Combing the WISE W4 catalogue and the Gaia Data Release 1: Searching for Infrared bright, optically faint objects across the full sky.

May 30, 2017

1   Motivation

The WISE W4 23μm band is shallow. Therefore, anything that is detected in W4, and is *not* a Milky Way star, or nearby e.g. dusty spiral galaxy, is going to be intrinsically very luminous. Furthermore, objects that are also detected in W4, but are faint/non-detected in the optical, or in the shorter WISE W1/W2 bands also have very interesting properties, (e.g., Assef et al., 2015; Tsai et al., 2015; Lonsdale et al., 2015; Assef et al., 2016; Díaz-Santos et al., 2016; Ricci et al., 2017; Wu et al., 2017; Jones et al., 2017; Farrah et al., 2017). The WISE W4 band is also crucial in the discovery and characterization of the "Extremely Red Quasar" population, using a colour selection of $r_{\mathrm{AB}}W4_{\mathrm{Vega}} > 14.0$ (Ross et al., 2015; Zakamska et al., 2016; Hamann et al., 2017).

Note, the W4 channel effective wavelength was recalibrated from the original 22μm by Brown et al. (2014).

2   Matching the Gaia DR1 and WISE W4 catalogs

2.1   WISE

The Wide-field Infrared Survey Explorer (WISE) mission description and initial on-orbit performance is described in Wright et al. (2010). We use the `AllWISE Data Release`.

There are 40,939,966 objects, with $> 2\sigma$ detections at WISE W4 in the AllWISE Catalog. The W4 PSF is 12", but the centroid positions should be good to $\lesssim 2''$ (WISE HelpDesk, priv. comm.). Figure 1 shows the sky distribution of these 40.9M objects. The WISE scanning pattern can clearly be `seen`.

2.2 Gaia DR1

We use the `Gaia Data Release 1`. (Gaia Collaboration et al., 2016,?)[1]

The Gaia DR1 magnitude histogram peaks around 20th magnitude in G-band. The G-band is a very wide filter, that covers the wavelength range frthat covers the wavelength range from about 350 to 1000nm, with the maximum energy transmission at $\sim$715 nm and the full width at half maximum of 408 nm. (Jordi &. Carrasco, 2007, ASPC, 364, 215).

There are 1,142,679,769 sources in total in the Gaia DR1.

2.3 Matching

We match the two catalogues with a matching radius of 2" and 10". This is done using some v. nice and quick code from R. Collins [More details required here]. The results are given in Figure 2 and Figure 4. Figure 3 shows the WISE W4 Unique ID (UID; which isa a proxy for object declination) versus the Gaia DR1 Source ID.

3 Results of matching

The matched 10" GaiaDR1xWISEW4 catalogue returns 71,593,922 objects since one-to-many (WISE-to-Gaia) matches are allowed. The Python `numpy unique` command is used to return the sorted unique elements of this catalogue. 24,671,865 WISE W4 objects have a unique match with a Gaia source within 10".

Thus, 16,268,101 objects in the WISE W4 catalogue do not have a

Figure 4 shows the matching radius separation histograms for objects, with and without duplicates.

Figure 5 (top) shows the all-sky distribution for the full 40.9M objects that are detected in WISE W4 (same as Figure 1 but with a different colourscale). Figure 5 (middle) shows the all-sky distrubtion of objects that were matched to a Gaia DR1 source. The overdensity of the Milky Way is clearly seen. Figure 5 (bottom) shows the 16.3M objects that do *not* have a match in the Gaia DR1.

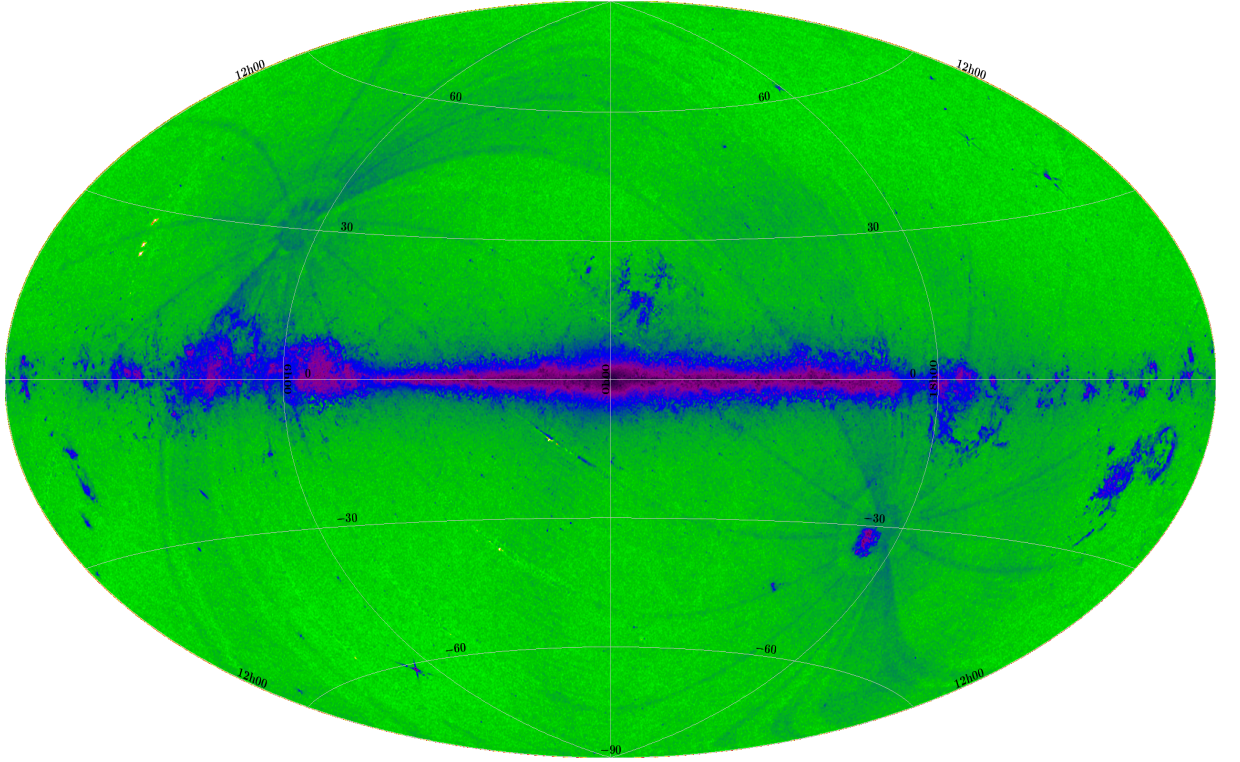[1]I don't know how to fix this citation.

Figure 1: The all-sky distribution of the 40.9M objects in the AllWISE W4 catalog. The WISE scanning pattern can clearly be seen.
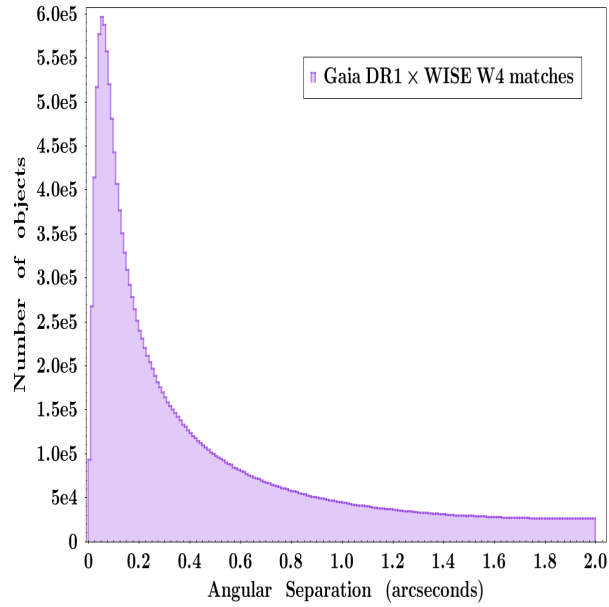

Figure 2: Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aliquam porta sodales est, vel cursus risus porta non.
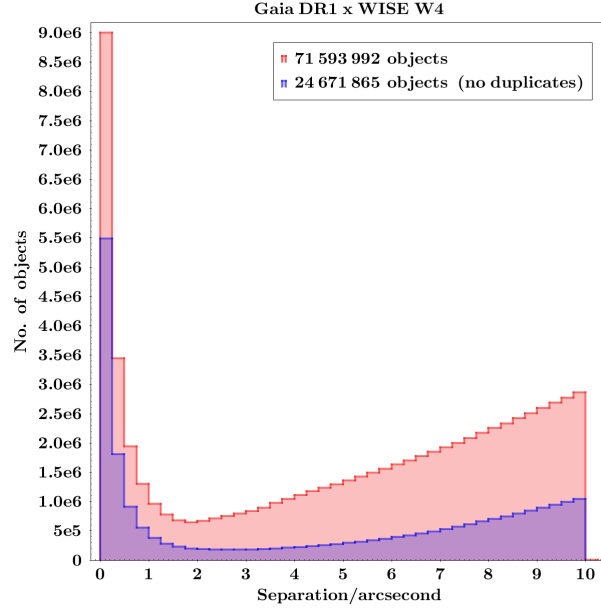
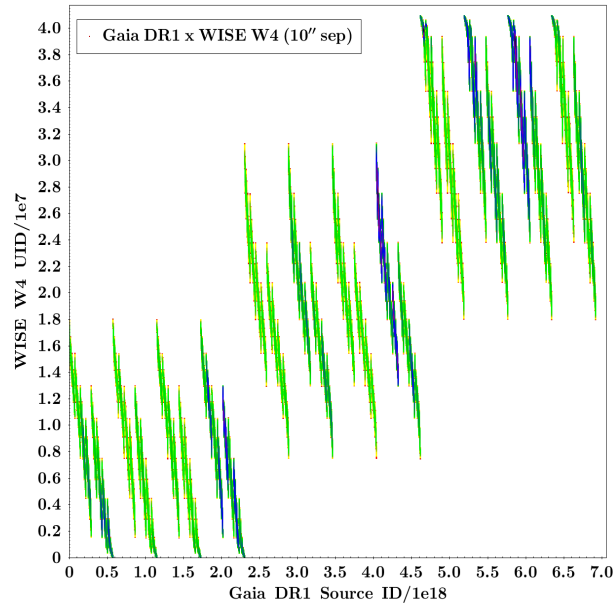Figure 3: The matching radius separation histograms for objects, with and without duplicates.

Figure 4: The WISE W4 Unique ID (UID; which isa a proxy for object declination) versus the Gaia DR1 Source ID.

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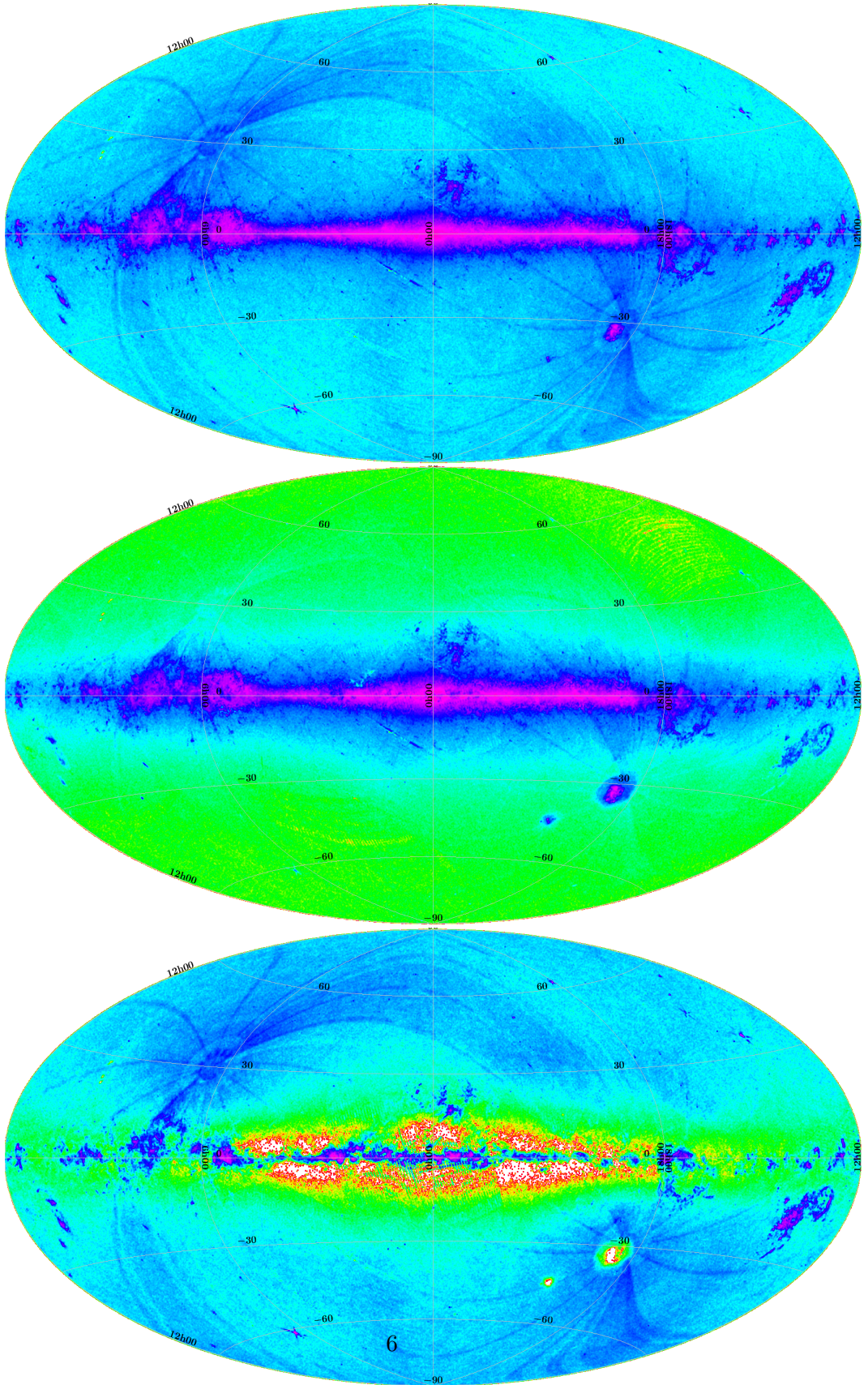
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Figure 5: Three aitoff projects for the Gaia DR1×WISE W4 matched catalog. *Top:* The full 40.9M objects that are detected in WISE W4. *Middle:* The 24.7M WISE W4 objects that are matched to a Gaia DR1 source. *Bottom:* The 16.3M WISE W4 objects that are not matched to a Gaia DR1 source.