



ELUSIVE AGN IN THE NEXT ERA

JUNE 12-15

GEORGE MASON UNIVERSITY

FAIRFAX, VIRGINIA



Dartmouth

CHRISTOPHER M CARROLL

**UNVEILING THE ELUSIVE AGNS IN MILLIONS
OF SDSS AND WISE GALAXIES**

MOTIVATION

TO STUDY LARGE-SCALE AGN POPULATION

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Assumptions:

- ▶ you are astronomers
- ▶ you know what an AGN is

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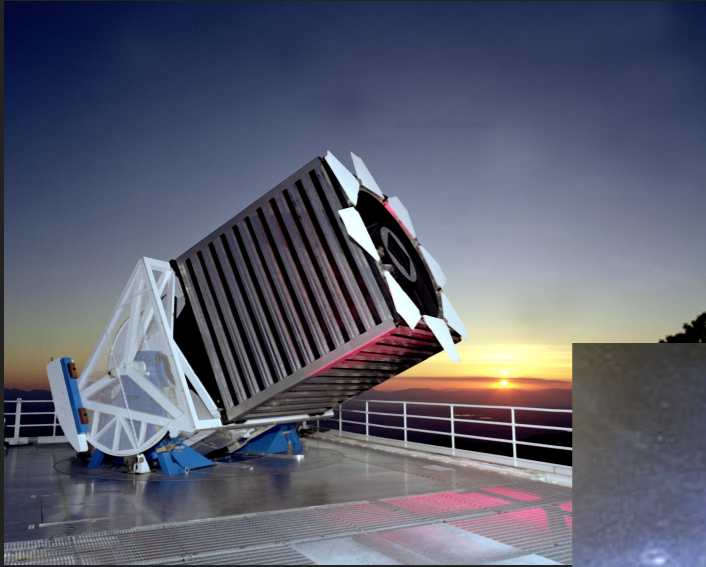
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Non-assumptions:

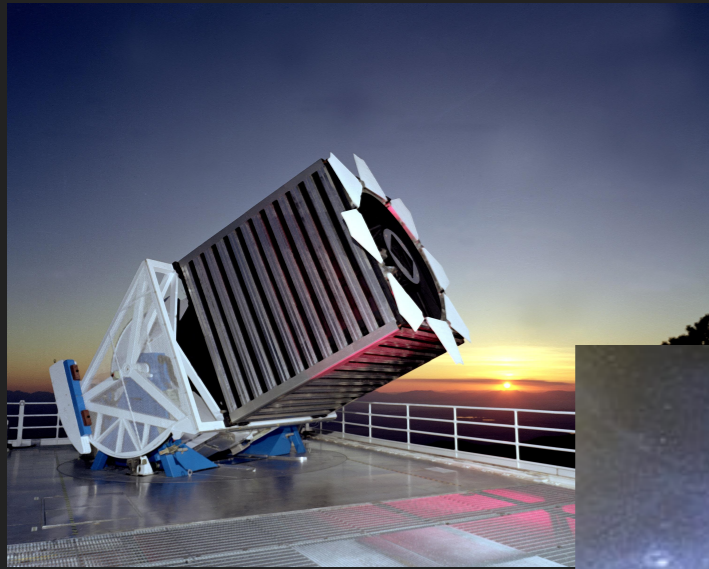
- ▶ how we define an obscured AGN

PHOTOMETRY

WE NEED A DATA SET...



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Quasar probabilities and redshifts from *WISE* mid-IR through *GALEX* UV photometry

M. A. DiPompeo,^{1*} J. Bovy,^{2†} A. D. Myers¹ and D. Lang³

¹Department of Physics and Astronomy 3905, University of Wyoming, 1000 E. University, Laramie, WY 82071, USA

²Institute for Advanced Study, Einstein Drive, Princeton, NJ 08450, USA

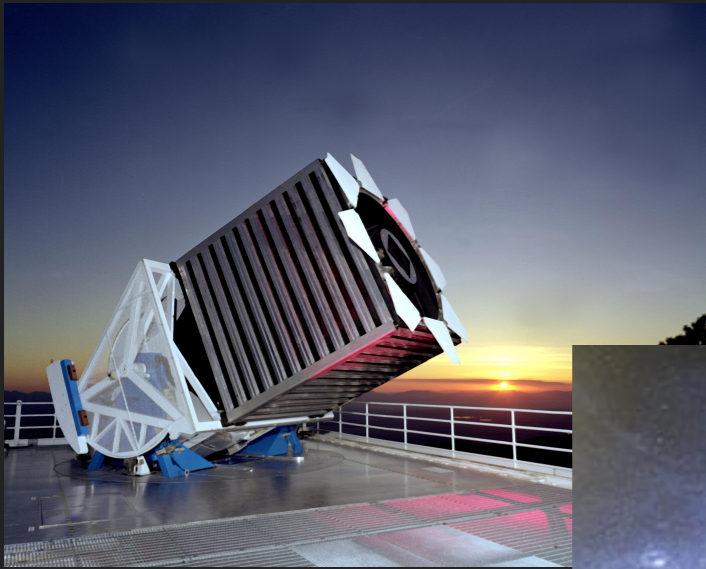
³McWilliams Center for Cosmology, Department of Physics, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, USA

Accepted 2015 July 10. Received 2015 July 9; in original form 2014 December 2

ABSTRACT

Extreme deconvolution (XD) of broad-band photometric data can both separate stars from quasars and generate probability density functions for quasar redshifts, while incorporating flux uncertainties and missing data. Mid-infrared photometric colours are now widely used to identify hot dust intrinsic to quasars, and the release of all-sky *WISE* data has led to a dramatic

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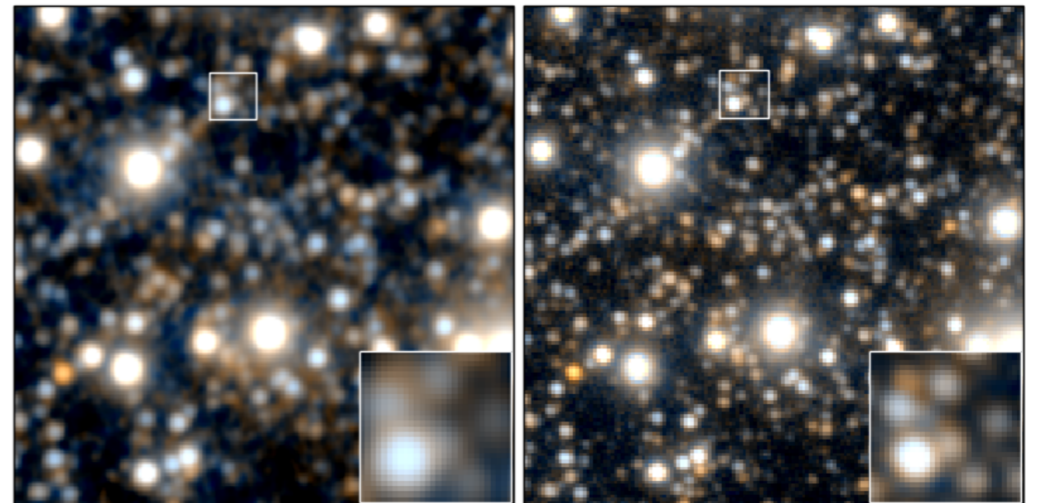
unWISE: unofficial, unblurred coadds of the *WISE* imaging

and

Forced photometry of SDSS sources in the *WISE* imaging

WISE All-Sky Release Atlas Image

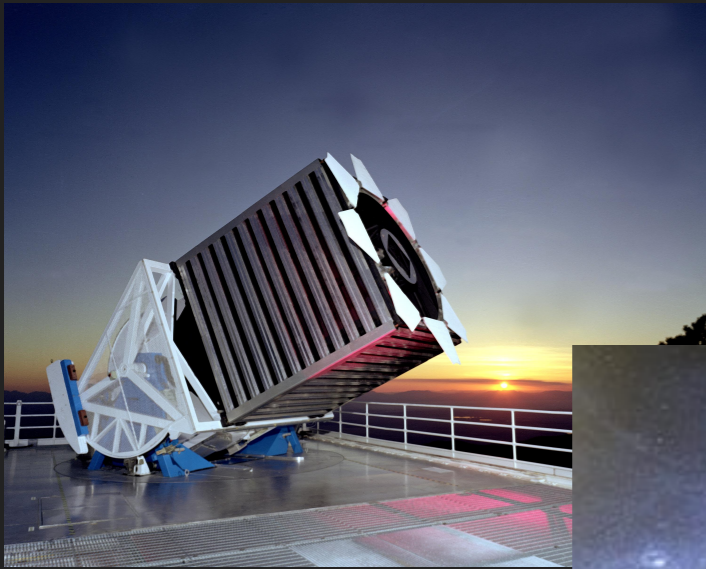
unWISE coadd



(W1,W2 composite, tile 2709p666, ~6 arcmin square)

WE NEED A DATA SET...

OF 80 MILLION OBJECTS



Monthly Notices
of the
ROYAL ASTRONOMICAL SOCIETY
MNRAS **452**, 3124–3138 (2015)



doi:10.1093/mnras/stv1562

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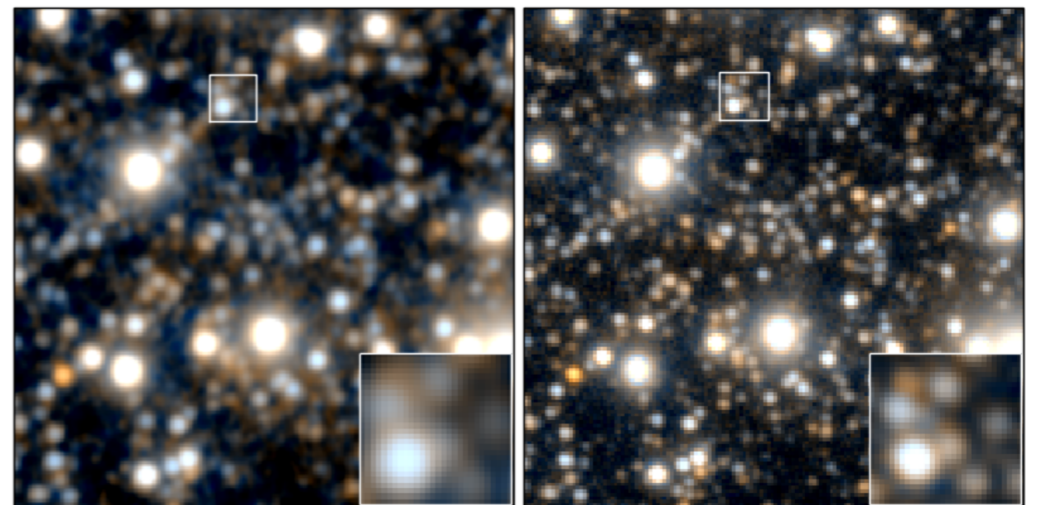
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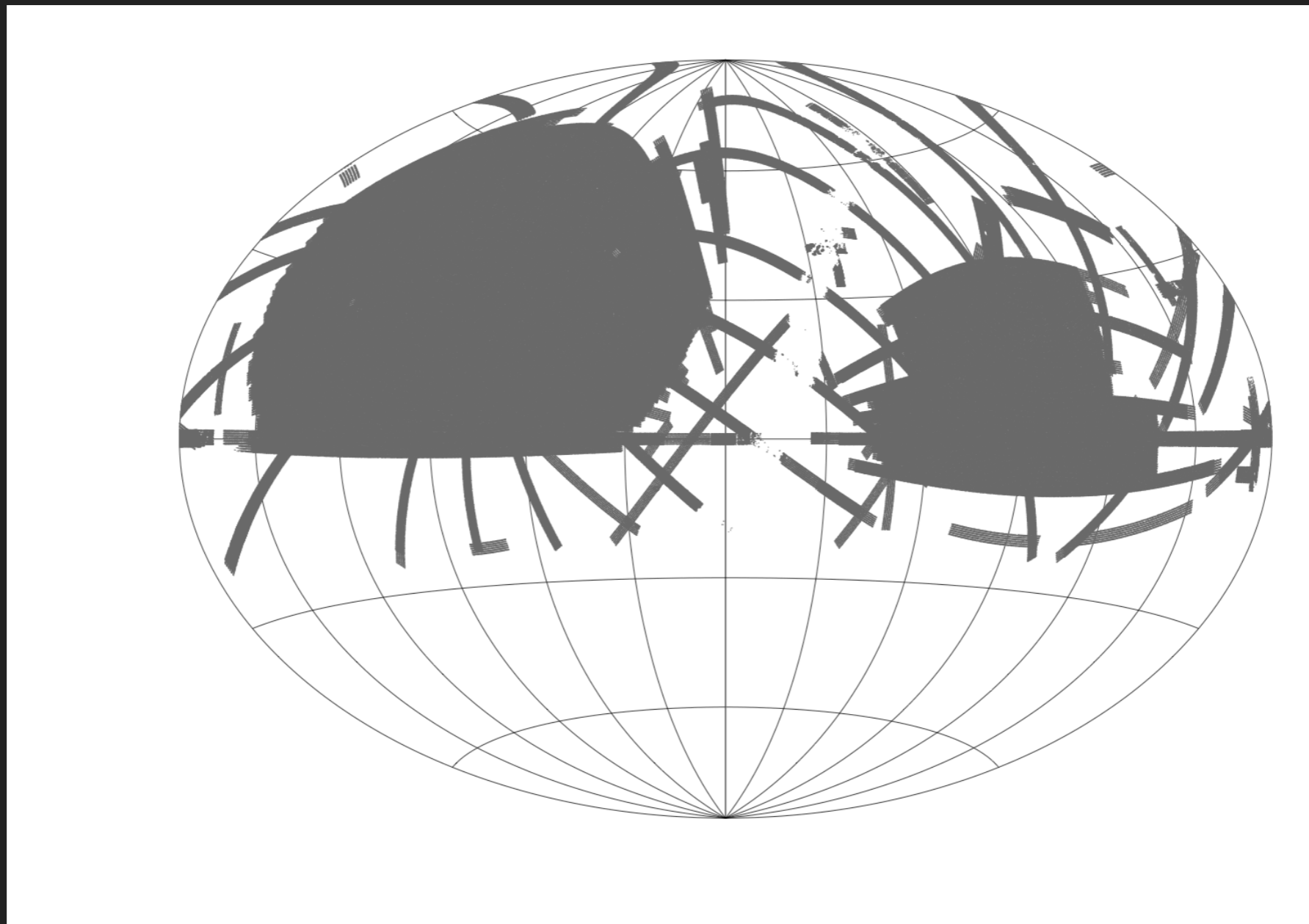
unWISE coadd



(W1,W2 composite, tile 2709p666, ~6 arcmin square)

SAMPLE COVERAGE

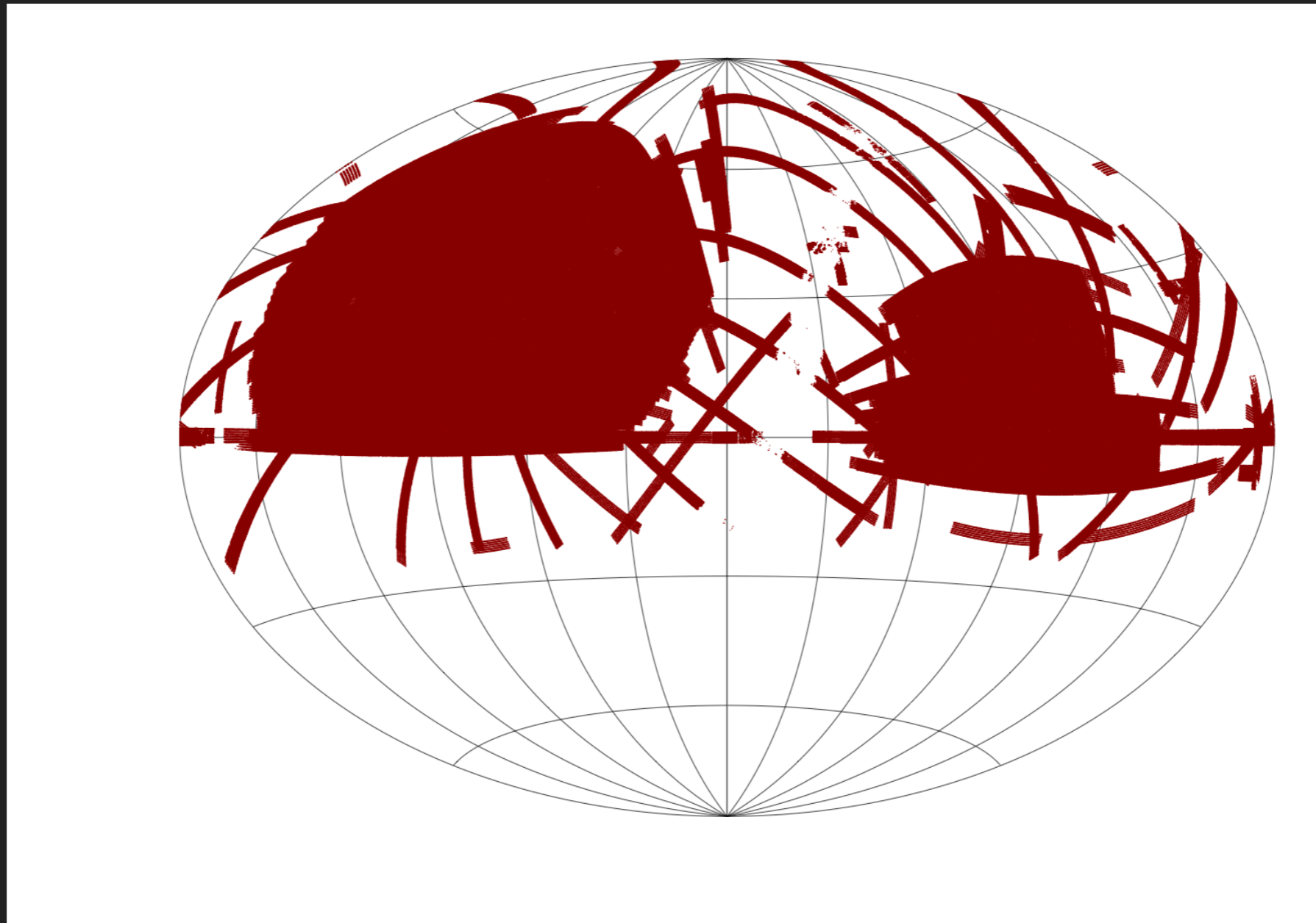
SDSS



Credit: M. DiPompeo

SAMPLE COVERAGE

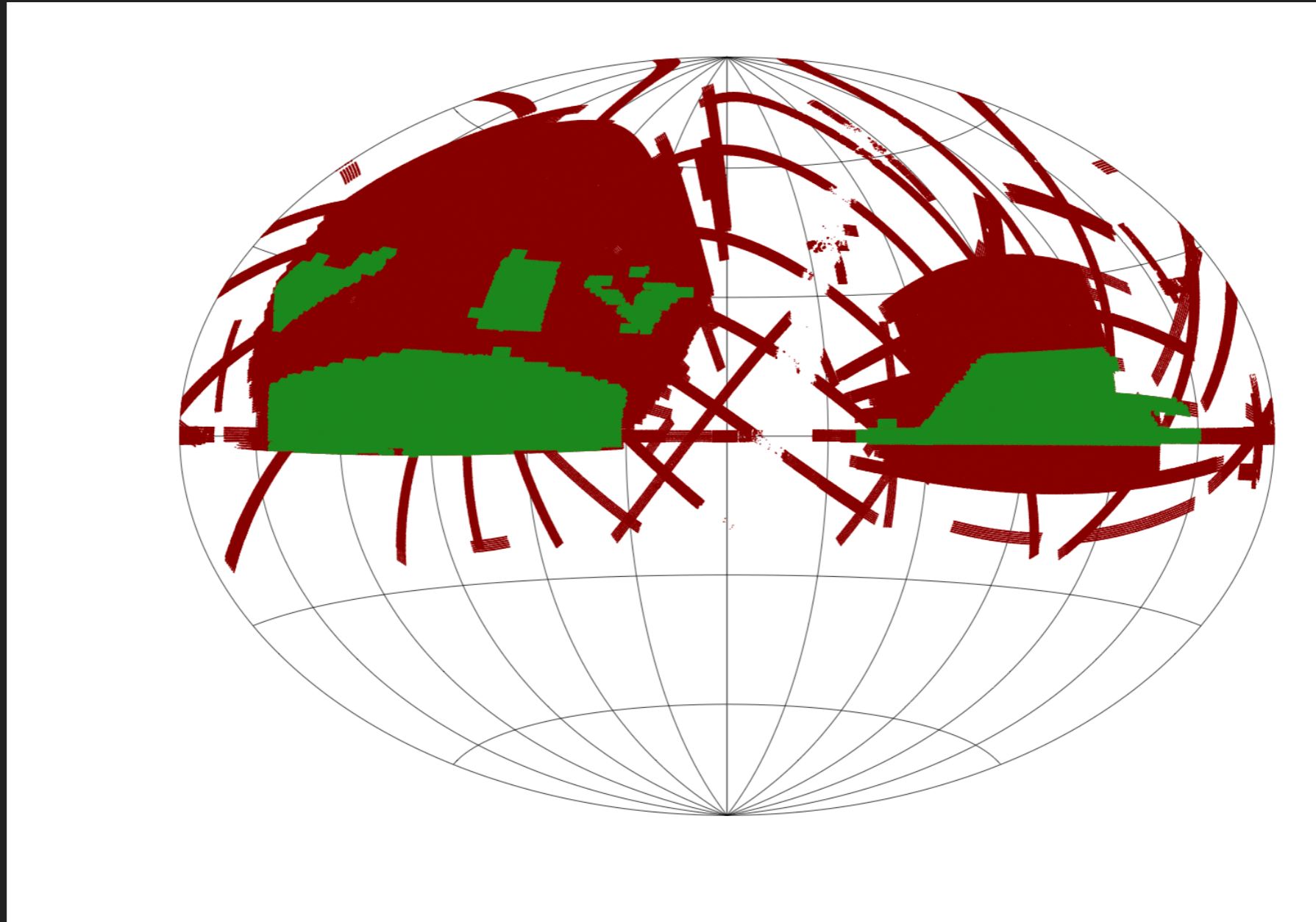
SDSS + WISE



Credit: M. DiPompeo

SAMPLE COVERAGE

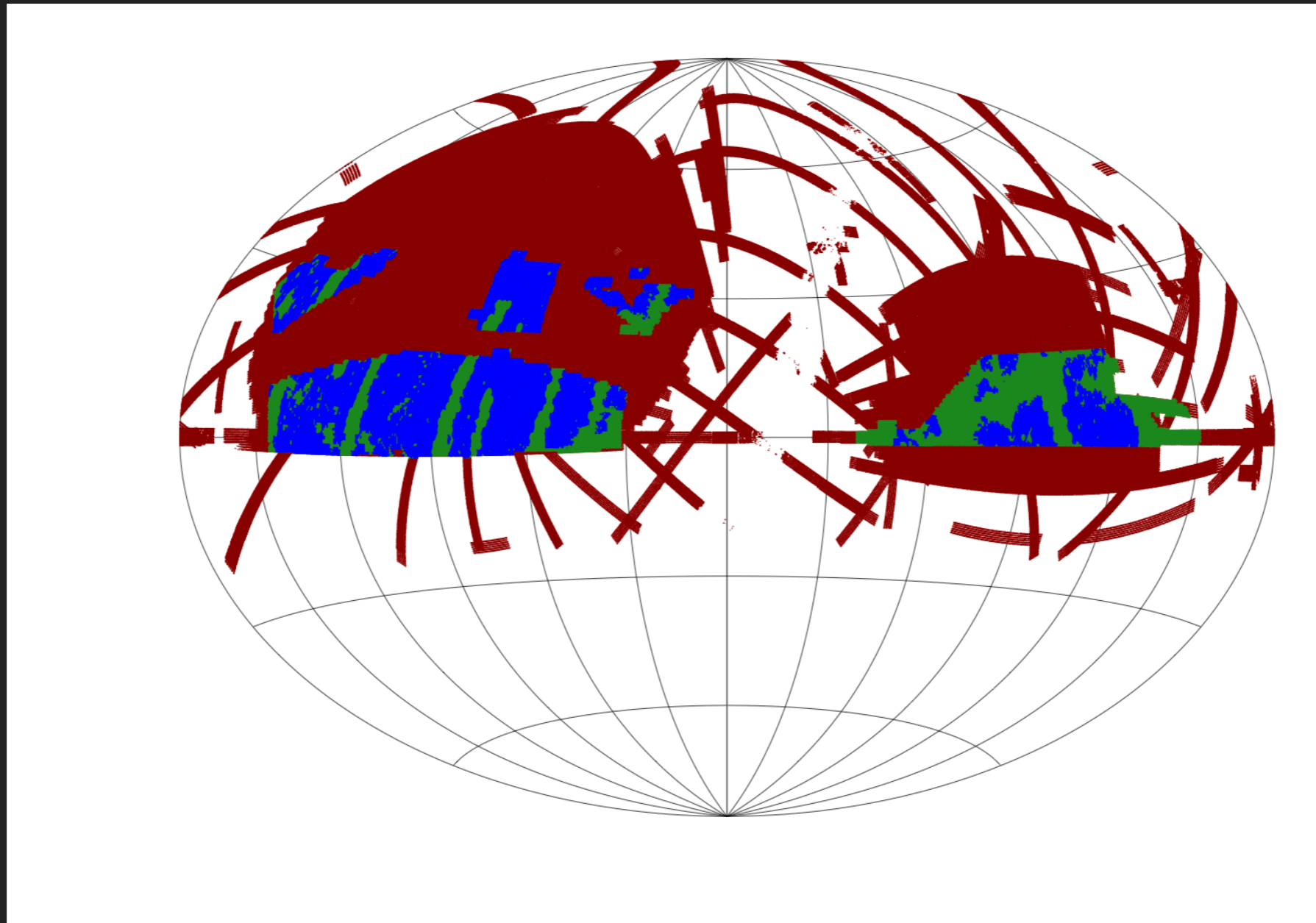
SDSS + WISE + UKIDSS



Credit: M. DiPompeo

SAMPLE COVERAGE

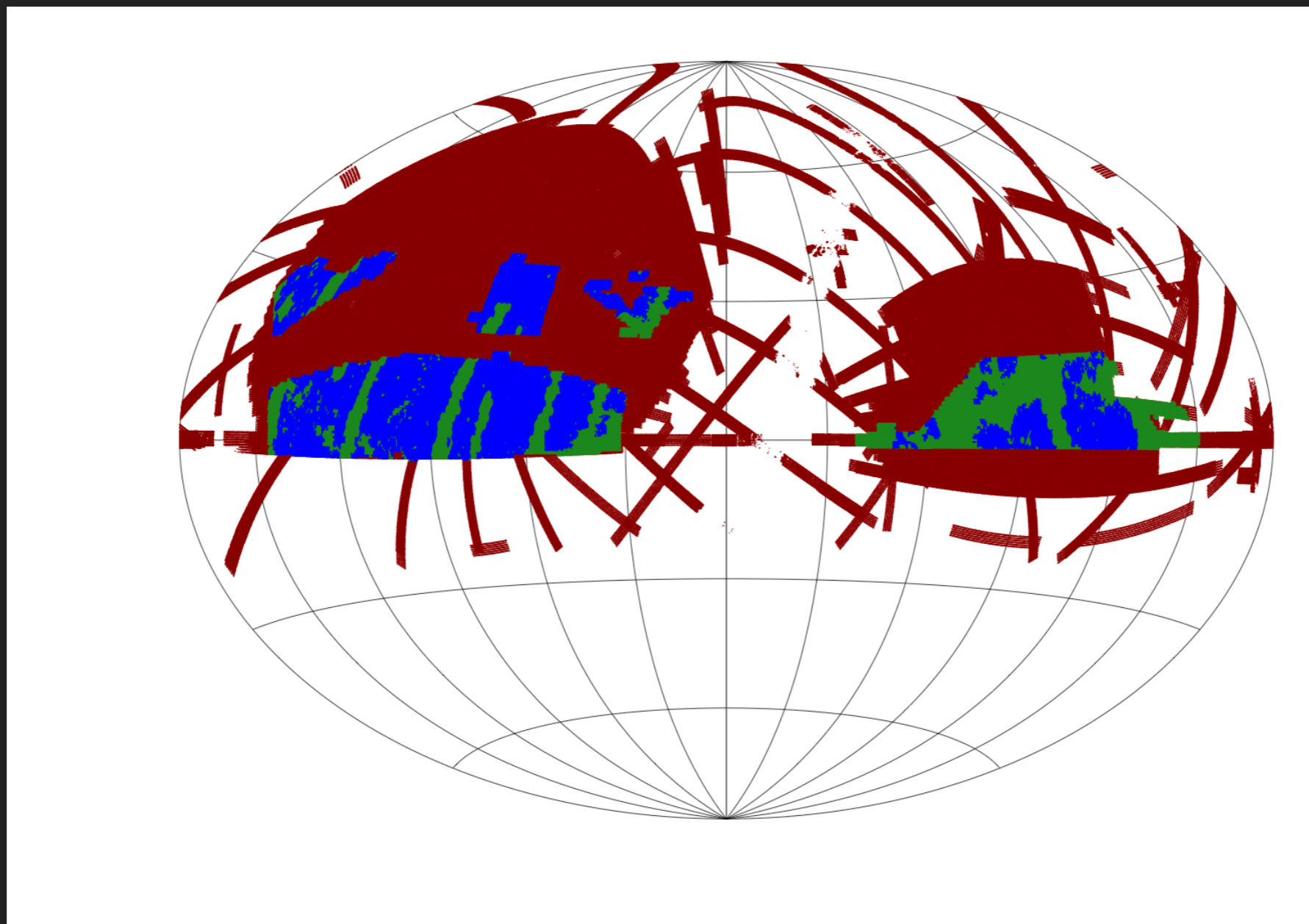
SDSS + WISE + UKIDSS + mask



Credit: M. DiPompeo

SAMPLE COVERAGE

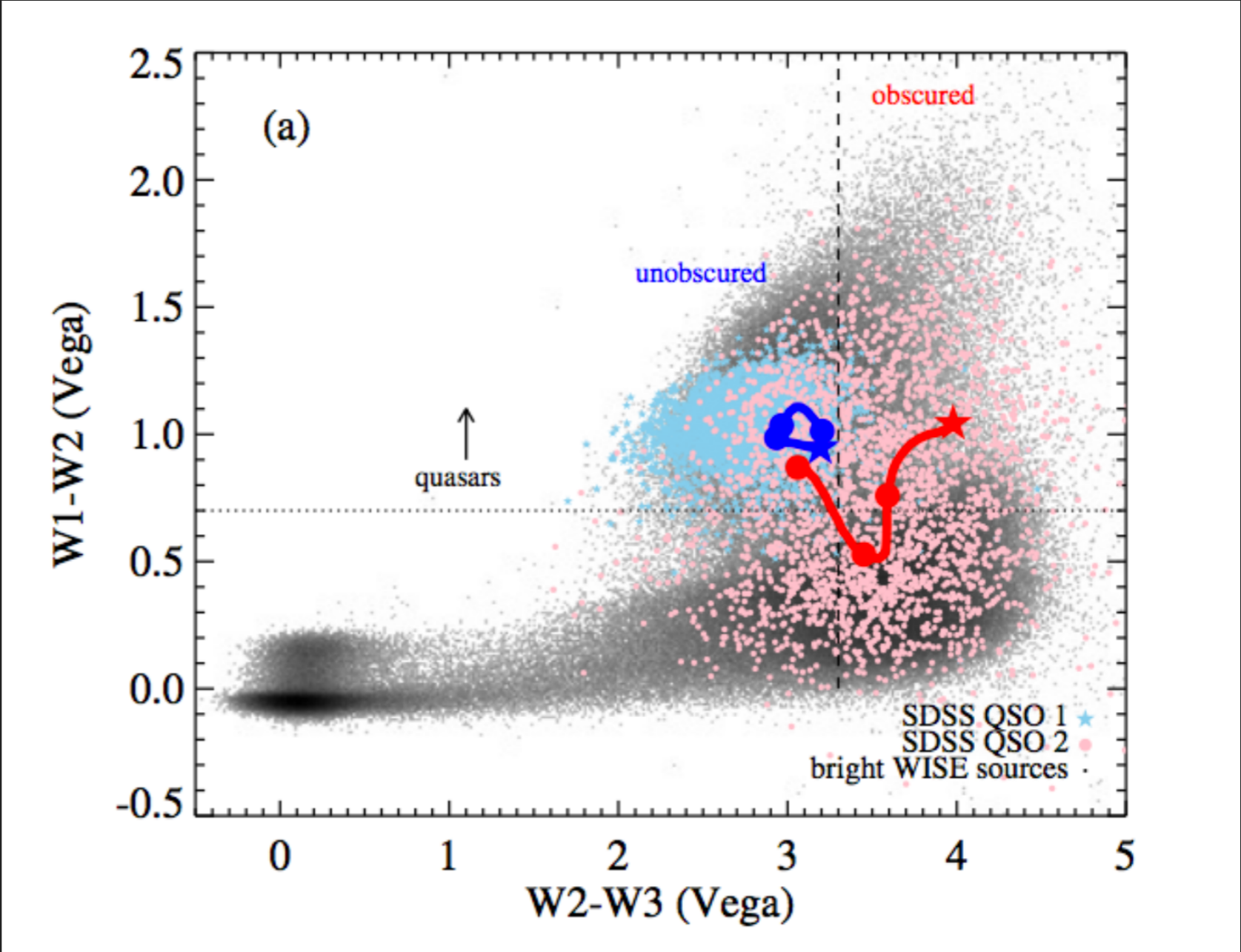
SDSS + WISE + UKIDSS + mask



Credit: M. DiPompeo

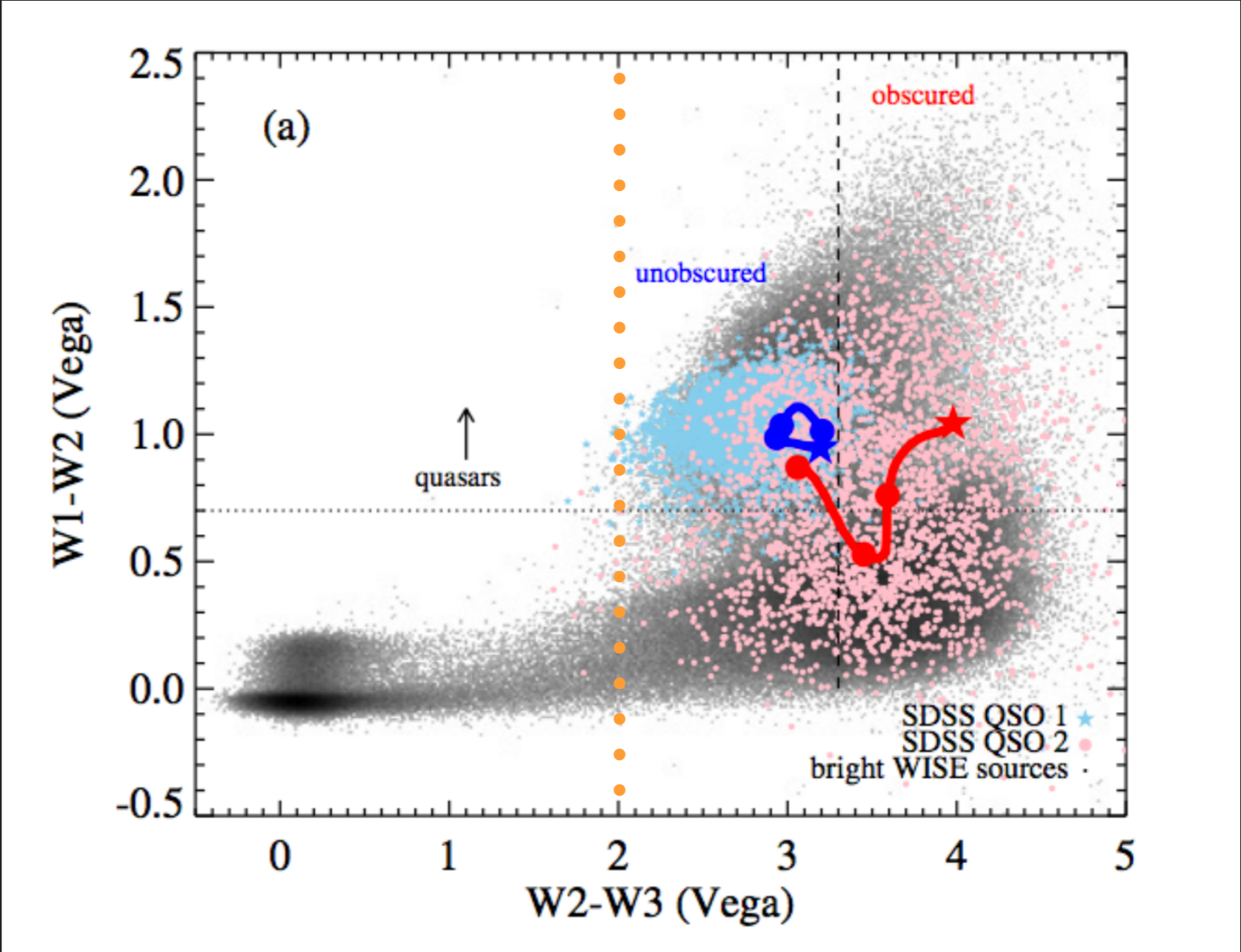
~6 million objects (2275 deg²)

SELECTION CRITERIA



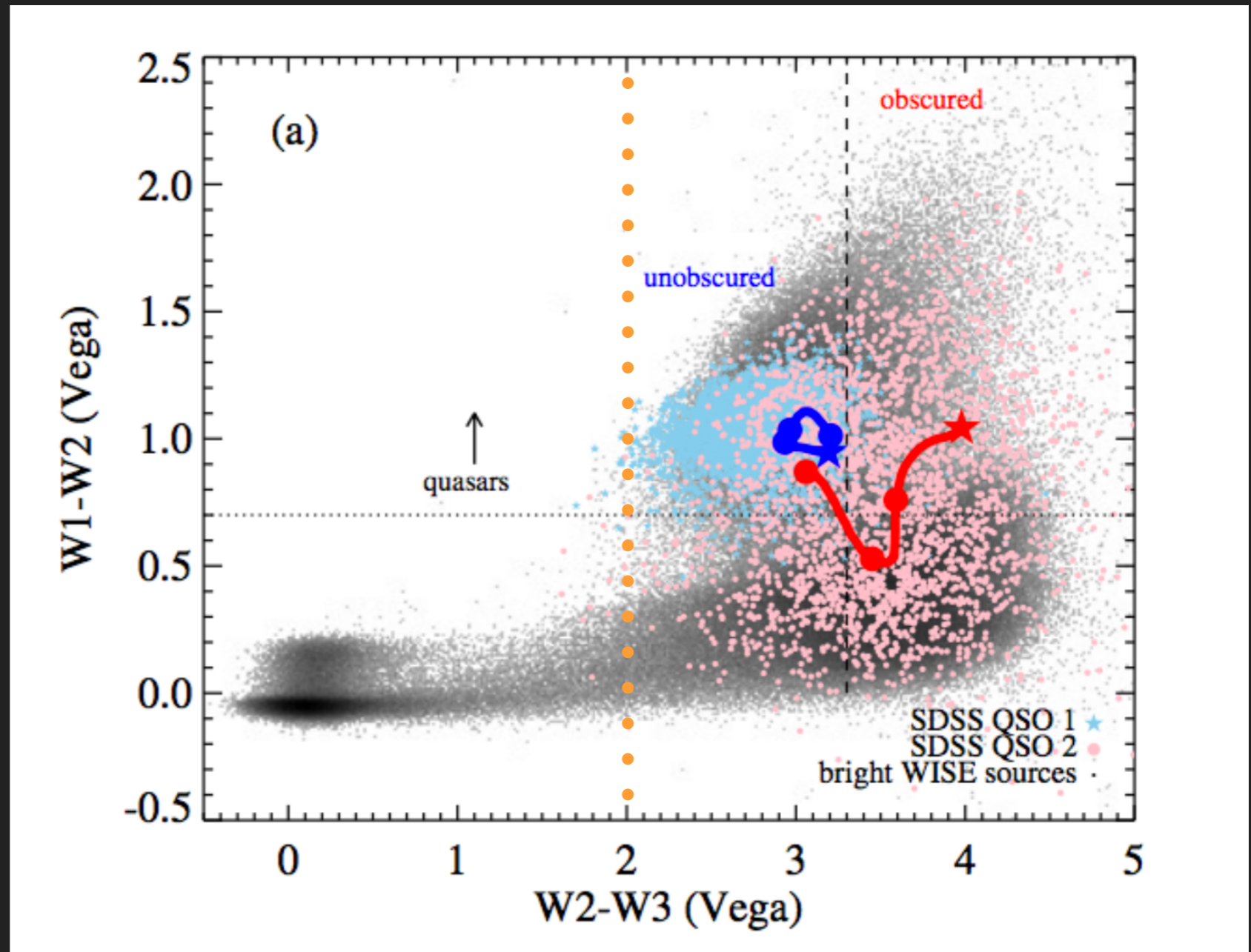
SELECTION CRITERIA

▶ $W2-W3 > 2.0$



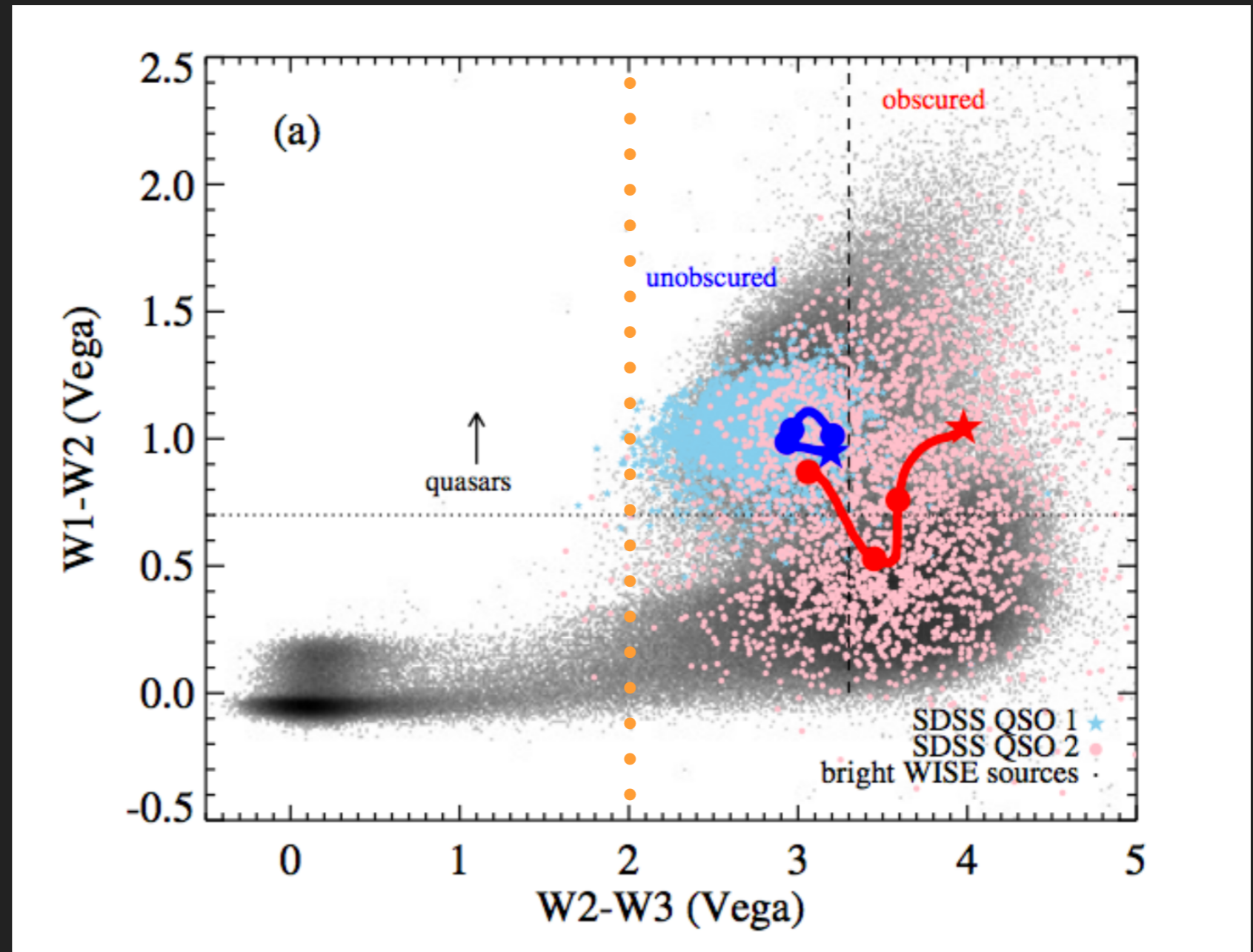
SELECTION CRITERIA

- ▶ $W2-W3 > 2.0$
- ▶ ...that's it!



SELECTION CRITERIA

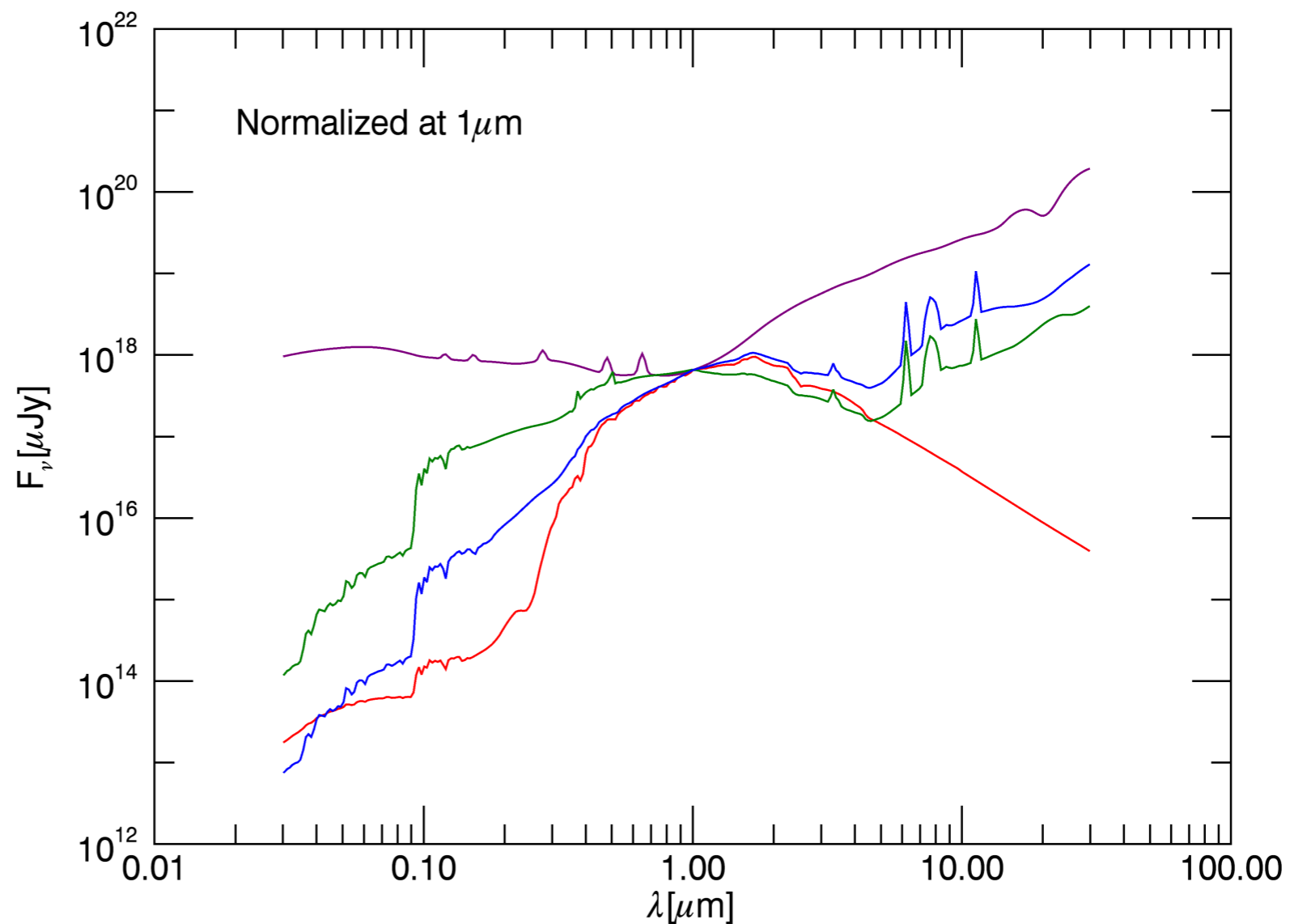
- ▶ $W2-W3 > 2.0$
- ▶ ...that's it!
- ▶ no $W1-W2$
- ▶ no $W2 < 15.05$



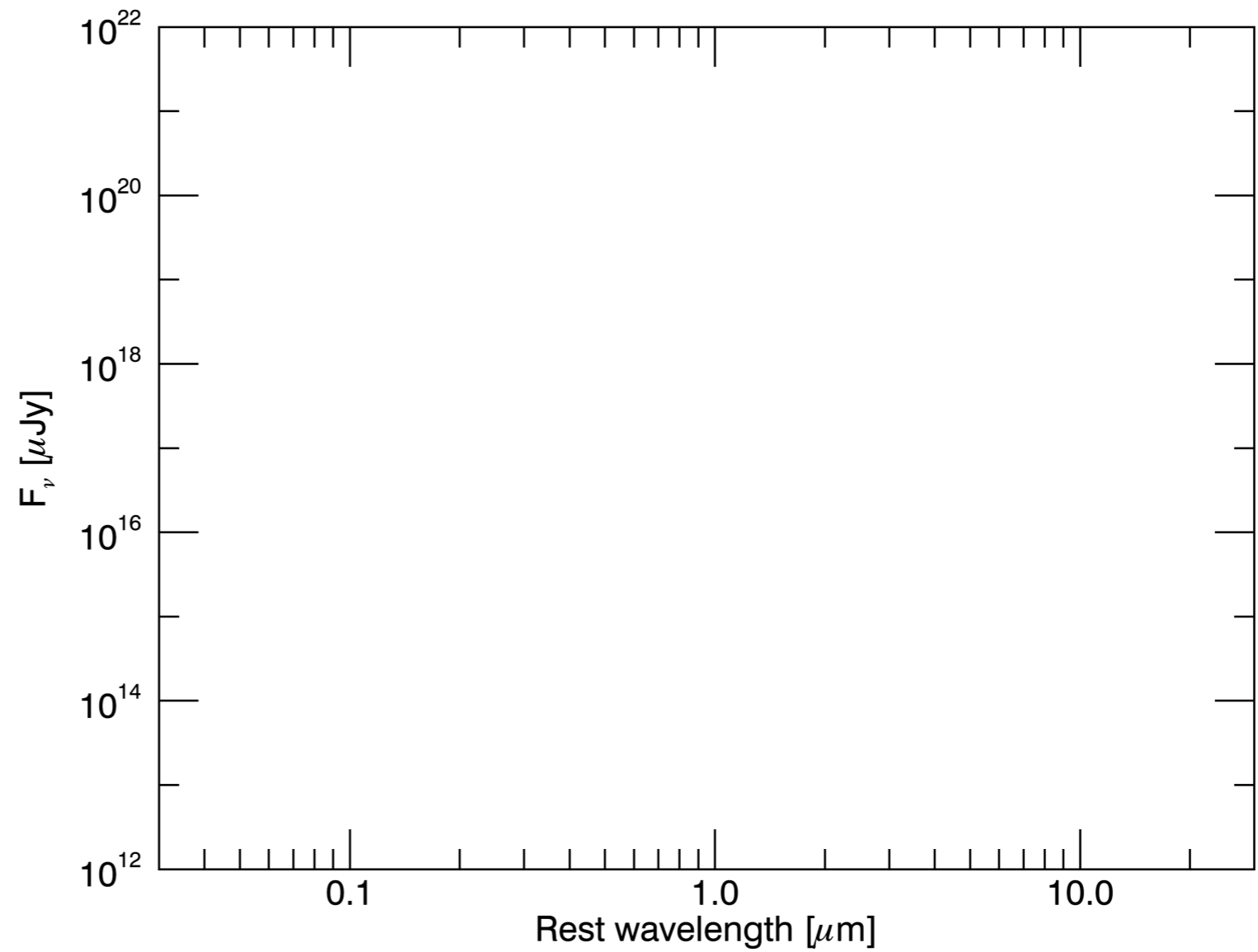
LOW RESOLUTION TEMPLATES FOR GALAXIES AND AGNS

Roberto Assef

Elliptical
Irregular
Sbc
Type I AGN

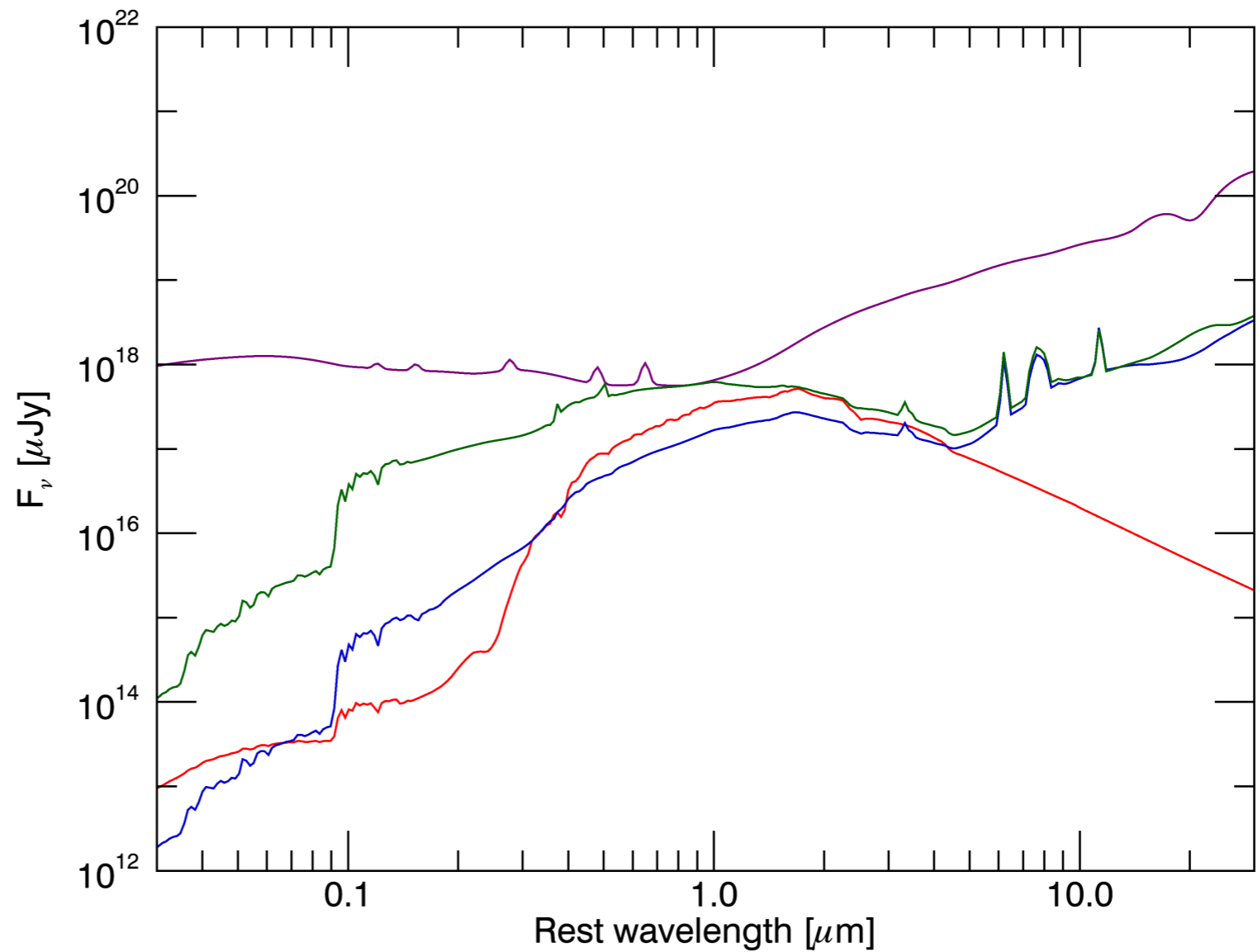


LET'S BUILD A MODEL!



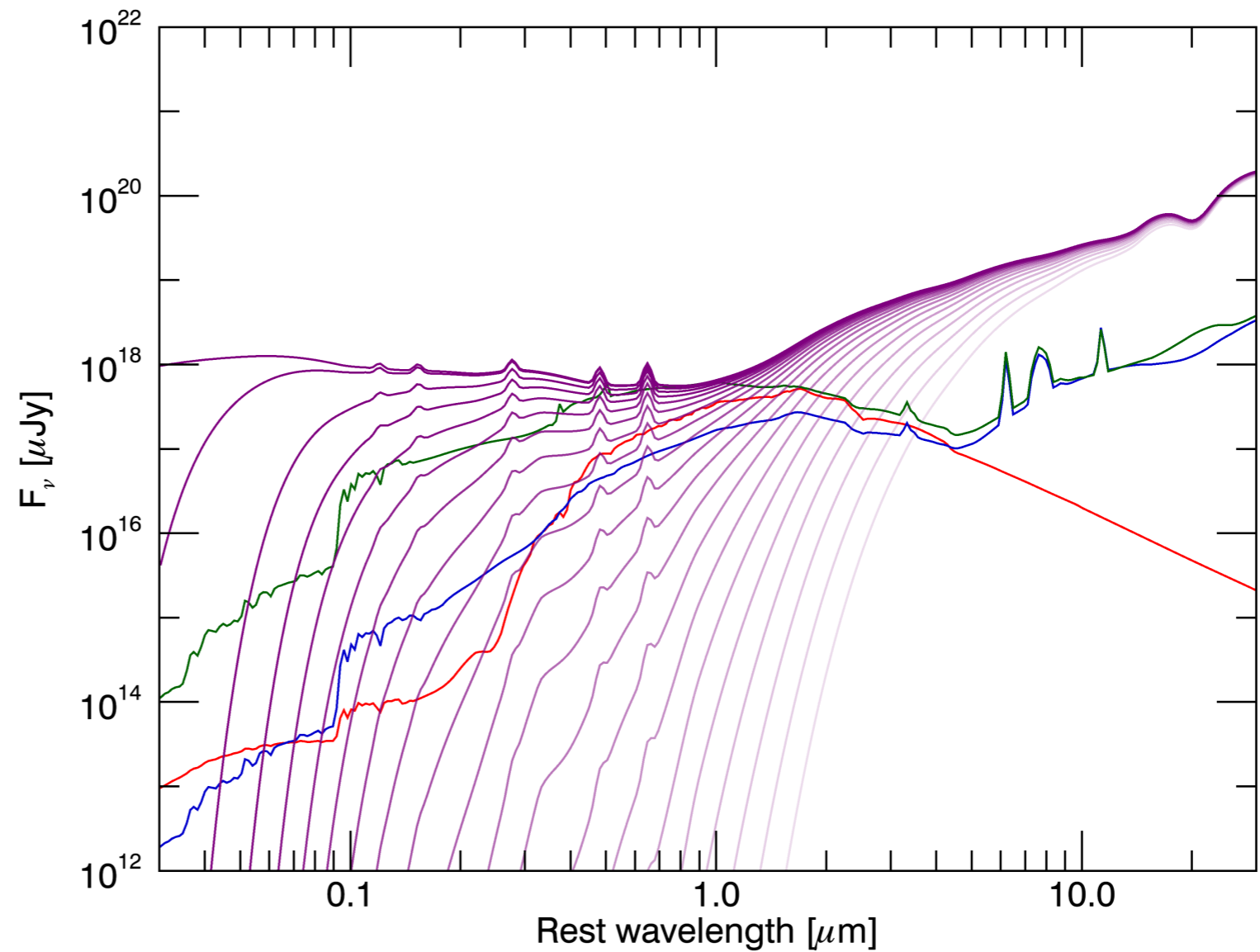
LET'S BUILD A MODEL!

- ▶ raw templates



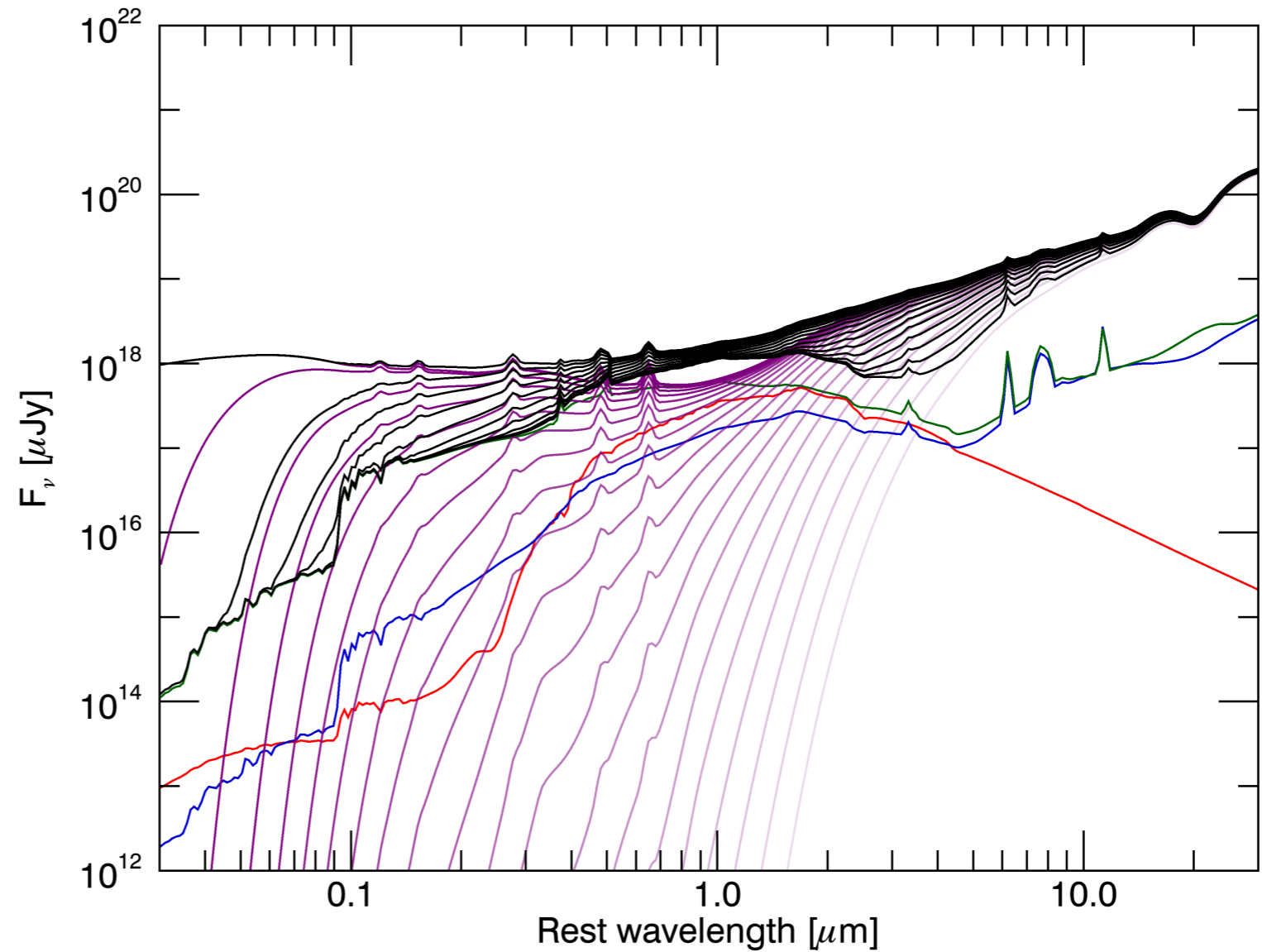
LET'S BUILD A MODEL!

- ▶ raw templates
- ▶ extinguish AGN



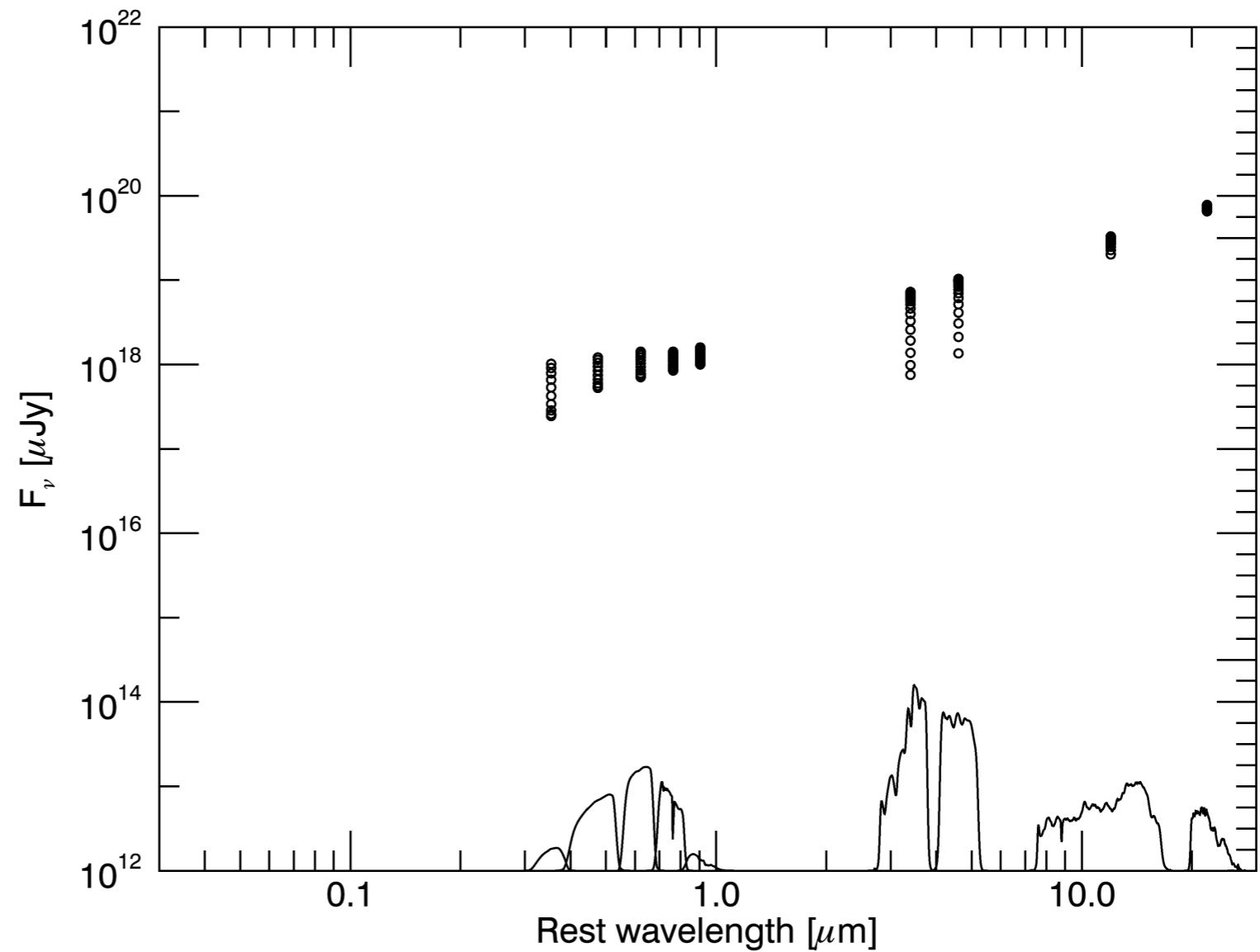
LET'S BUILD A MODEL!

- ▶ raw templates
- ▶ extinguish AGN
- ▶ coadd temp



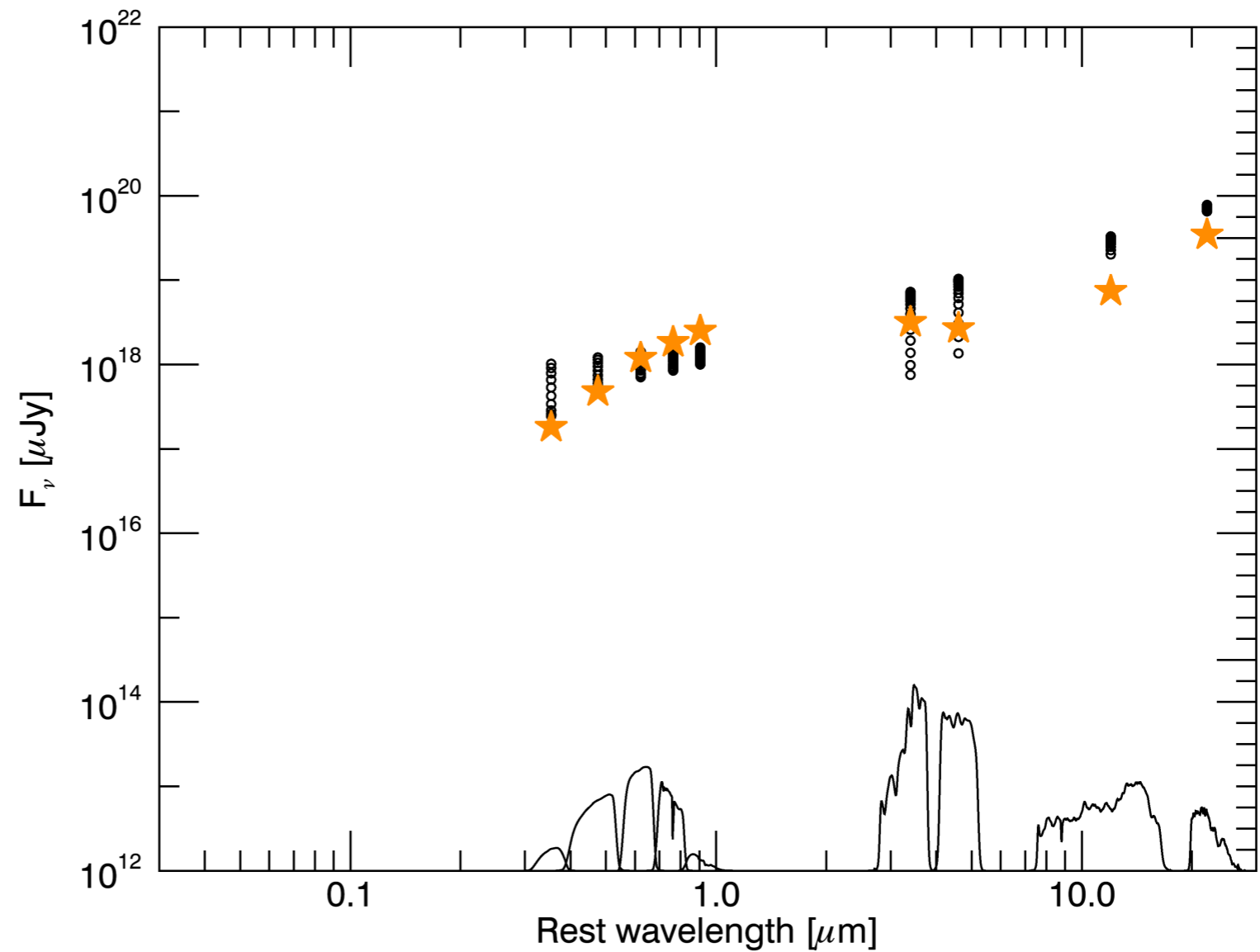
LET'S BUILD A MODEL!

- ▶ raw templates
- ▶ extinguish AGN
- ▶ coadd temp
- ▶ bandpass



LET'S BUILD A MODEL!

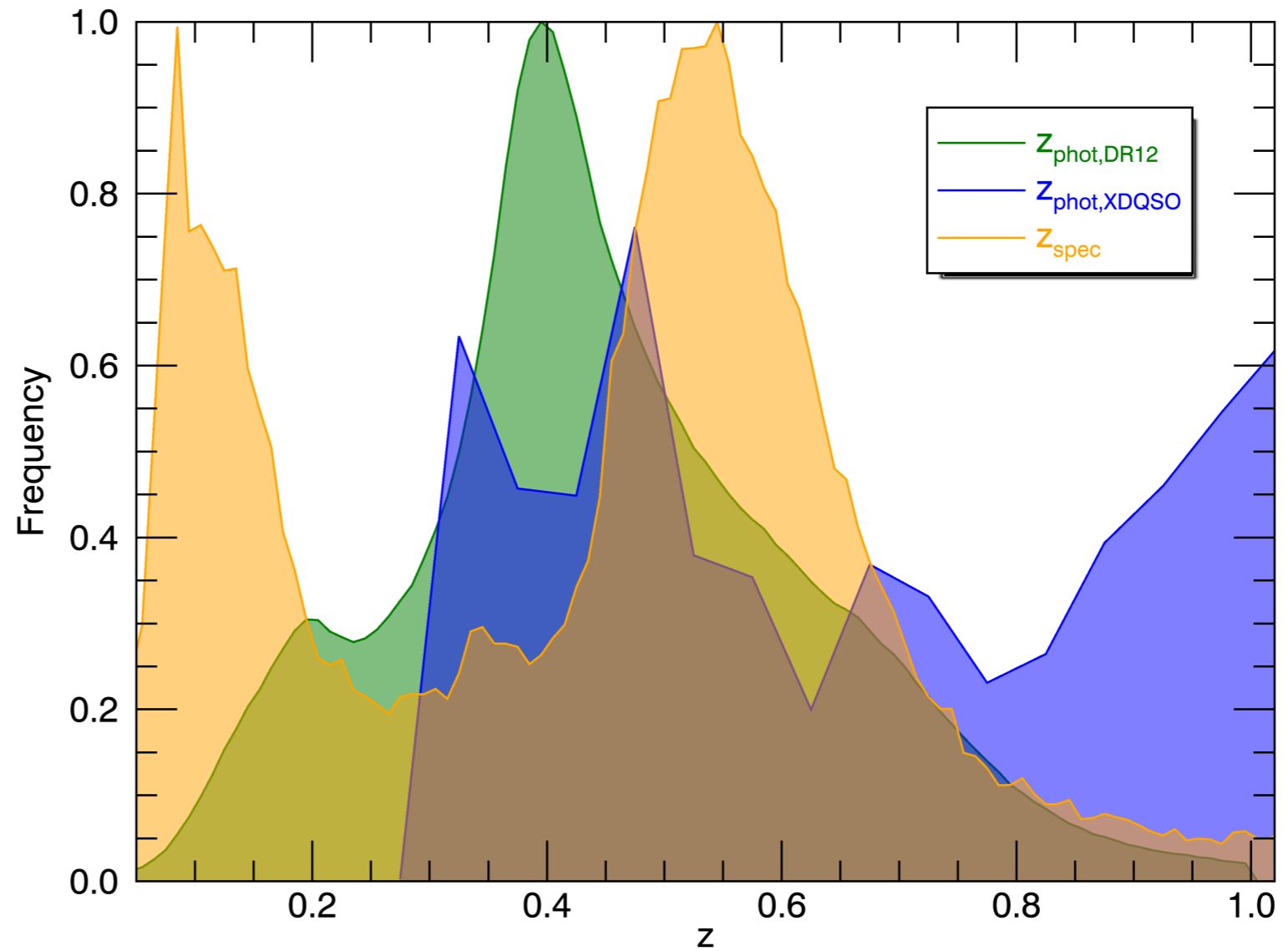
- ▶ raw templates
- ▶ extinguish AGN
- ▶ coadd temp
- ▶ bandpass
- ▶ fit your data!



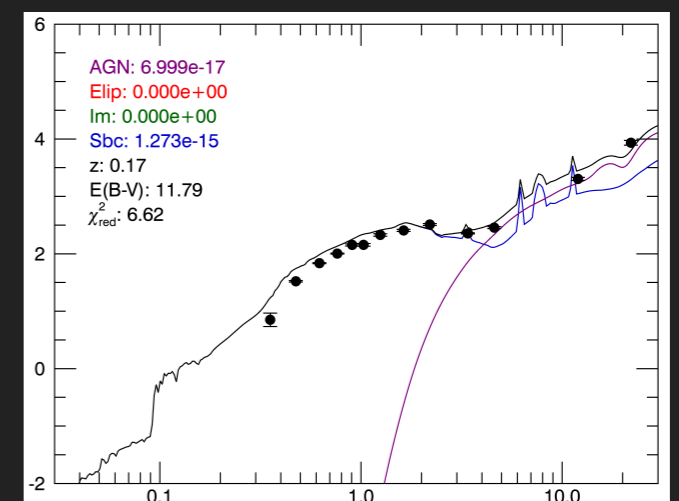
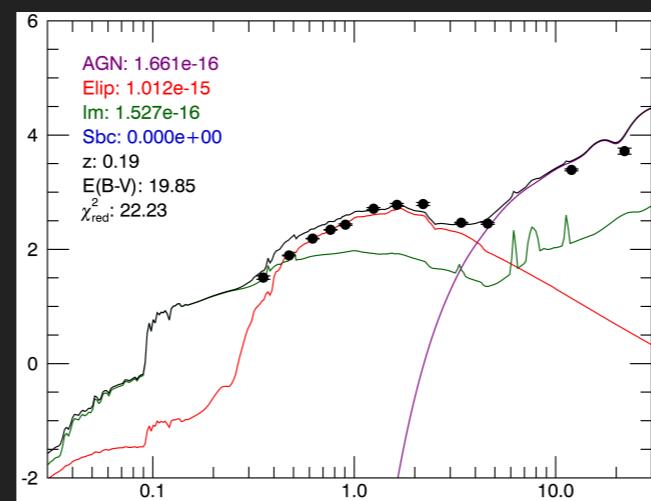
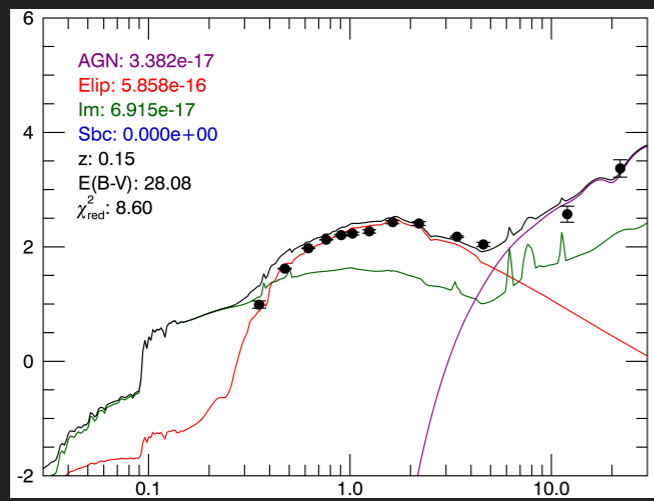
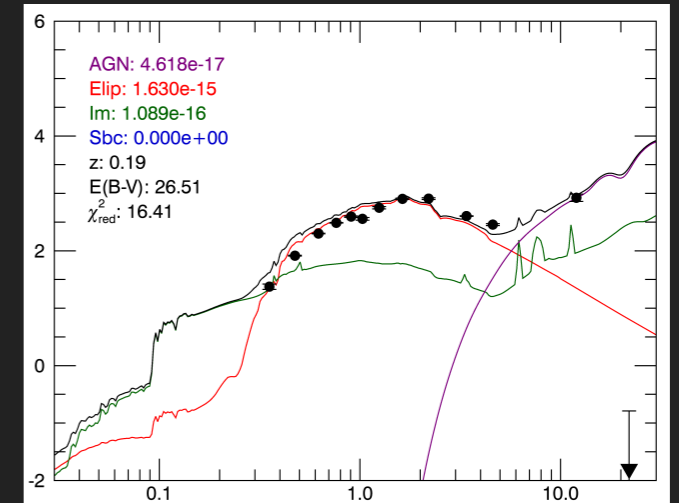
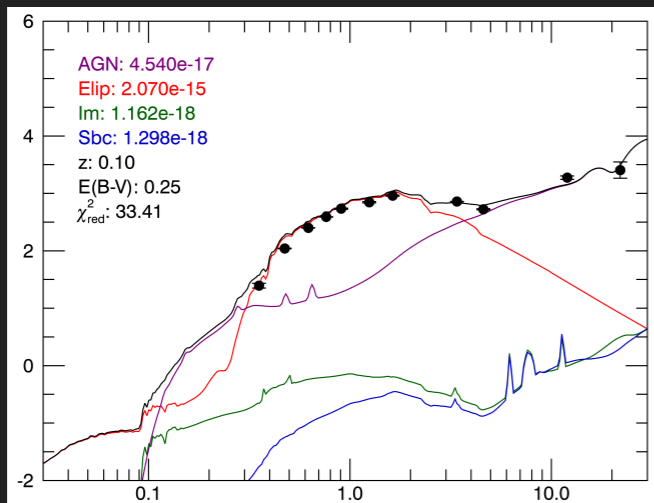
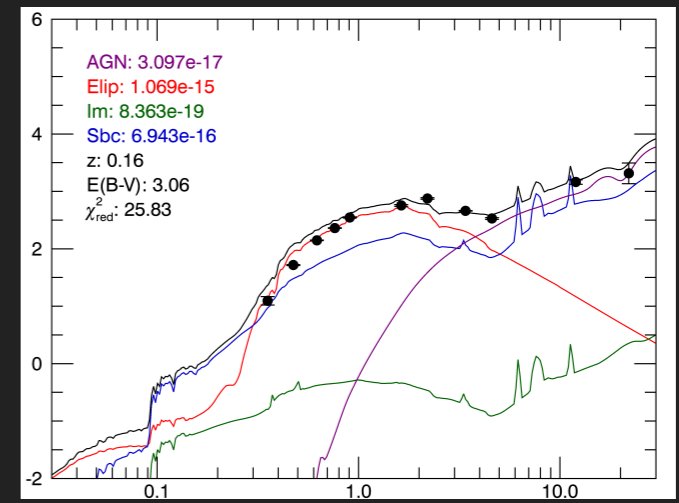
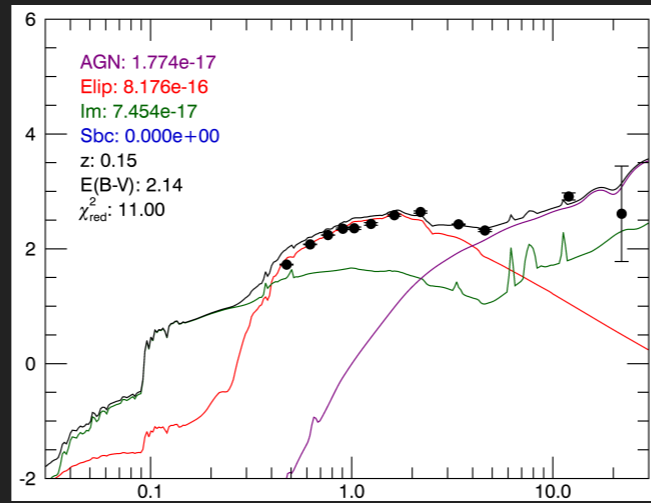
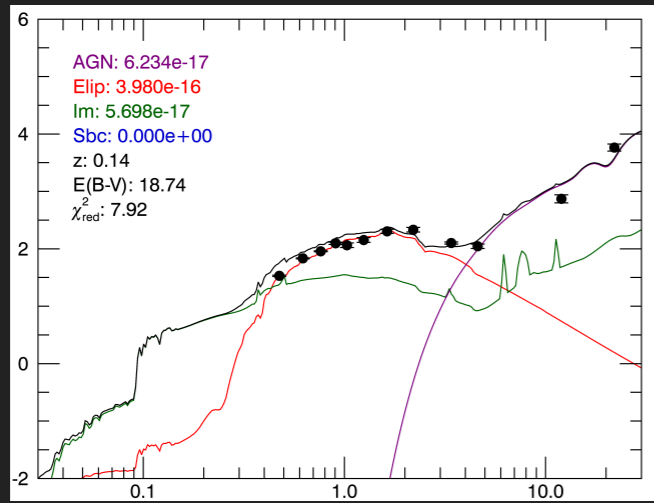
REDSHIFT DISTRIBUTION

histograms normalized to 1

- ▶ 93% z_{phot}
- ▶ 3% XDQSO
- ▶ 4% z_{spec}



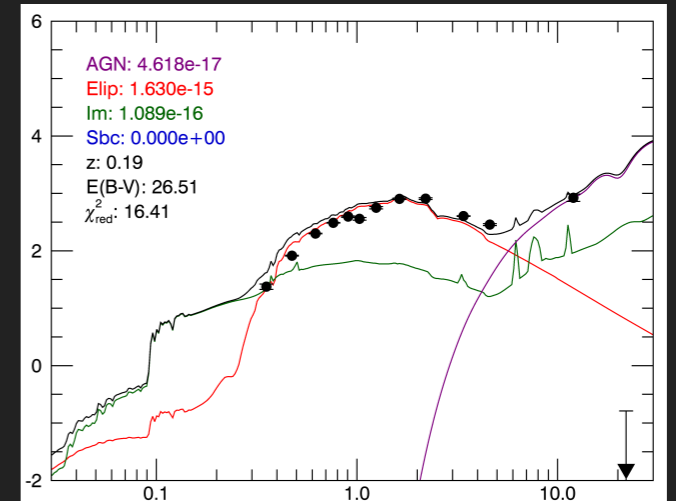
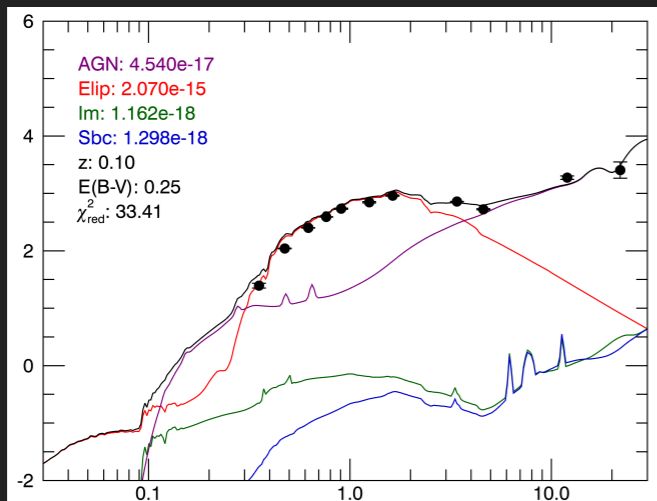
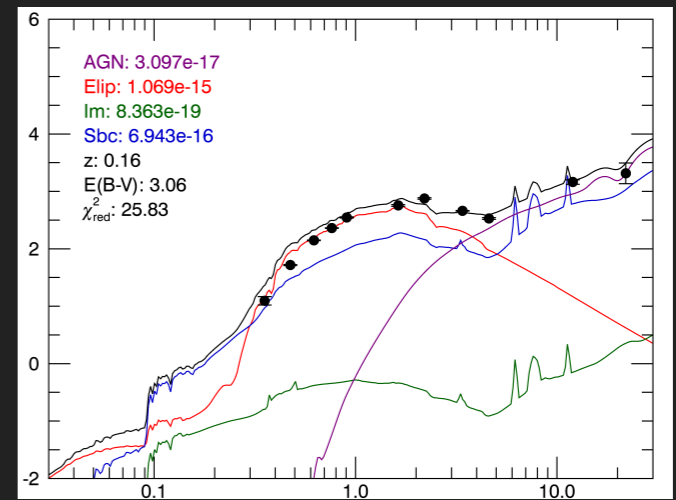
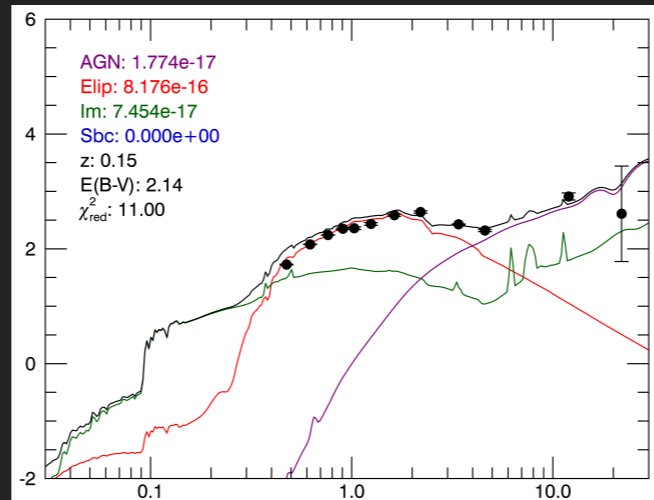
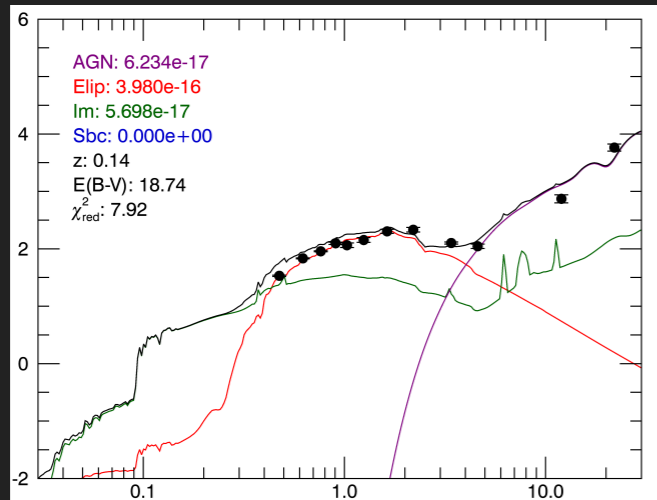
EXAMPLE FITS



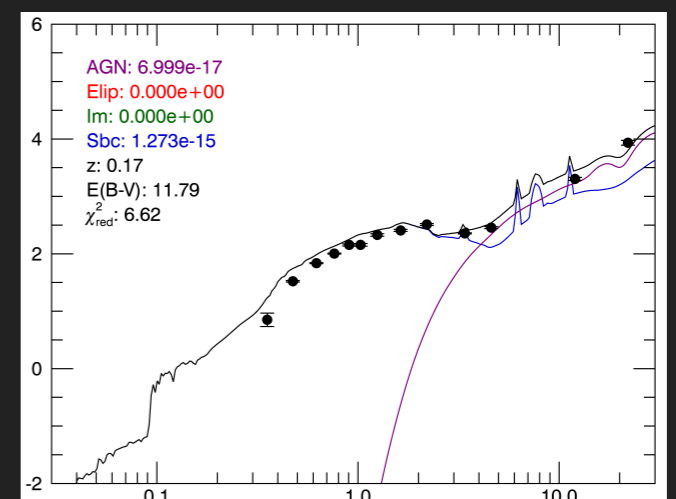
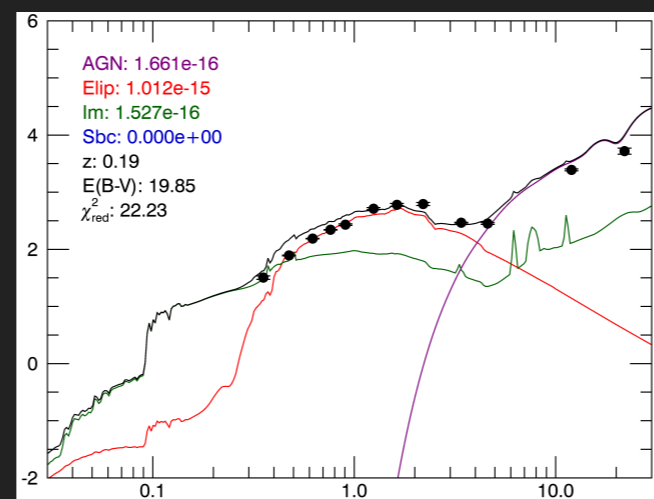
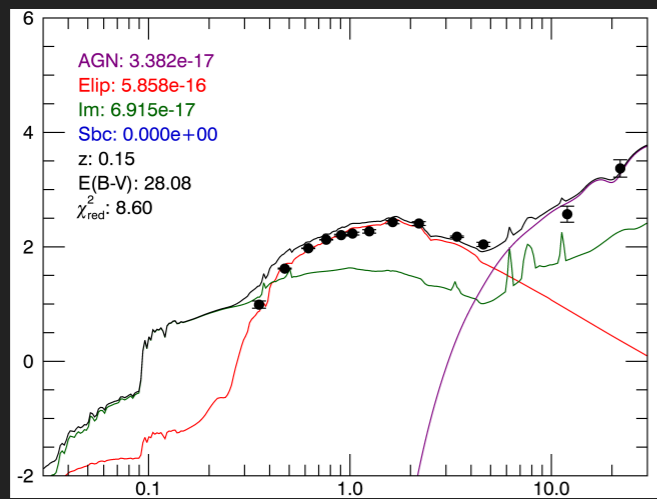
$\log(F_\nu)$ [μJy]

λ [μm]

EXAMPLE FITS



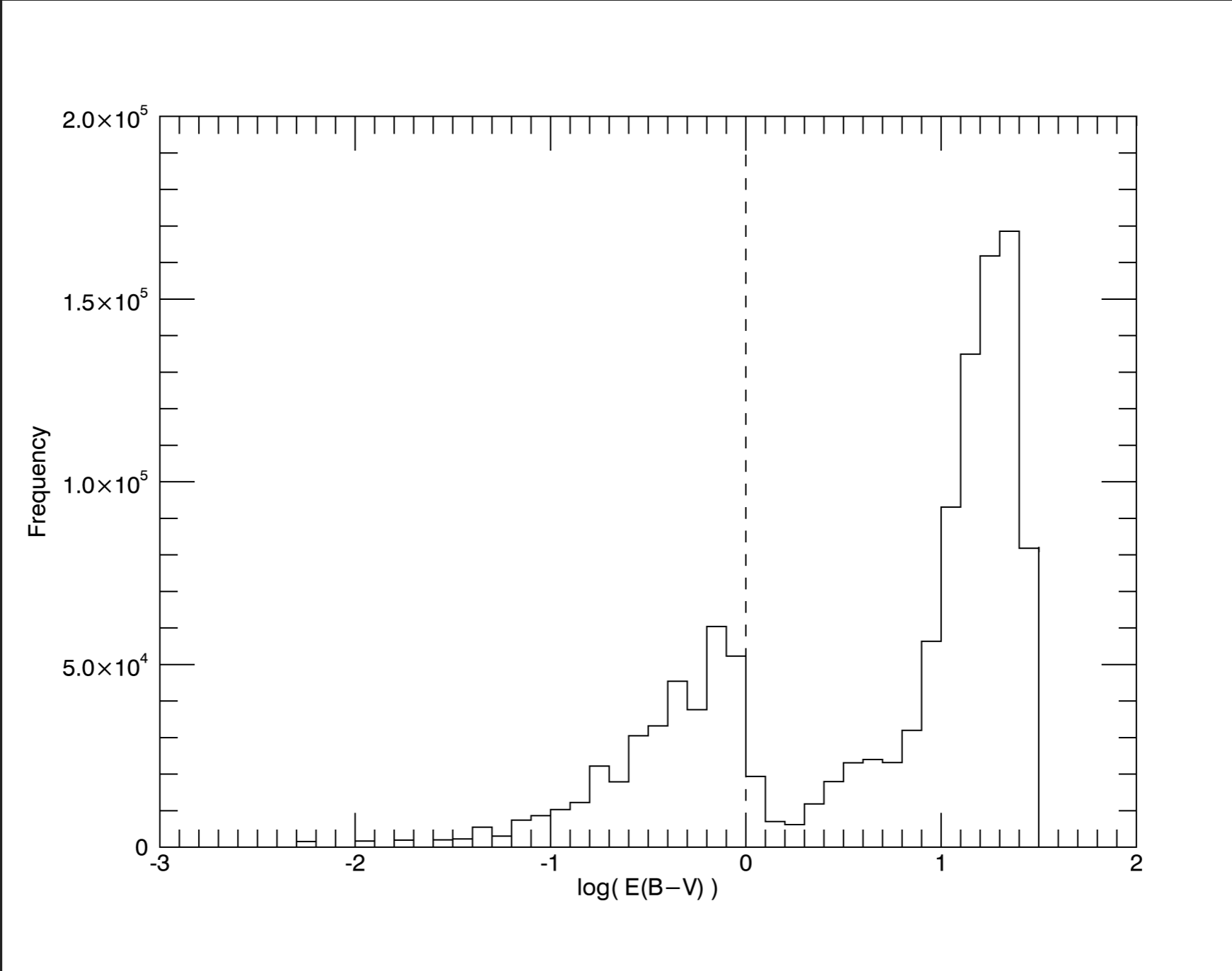
> 1.2 million sources!



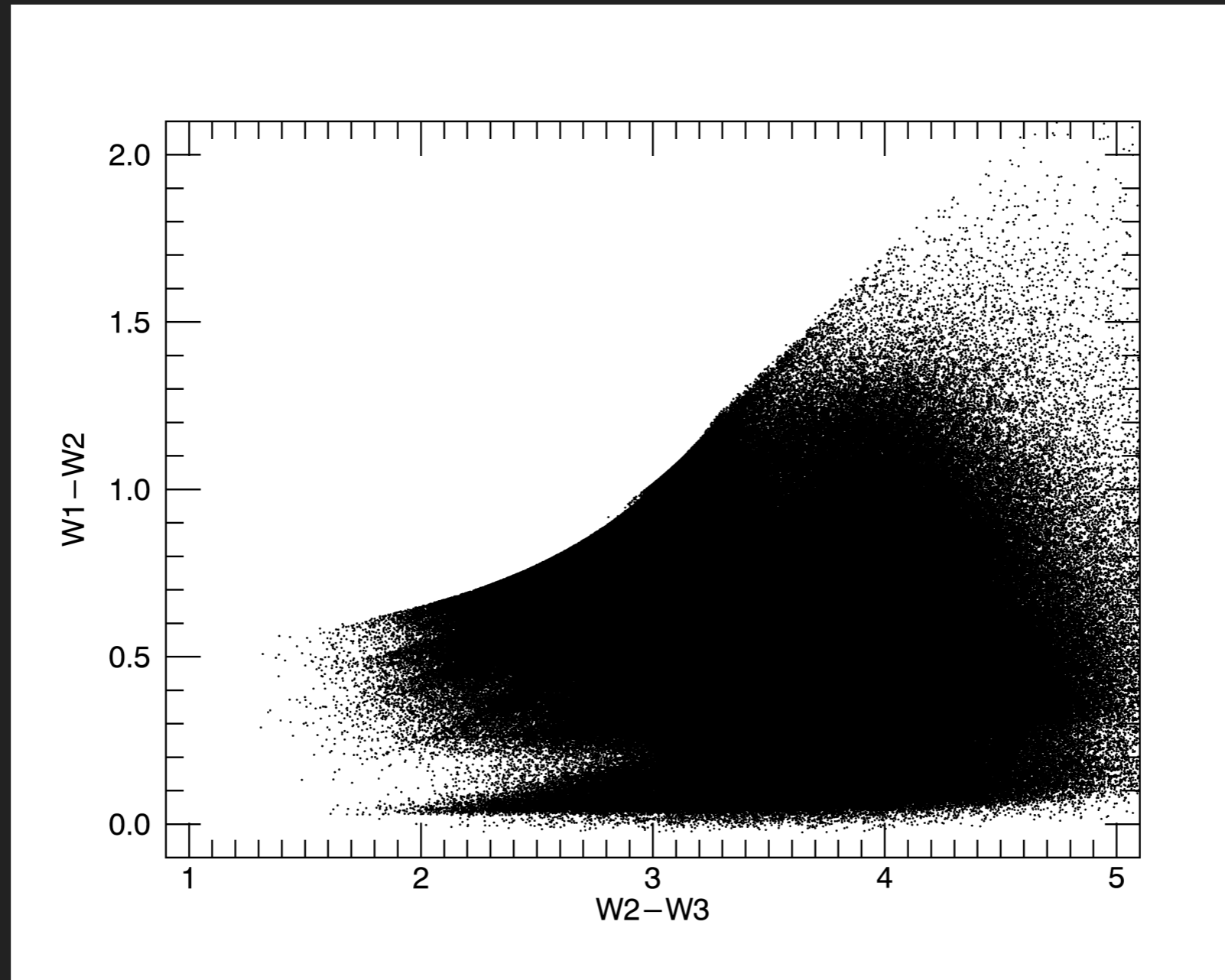
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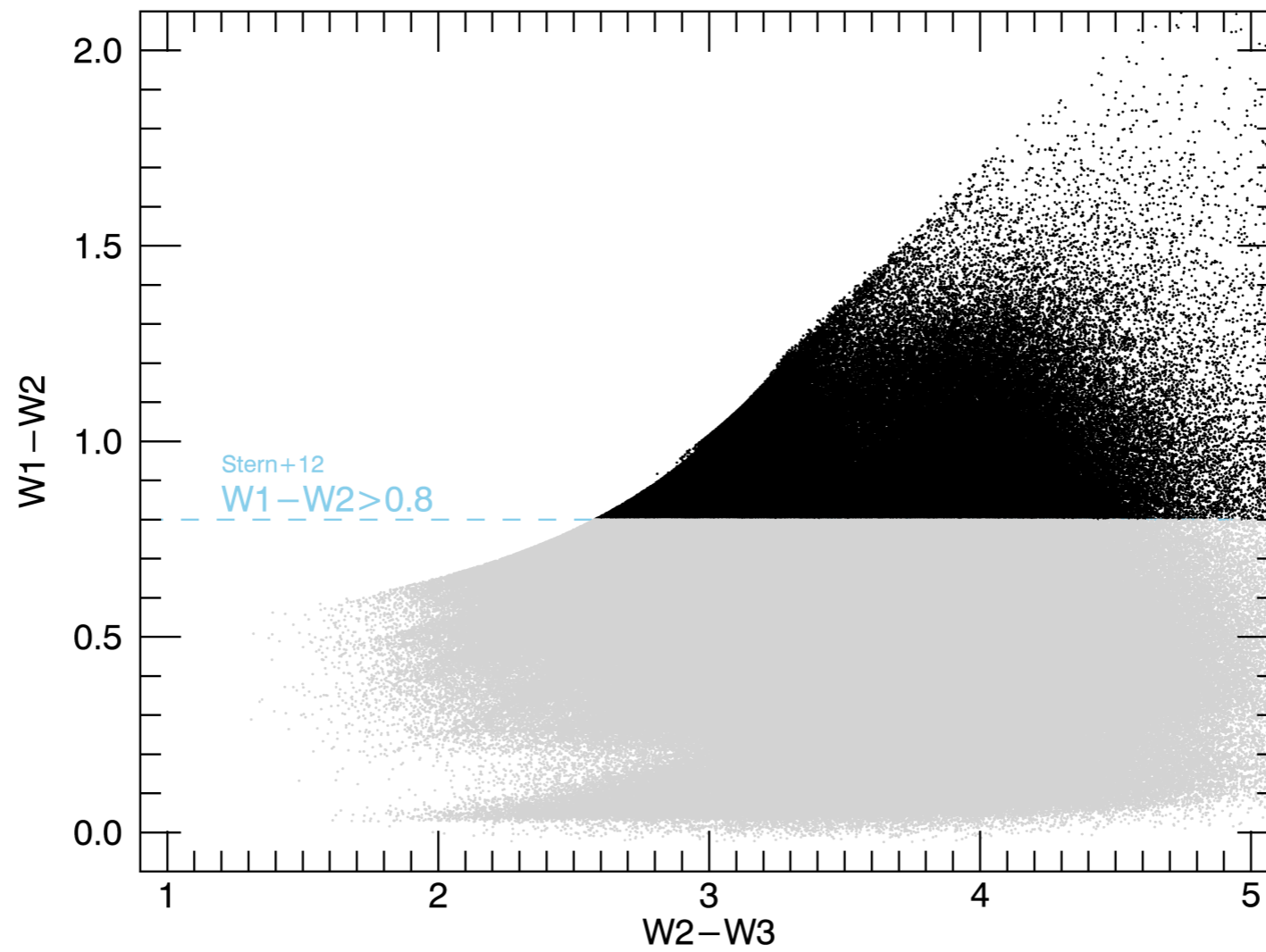
NUCLEAR OBSCURATION



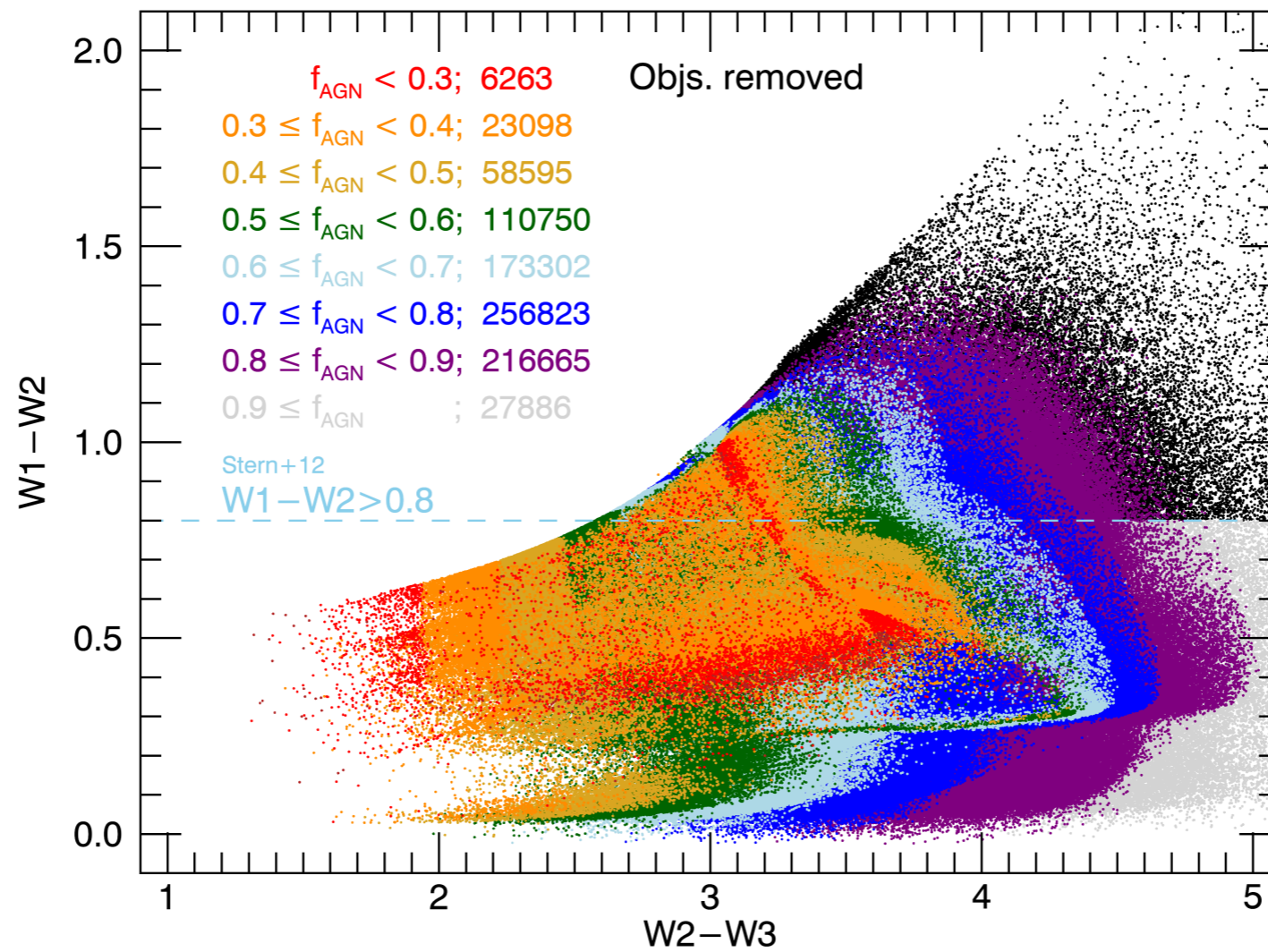
WISE COLOR SPACE



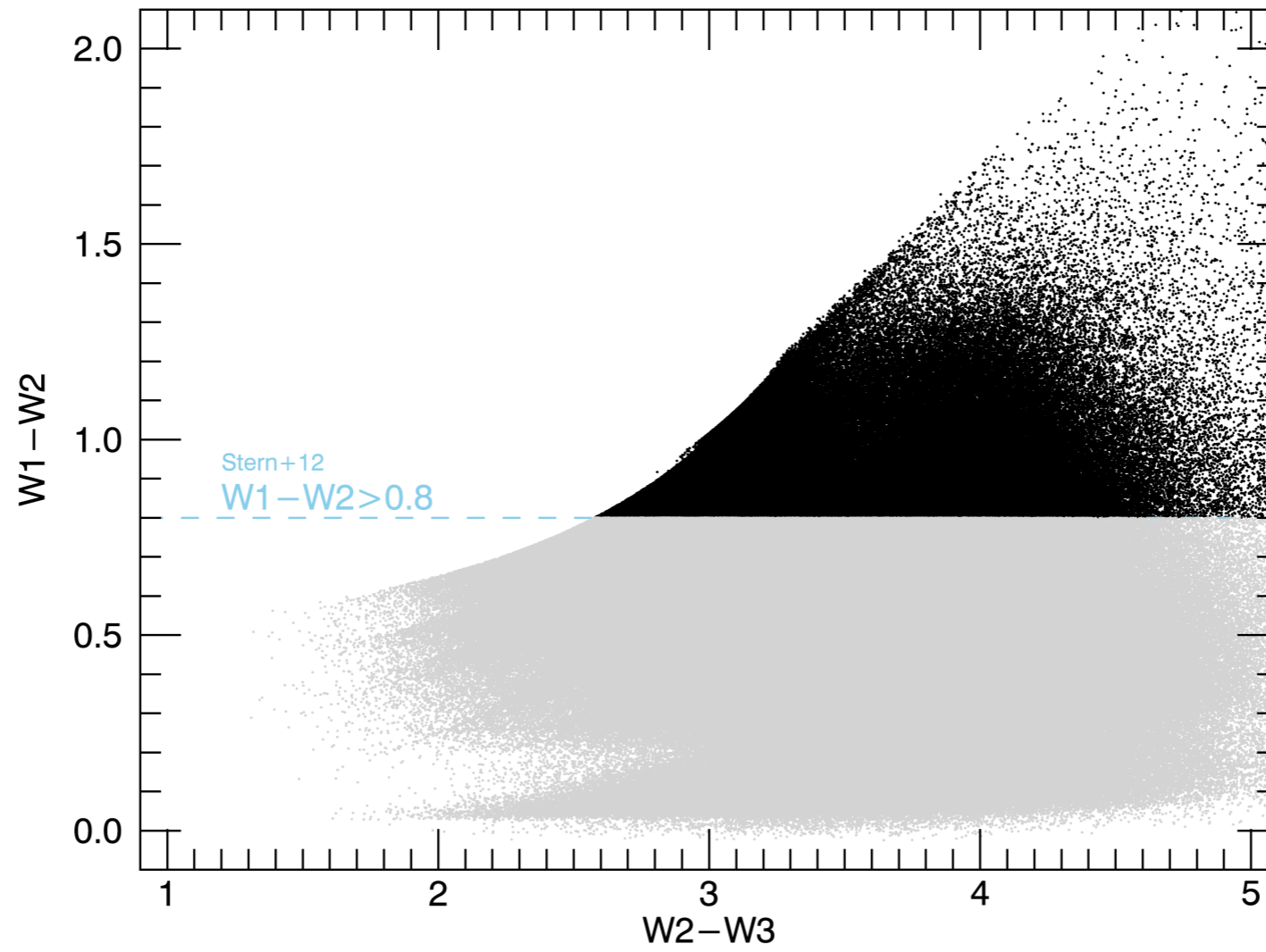
WISE COLOR SPACE



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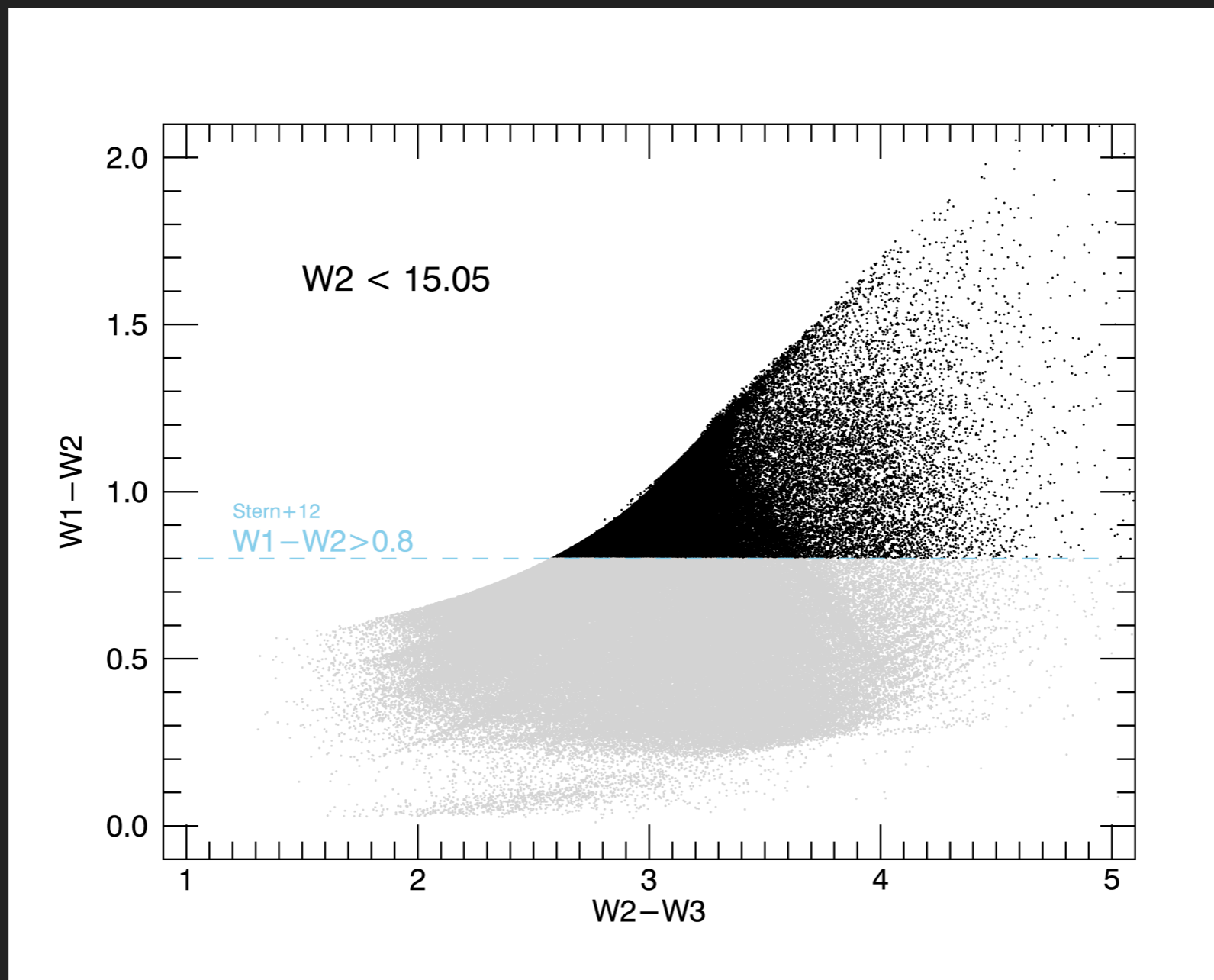


WISE COLOR SPACE

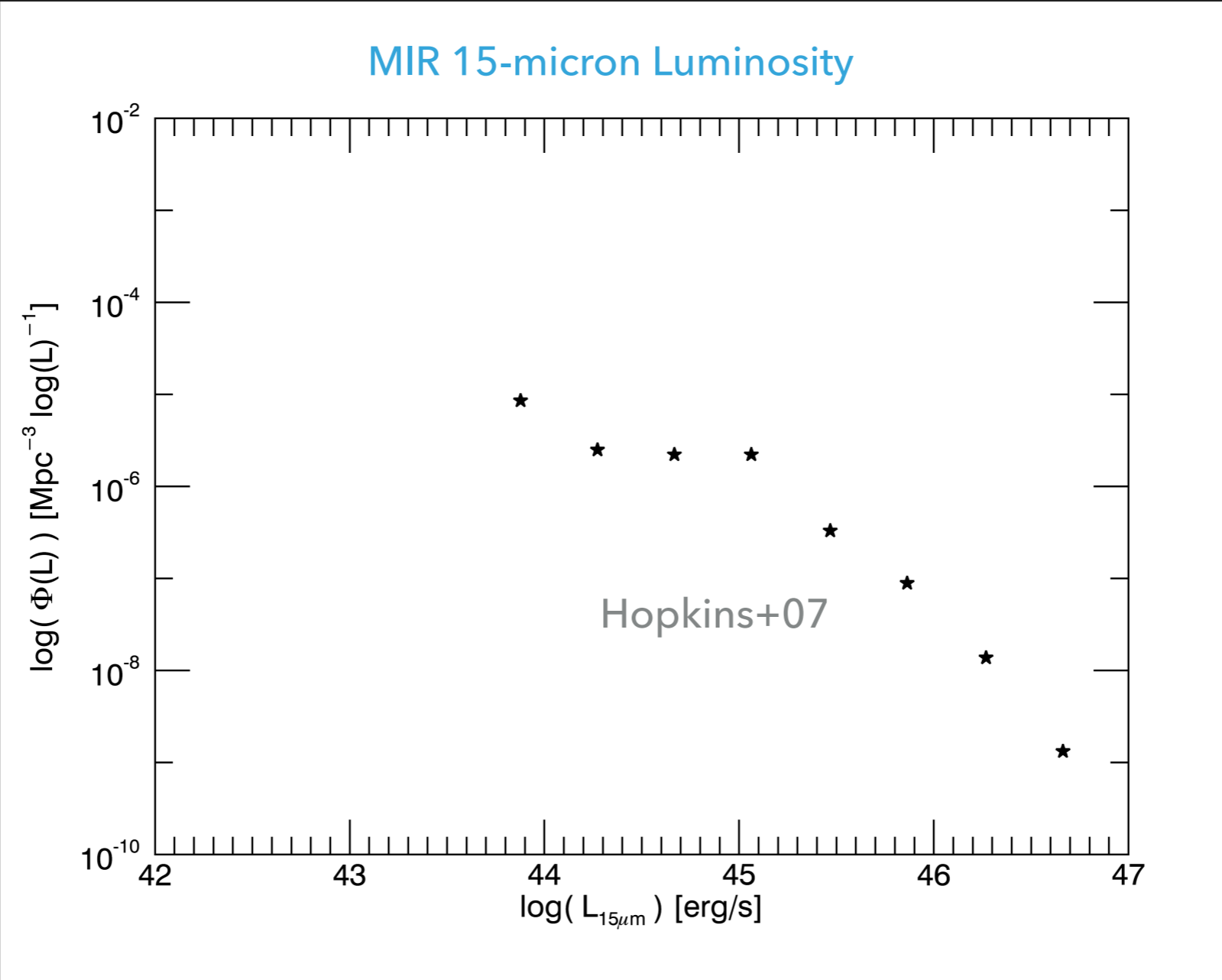


WISE COLOR SPACE

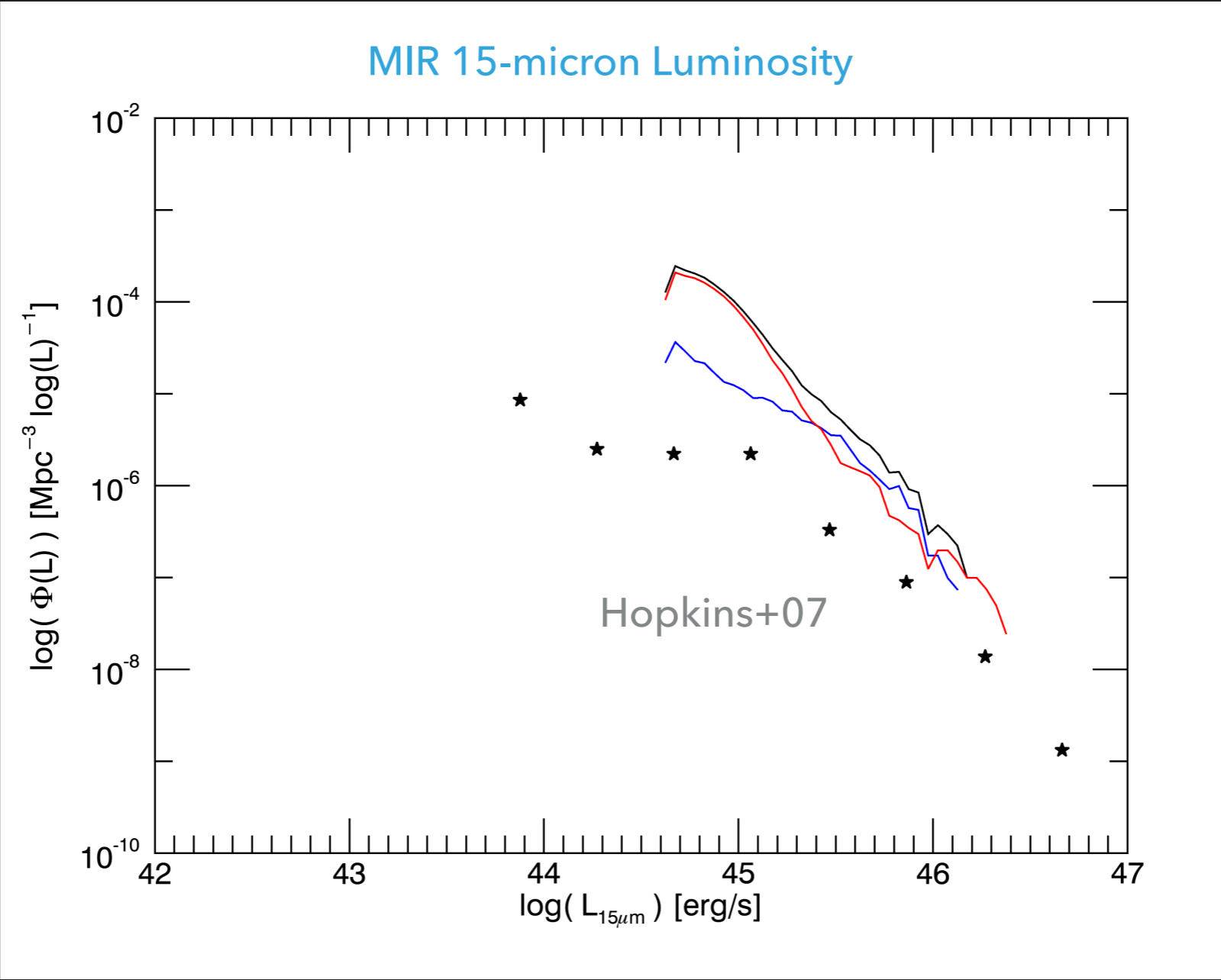
only **100,000** objects survive!



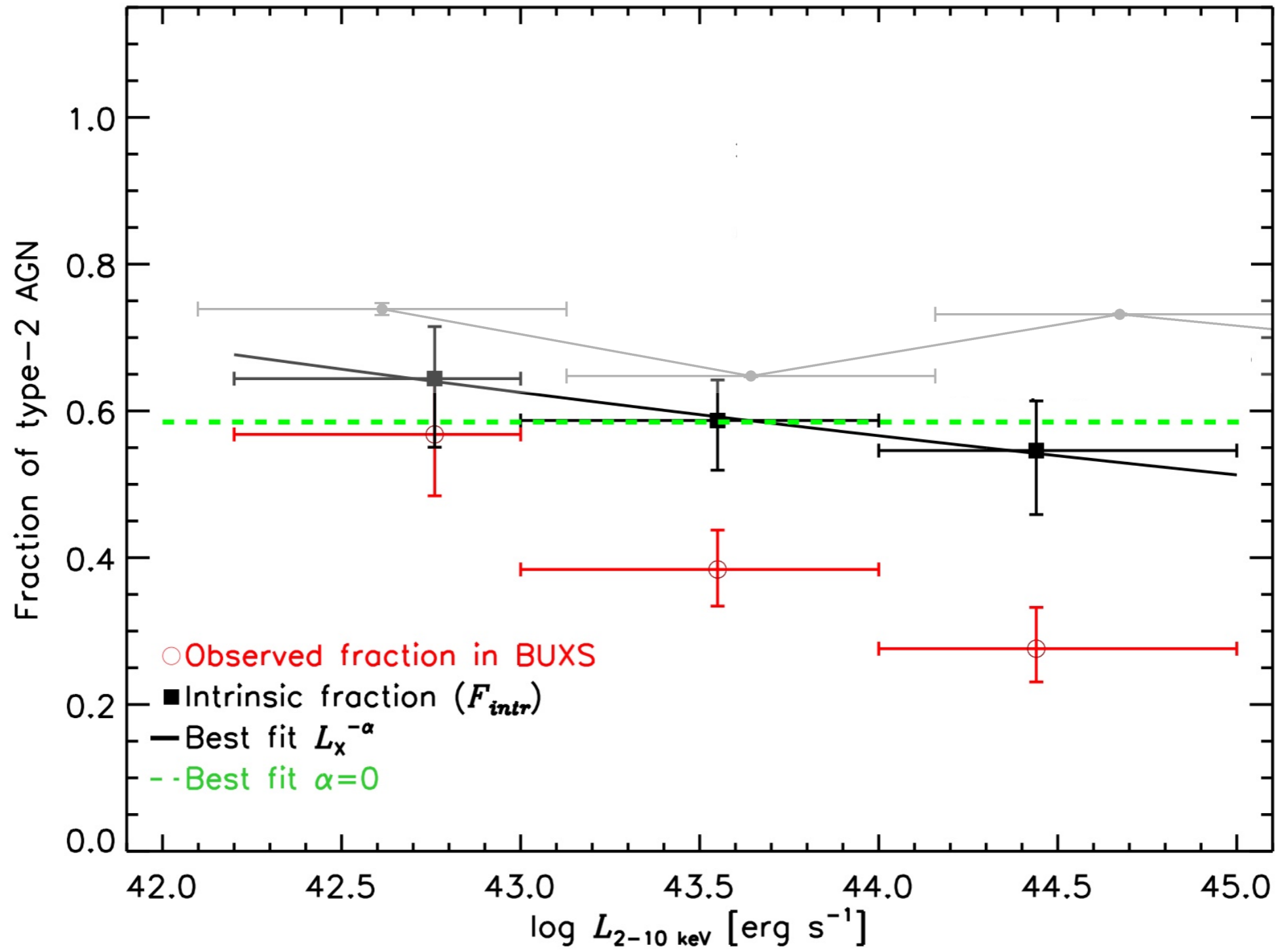
QSO LUMINOSITY FUNCTION



QSO LUMINOSITY FUNCTION



OBSCURED FRACTION

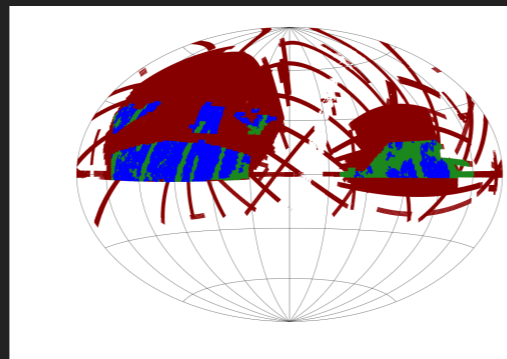


TAKEAWAY

- ▶ large-scale SED modeling is tractable
- ▶ forced photometry makes MIR even more dependable
- ▶ have a handle on the “elusive” numbers
 - ▶ ~70% at $W1-W2 > 0.8$
- ▶ slight increase in L function
- ▶ direct measurement of AGN obscured fraction

THIS IS ONLY $\sim 2275 \text{ DEG}^2$

~6 million



~25 million

