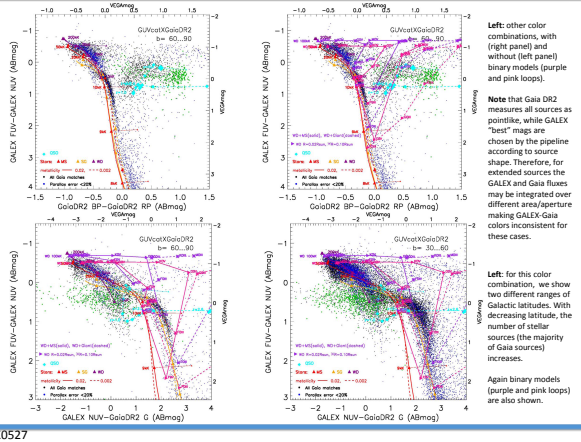
31,925,294 Gaia DR2 counterparts to 30,024,791 GUVcat _AIS unique sources, they add to the GALEX FUV and NUV measurements photometry in the Gaia G band, often also in Gaia BP and RP bands;

26,275,572 matches have a parallax measurement: of these, 21,084,628, 18,588,140, and 16,357,505 have a parallax error less than 50%, 30%, and 20%, respectively.

The area coverage is the same as GALEX_AIS (see Bianchi et al 2019, AREAcat) NOTE: GALEX mags are ABmag, Gaia are kept in Vegamag (to keep original data; transformations are provided by Bianchi & Shiao 2020).



Gaia does not have specific tags to classify source shape. We used a combination of tags with values indicative of a bad fit to the Gaia nominal PSF, suggestive of a non-pointlike source shape – such as an extended object. These are marked with green dots and approximately match the expected galaxies locus. Blue dots here mark sources with parallax error <20%. Many cool sources have a good parallax, in fact cooler sources have fainter UV emission thus only the nearby ones are seen by GALEX.

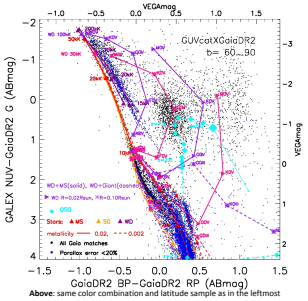


Left: other color combinations, with (right panel) and without (left panel) binary models (purple and pink loops).

Note that Gaia DR2 measures all sources as pointlike, while GALEX "best" mags are chosen by the pipeline according to source shape. Therefore, for extended sources the GALEX and Gaia fluxes may be integrated over different area/aperture making GALEX-Gaia colors inconsistent for these cases.

Left: for this color combination, we show two different ranges of Galactic latitudes. With decreasing latitude, the number of stellar sources (the majority of Gaia sources) increases.

Again binary models (purple and pink loops) are also shown.



Above: same color combination and latitude sample as in the leftmost panel, but only sources with more stringent error cuts in all filters are shown. The effect of error cuts is to decrease the number of sources, and to make the features corresponding to different object classes sharper, i.e. the loci in the color-color diagram more defined. See for example the marked sequence of low-metallicity supergiants (numerous because well measurable at larger distances) between Teff~10,000K and ~8kK. Here binary models colors are also shown (hot WD + cooler star), as described above for the SDSS matches, with purple/pink loops

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