

# The WISE *W*4 Compendium

Nicholas P. Ross<sup>1\*</sup>

<sup>1</sup>*Institute for Astronomy, University of Edinburgh, Royal Observatory, Edinburgh, EH9 3HJ, United Kingdom*

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## ABSTRACT

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**Key words:** Astronomical data bases: surveys – Quasars: general – galaxies: evolution – galaxies: infrared.

## 1 INTRODUCTION

Along with nuclear fusion, gravitational accretion onto a black hole is one of the two major energy sources available to a galaxy. After dark matter, dust in galaxies is the most poorly understood constituent of galaxies. Sky surveys, in new electromagnetic wavebands, have long provided key datasets and led to new insights into our Universe. In this paper, we present the “WISE *W*4 Compendium” (WW4C); a detailed study into the objects that were detected in the longest waveband, 20–28 $\mu$ m observed, on the Wide-Field Infrared Survey Explorer (WISE; Wright et al. 2010; Cutri 2013) mission. This study will describe all 40 million objects that are detected in the WISE *W*4-band, but will concentrate on those objects most affected by radiating dust emission and well described by extragalactic, and AGN, spectral energy distributions (SEDs). The motivations of the WW4C are numerous, but the primary science we will pursue is the identification of bolometric luminous AGN, especially those that might not be observed in X-ray/UV/optical surveys. However, we will aim to remain as agnostic as possible to the origin of the objects that are emit in the mid-infrared.

WISE mapped the sky in 4 passbands, in bands centered at wavelengths of 3.4, 4.6, 12, and 23 $\mu$ m. In total the release all sky “ALLWISE” catalog, contains nearly 750 million detections at high-significance<sup>1</sup>. This dataset is a significant advance in quality and depth than prior missions, and will remain the all-sky state-of-the-art for the foreseeable future.

Numerous studies have investigated the WISE MIR All-

Description	# objects	% of Total
AllWISE Source Catalog	747,634,026	100.0000
All <i>W</i> 4 detections	40,939,966	5.4759
<i>W</i> 4 Only	35,818	0.0048

**Table 1.**

WISE data release for various scientific reasons. Indeed there are too many studies to mention here and do all justice to their findings. As such, we concentrate with those with a AGN flavour.

Assef et al. (2013), Stern et al. (2012)

### 1.1 A Few Preparatory Notes

Brown et al. (2014), in PASA, is the paper about Recalibrating the Wide-field Infrared Survey Explorer (WISE) *W*4 Filter,

Brown et al. (2014), in ApJS, is the paper about An Atlas of Galaxy Spectral Energy Distributions from the Ultraviolet to the Mid-infrared.

## 2 DATA

There are 747,634,026 total entries in the AllWISE Source Catalog. Of these, 40,939,966 (5.476%) are *W*4-detected.

\* email: npross@roe.ac.uk

<sup>1</sup> [http://wise2.ipac.caltech.edu/docs/release/allwise/expsup/sec2\\_1.html](http://wise2.ipac.caltech.edu/docs/release/allwise/expsup/sec2_1.html)

### 3 THE WW4C

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#### 3.1 Dust Overview

<http://arxiv.org/pdf/1605.06671.pdf>

### 4 GALACTIC OBJECTS IN THE WW4C

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#### 4.1 Stars

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#### 4.2 Brown Dwarfs

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#### 4.3 PNe

<http://www.astroscu.unam.mx/apn6/PROCEEDINGS/Kronberger.pdf>  
Kronberger et al. 2014

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## 5 LOCAL EXTRAGALACTIC OBJECTS

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### 5.1 Spirals in the Beam

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### 5.2 Merging Systems

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## 6 DISTANT EXTRAGALACTIC OBJECTS

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cursus accumsan. Maecenas sit amet libero in elit mattis iaculis sed quis elit. Pellentesque vitae mauris nunc.

### 6.1 The so-called “DOGs”

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## 7 AGN

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### 7.1 Mullaney SEDs

### 7.2 Number Density of High- $z$ Sources

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## 8 CONCLUSIONS

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Mission Part	Duration	Cryogenic?	Connected Data Release	Detected Objects combination	det_bit	Number of objects	Percentage of AllWISE
First 105 days	14 January 2010 to 29 April 2010	Yes	Preliminary	W1-W2-W3-W4	15	25 882 083	3.5
				W1-W2-W4	11	11 309 923	1.5
				W1-W4	9	2 347 472	0.3
				W1-W3-W4	13	859 426	0.1
				W3-W4	12	454 160	0.1
				W1	8	35 818	<0.1
				W2-W3-W4	14	35 528	<0.1
				W2-W4	10	15 556	<0.1
				W4-any		40 939 966	5.5

**Table A1.** Band-Detection Combinations ( $> 2\sigma$  per Band) in the AllWISE Catalog. See [http://wise2.ipac.caltech.edu/docs/release/allwise/expsup/sec2\\_1.html](http://wise2.ipac.caltech.edu/docs/release/allwise/expsup/sec2_1.html).

consectetur tempus ac eget est. Curabitur malesuada arcu sit amet metus dictum at dapibus arcu accumsan. Fusce sollicitudin luctus rutrum.

- This sample spans a redshift range of  $0.28 < z < 4.36$  and has a bimodal distribution, with peaks at  $z \sim 0.8$  and  $z \sim 2.5$ .

- We recover a wide range of quasar spectra in this selection. The majority of the objects have spectra of reddened Type 1 quasars, Type 2 quasars (both at low and high redshift) and objects with strong absorption features.

- There is a relatively high fraction of Type 2 objects at low redshift, suggesting that a high optical-to-infrared colour can be an efficient selection of narrow-line quasars.

- There are three objects that are detected in the W4-band but not W1 or W2 (i.e., “W1W2-dropouts”), all of which are at  $z > 2.6$ .

- We identify an intriguing class of objects at  $z \simeq 2 - 3$  which are characterized by equivalent widths of REW(C IV)  $\gtrsim 150\text{\AA}$ . These objects often also have unusual line properties. We speculate that the large REWs may be caused by suppressed continuum emission analogous to Type 2 quasars in the Unified Model. However, there is no obvious mechanism in the Unified Model to suppress the continuum without also suppressing the broad emission lines, thus potentially providing an interesting challenge to quasar models.

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## APPENDIX A: DIFFERENCES AND USAGE OF VARIOUS WISE CATALOGS

The WISE Mission consisted of different stages and subsequently different catalog releases.

### A1 Parts of the WISE mission

As noted in Meisner et al. (2016),

## APPENDIX B: II. ALLWISE SOURCE CATALOG AND REJECT TABLE

### B1 II.1.a. Format and Column Descriptions

[http://wise2.ipac.caltech.edu/docs/release/allwise/expsup/sec2\\_1a.html#det\\_bit](http://wise2.ipac.caltech.edu/docs/release/allwise/expsup/sec2_1a.html#det_bit)

Bit-encoded integer indicating bands in which a source has a  $w?snr > 2$  detection. For example, a source detected in

**Table B1.** Band-Detection Combinations ( $> 2\sigma$  per Band) in the AllWISE Catalog. See [http://wise2.ipac.caltech.edu/docs/release/allwise/expsup/sec2\\_1.html](http://wise2.ipac.caltech.edu/docs/release/allwise/expsup/sec2_1.html).

W1 only has **det\_bit**=1 (binary 0001). A source detected in W4 only has **det\_bit**=8 (binary 1000). A source detected in all four bands has **det\_bit**=15 (binary 1111).

[http://wise2.ipac.caltech.edu/docs/release/allwise/expsup/sec2\\_1.html](http://wise2.ipac.caltech.edu/docs/release/allwise/expsup/sec2_1.html)

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Wright E. L., et al., 2010, AJ, 140, 1868