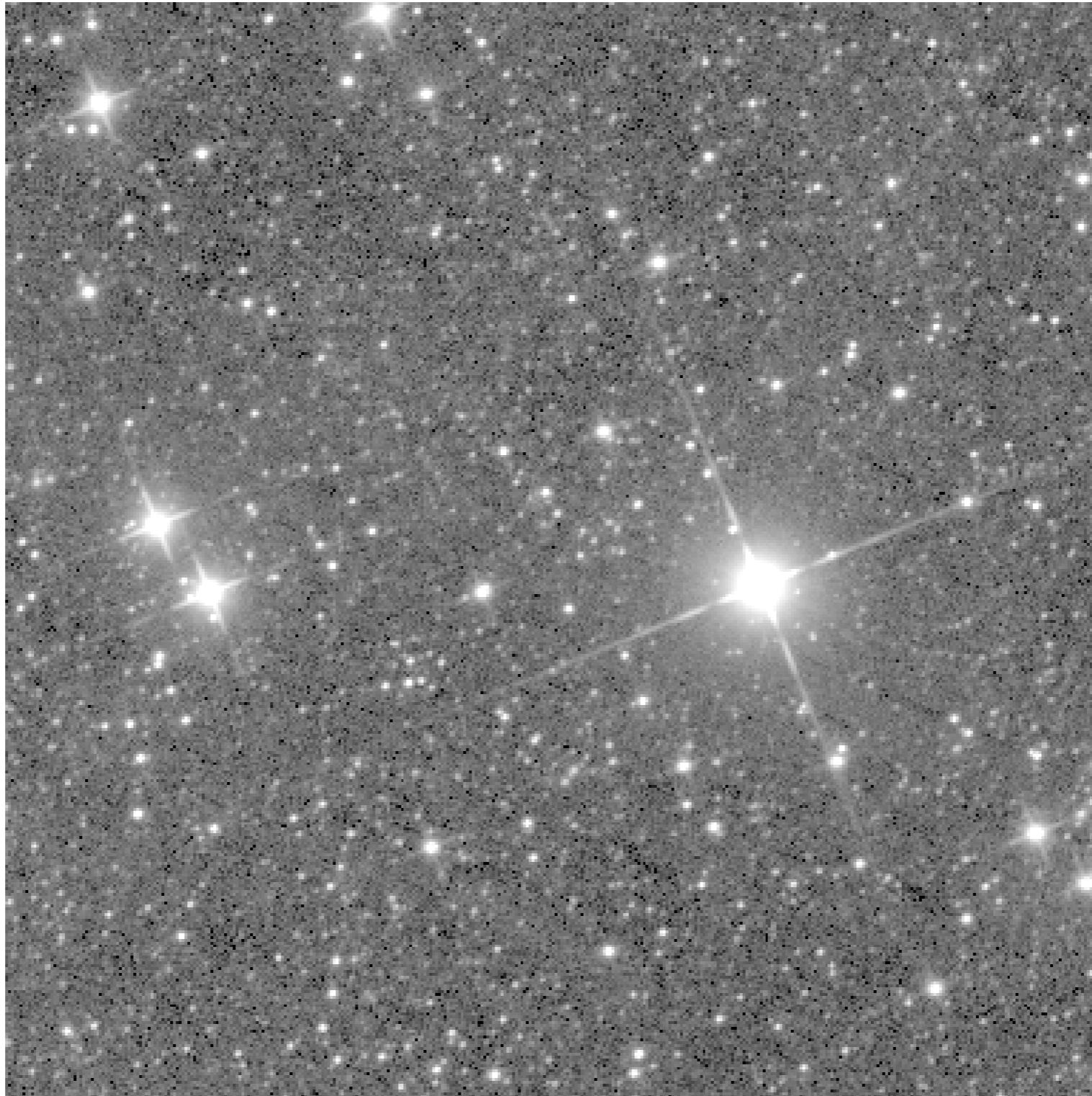


The Effect of Unresolved Contaminant Stars on the Cross- Matching of Photometric Catalogues

Tom J Wilson, University of Exeter
Tim Naylor, also University of Exeter
t.j.wilson@exeter.ac.uk

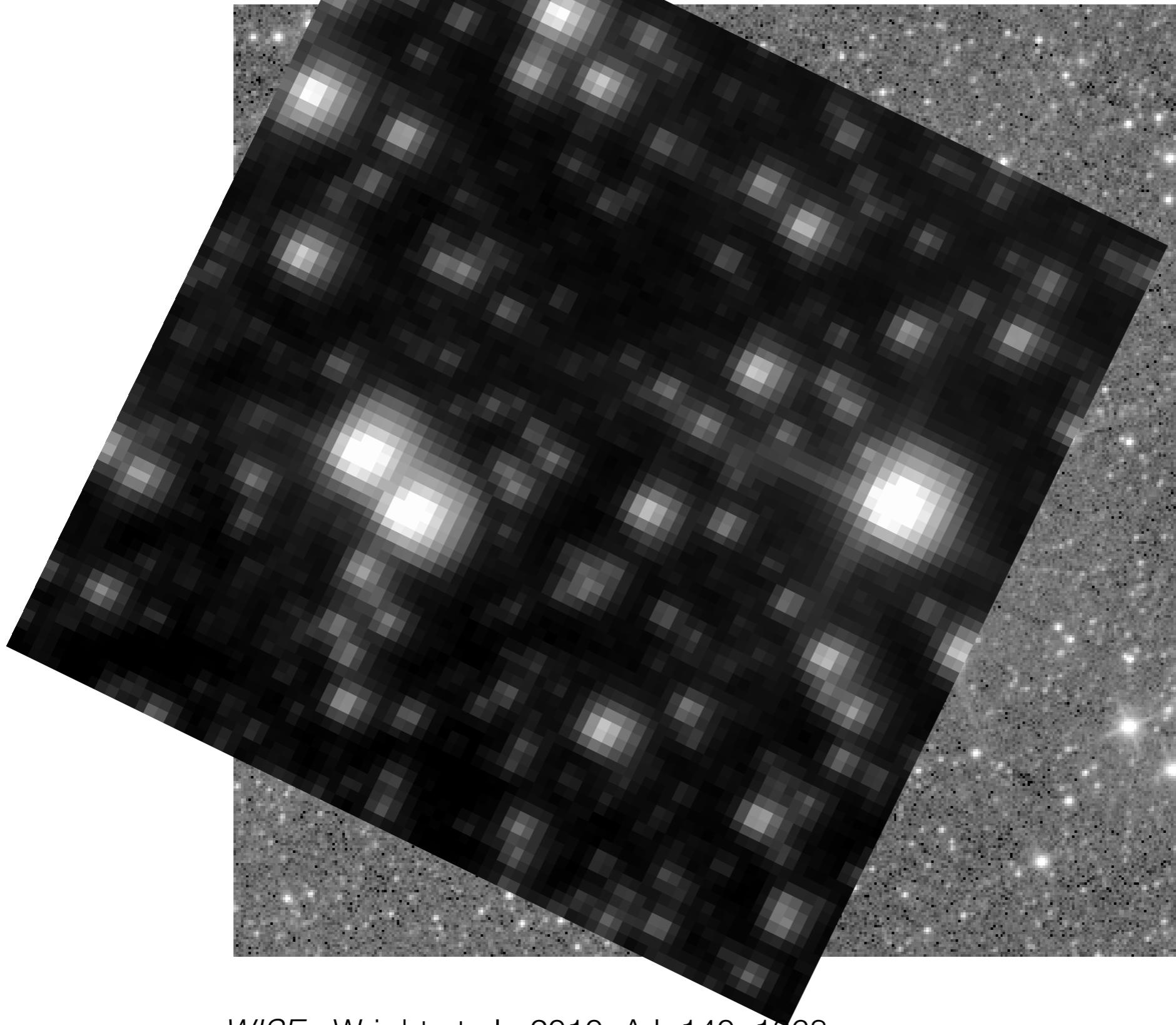
Photometric Observations



WISE - Wright et al., 2010, AJ, 140, 1868

WISE W1
Tom J Wilson @onoddil

Photometric Observations

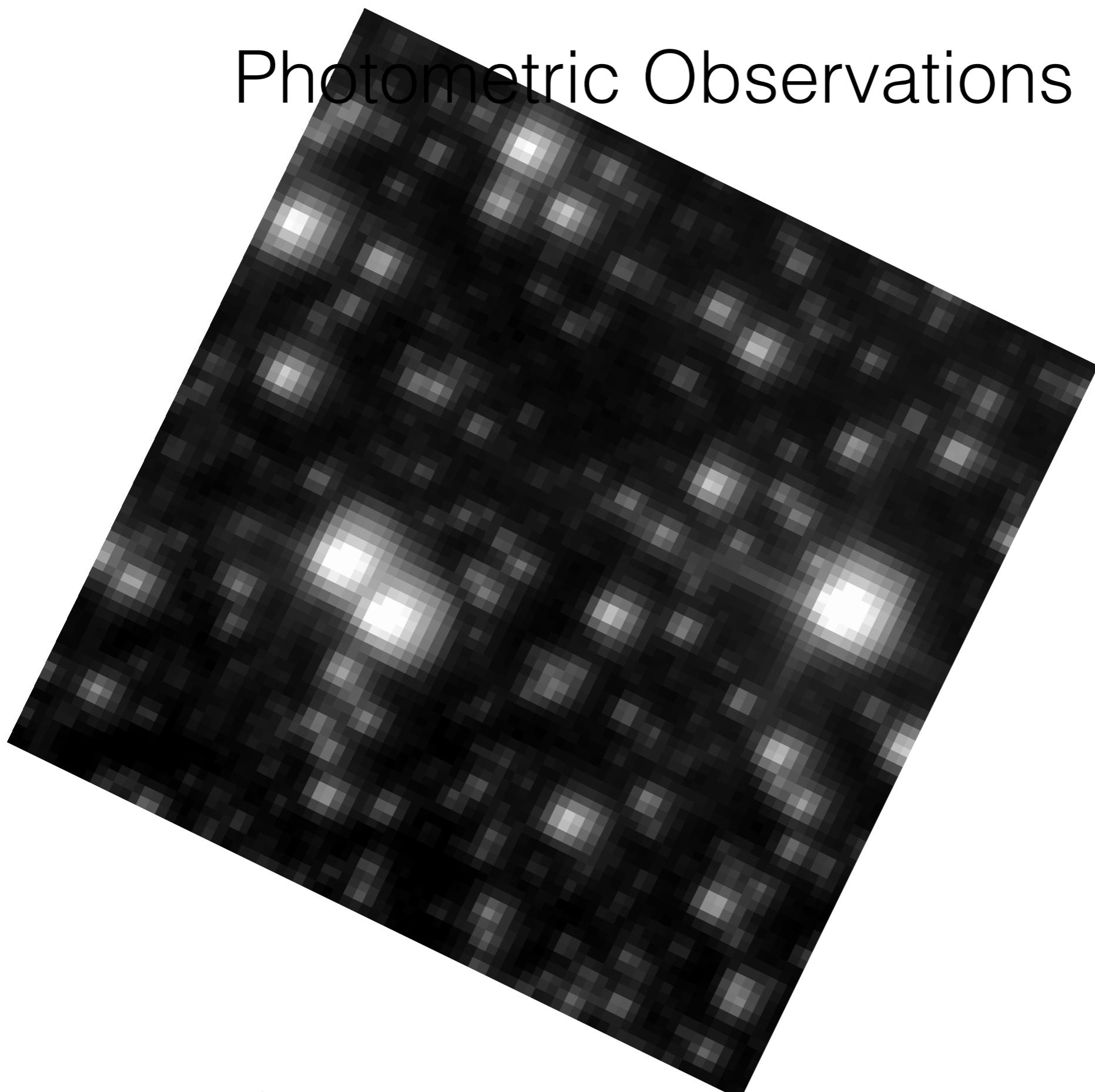


WISE - Wright et al., 2010, AJ, 140, 1868

TESS - Ricker et al., 2015, JATIS, 1, 14003

TESS T
Tom J Wilson @onoddil

Photometric Observations



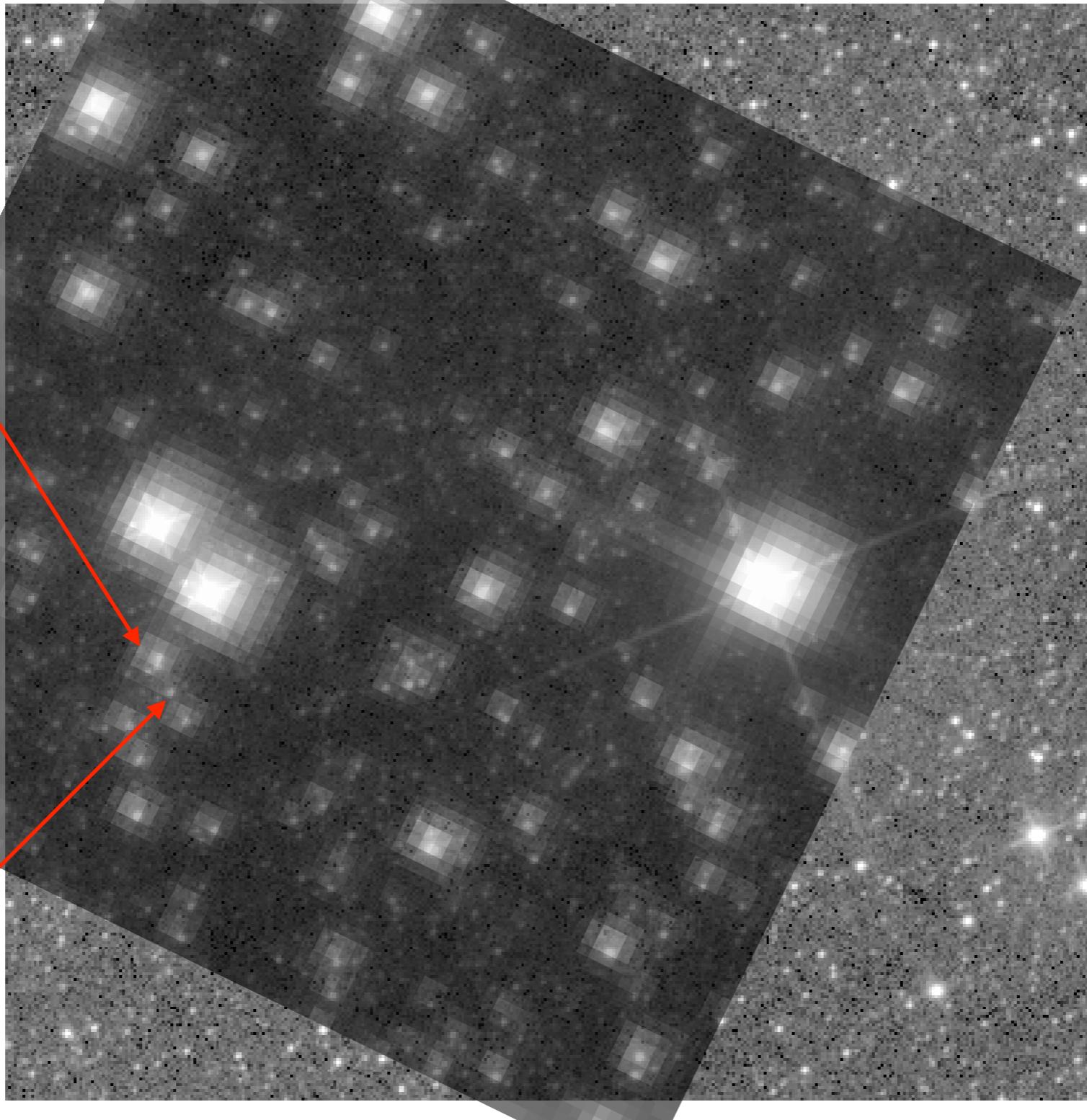
WISE - Wright et al., 2010, AJ, 140, 1868
TESS - Ricker et al., 2015, JATIS, 1, 14003

TESS T
Tom J Wilson @onoddil

Photometric Observations

Unresolved
double star
“pair”!

Completely
unresolved
source!

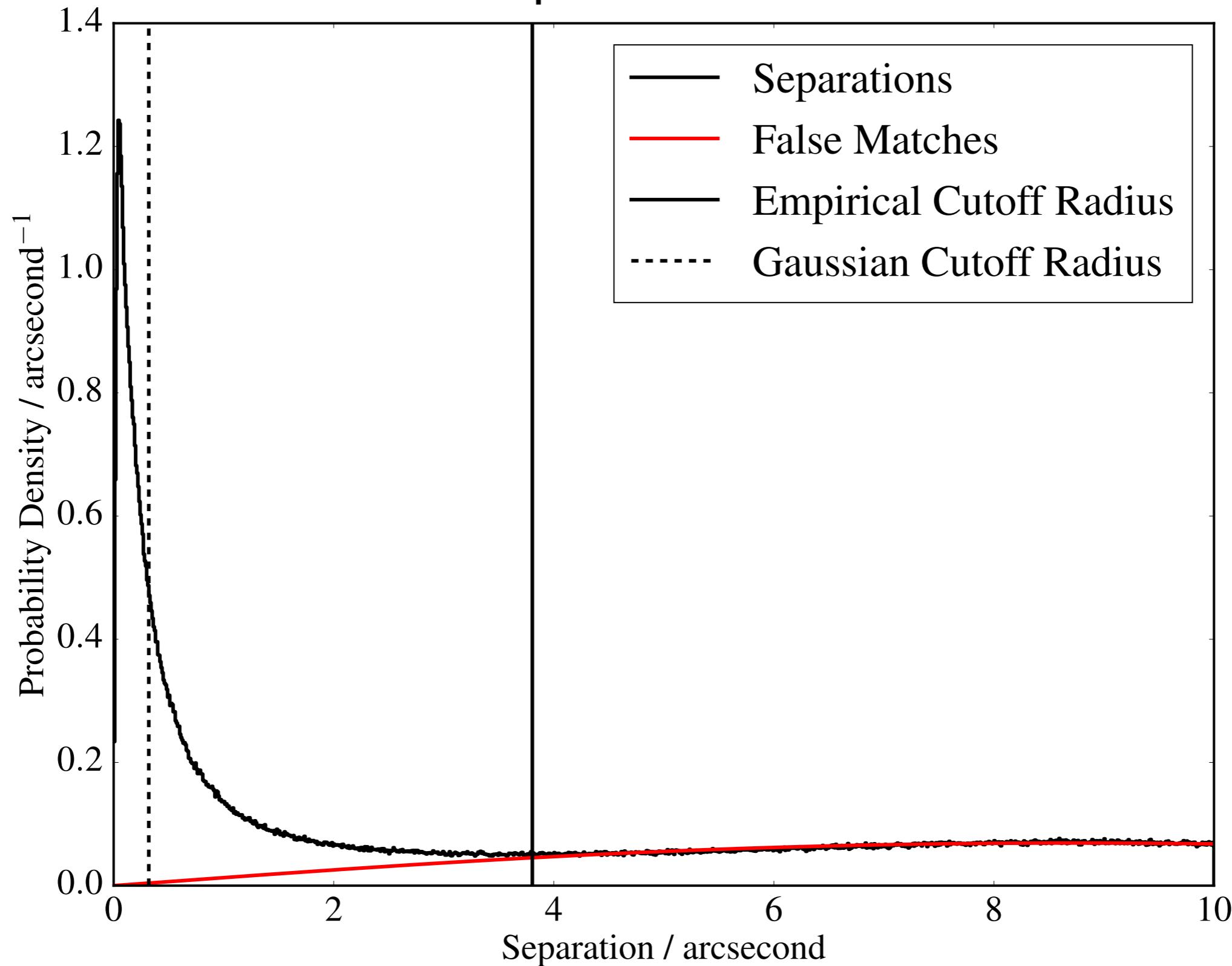


WISE - Wright et al., 2010, AJ, 140, 1868

TESS - Ricker et al., 2015, JATIS, 1, 14003

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Cross-match Separation Distributions



Gaia DR2 - Gaia Collaboration, Brown A. G. A., et al. 2018, A&A, 616, 1

WISE - Wright et al., 2010, AJ, 140, 1868

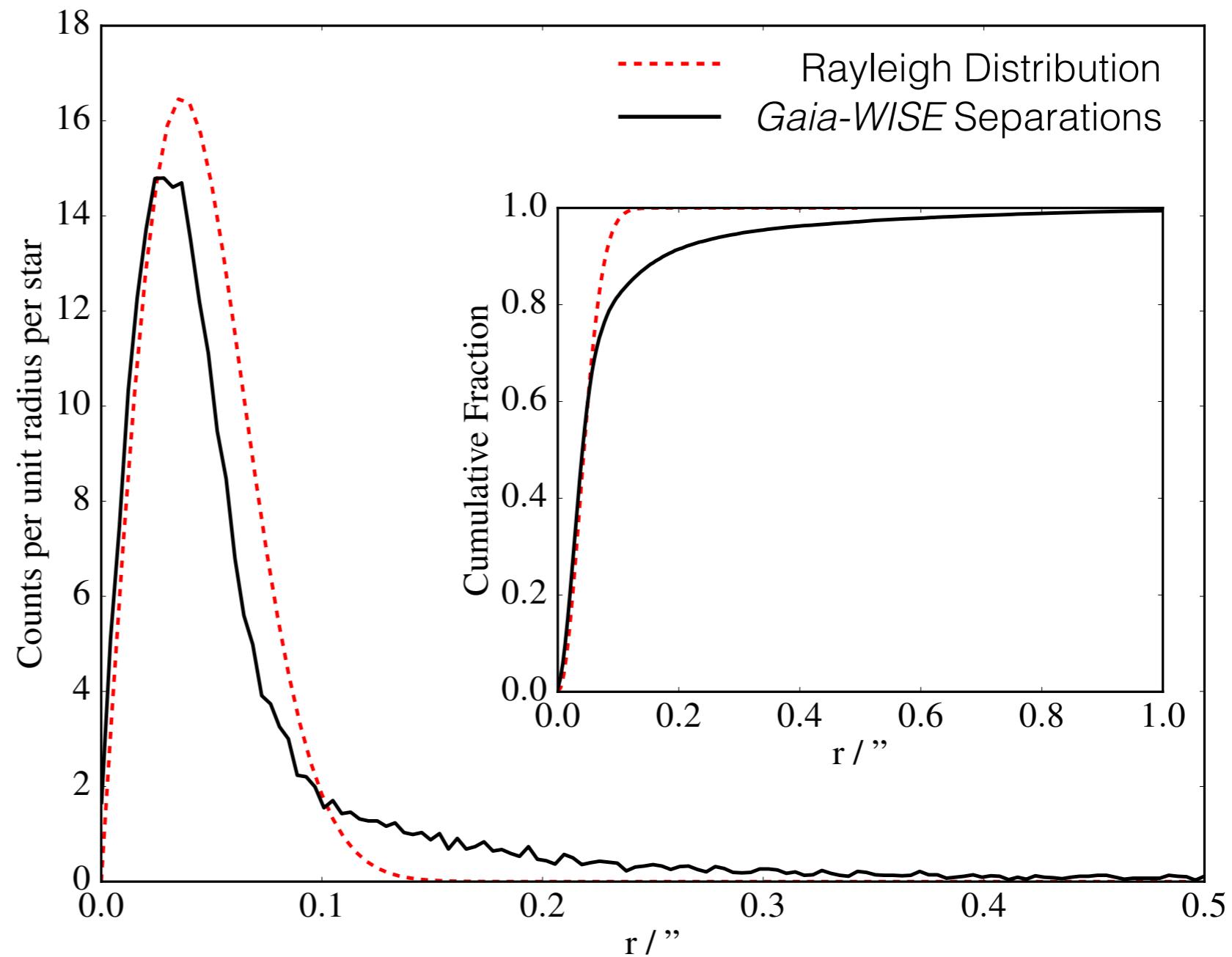
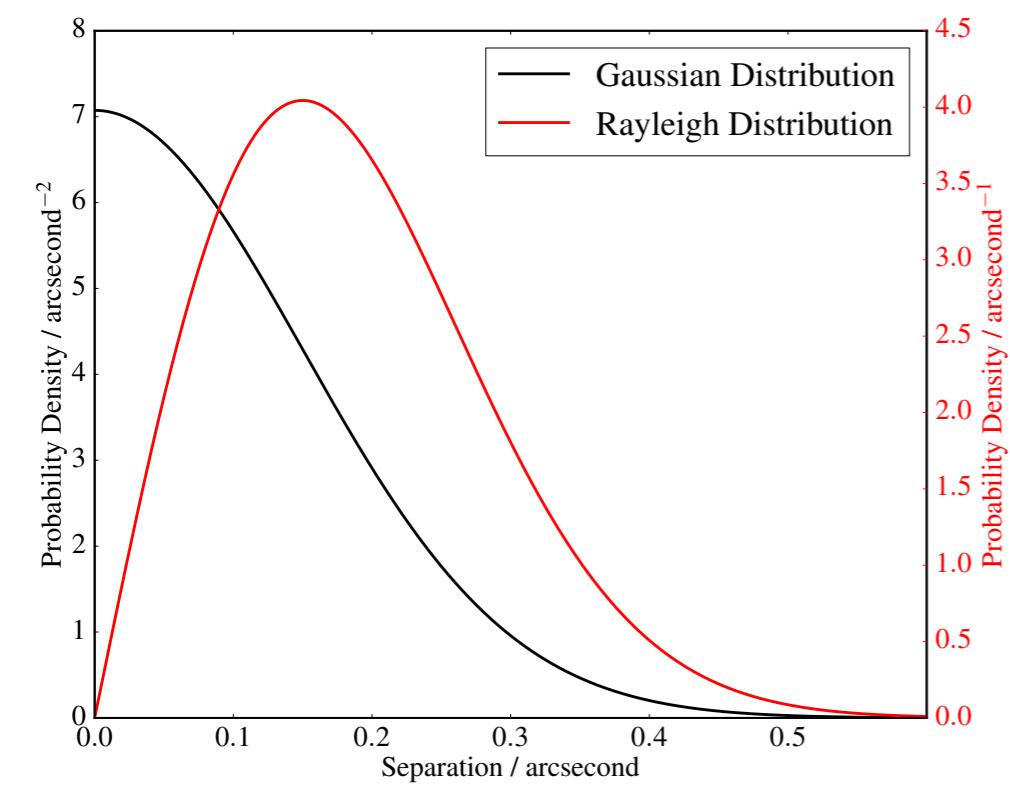
Tom J Wilson @onoddil

The Astrometric Uncertainty Function

$$g(x, y, \sigma) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$



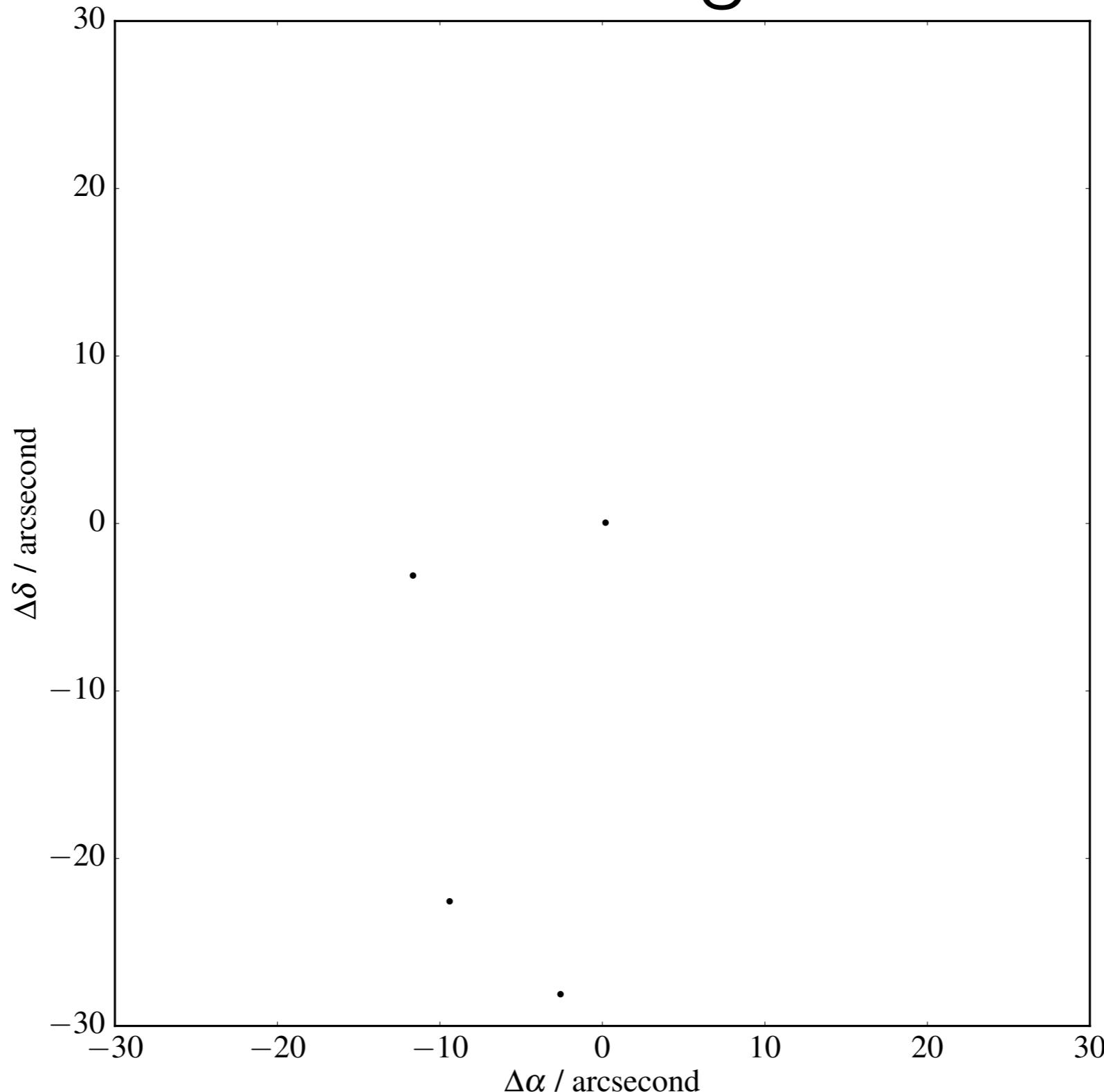
$$g(r, \sigma) = \frac{r}{\sigma^2} e^{-\frac{r^2}{2\sigma^2}}$$



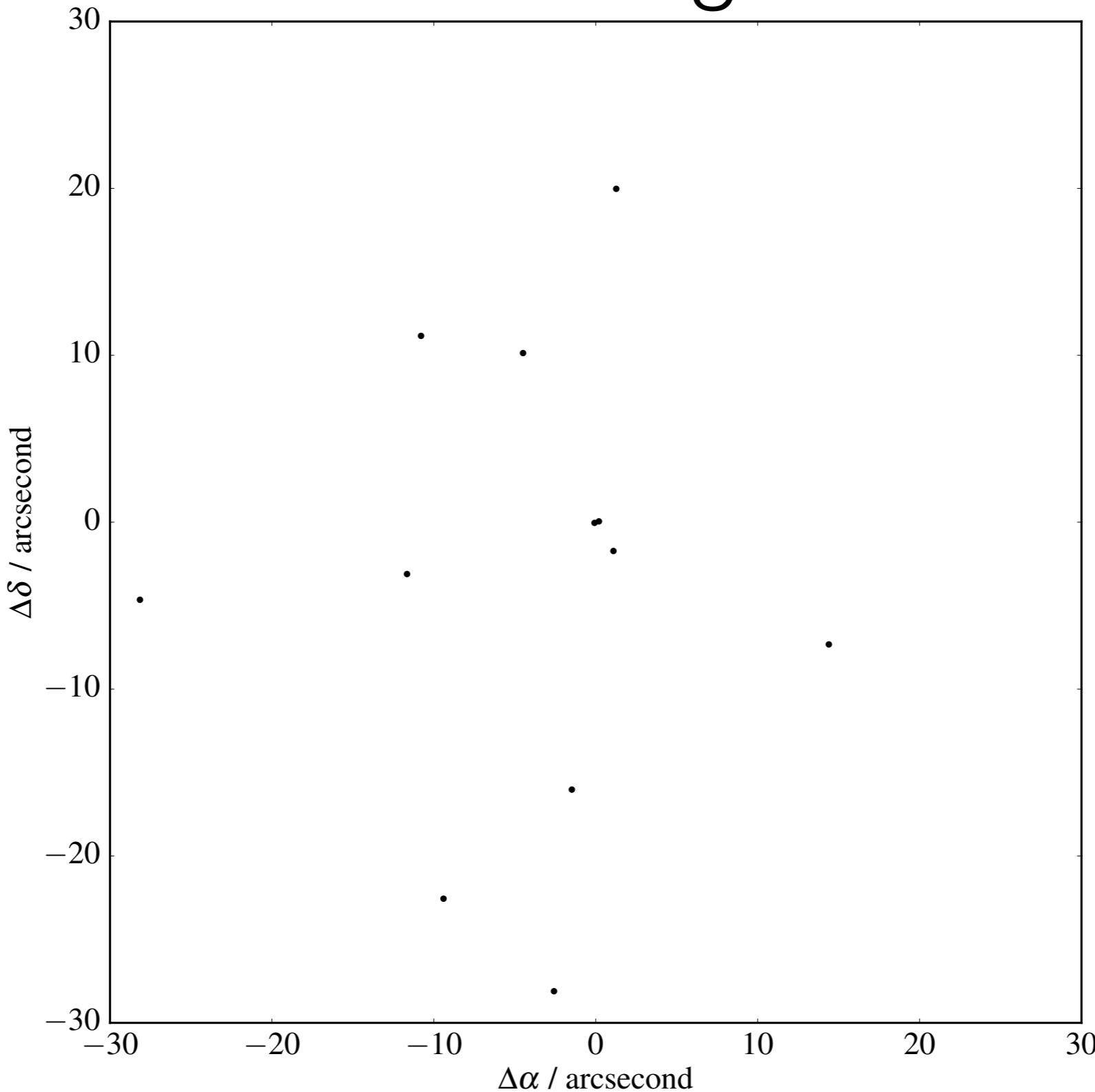
Gaia DR2 - Gaia Collaboration, Brown A. G. A., et al. 2018, A&A, 616, 1
WISE - Wright et al., 2010, AJ, 140, 1868
Wilson & Naylor, 2017, MNRAS, 468, 2517

Tom J Wilson @onoddil

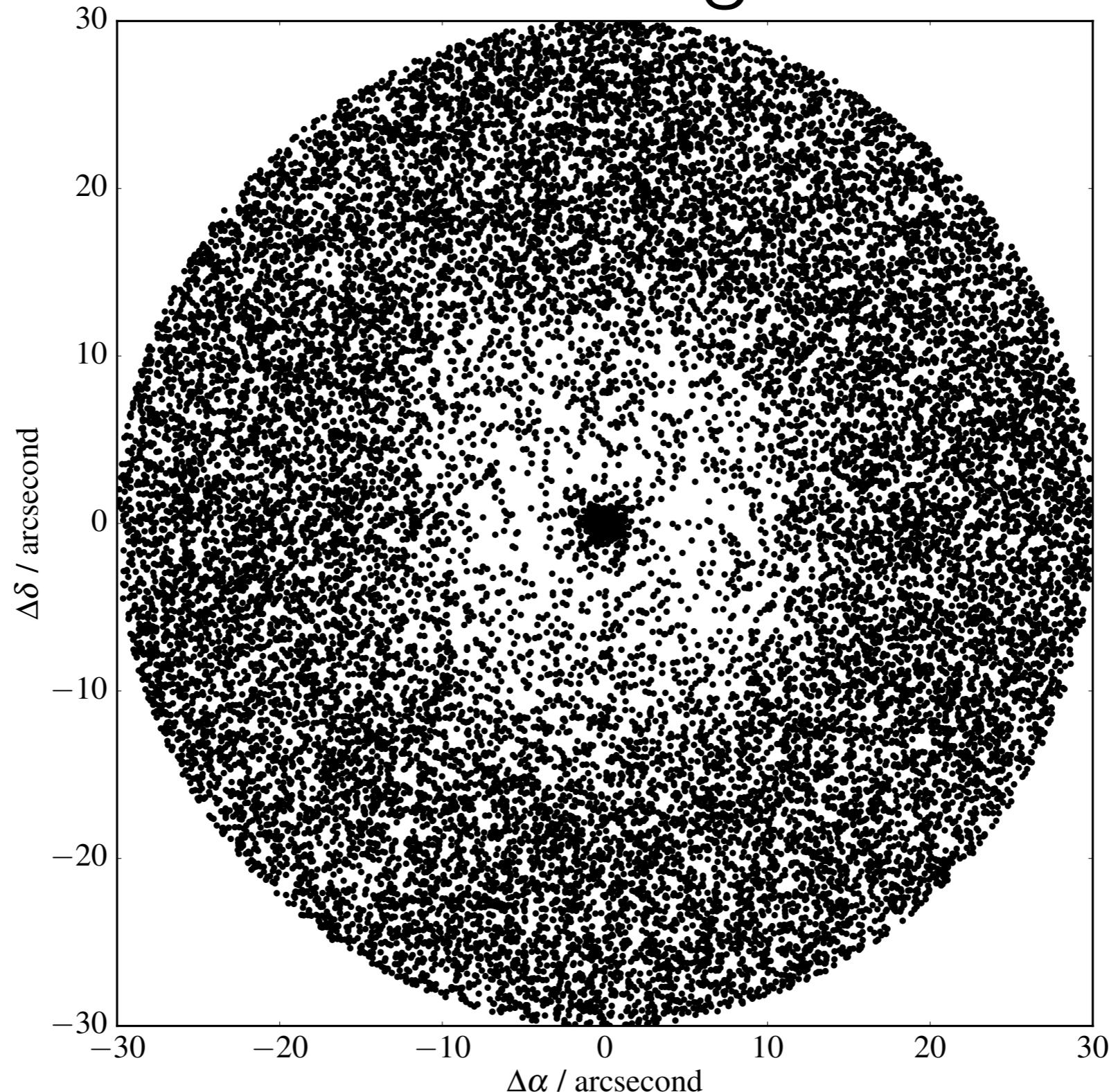
The Astrometric Uncertainty Function: Crowding



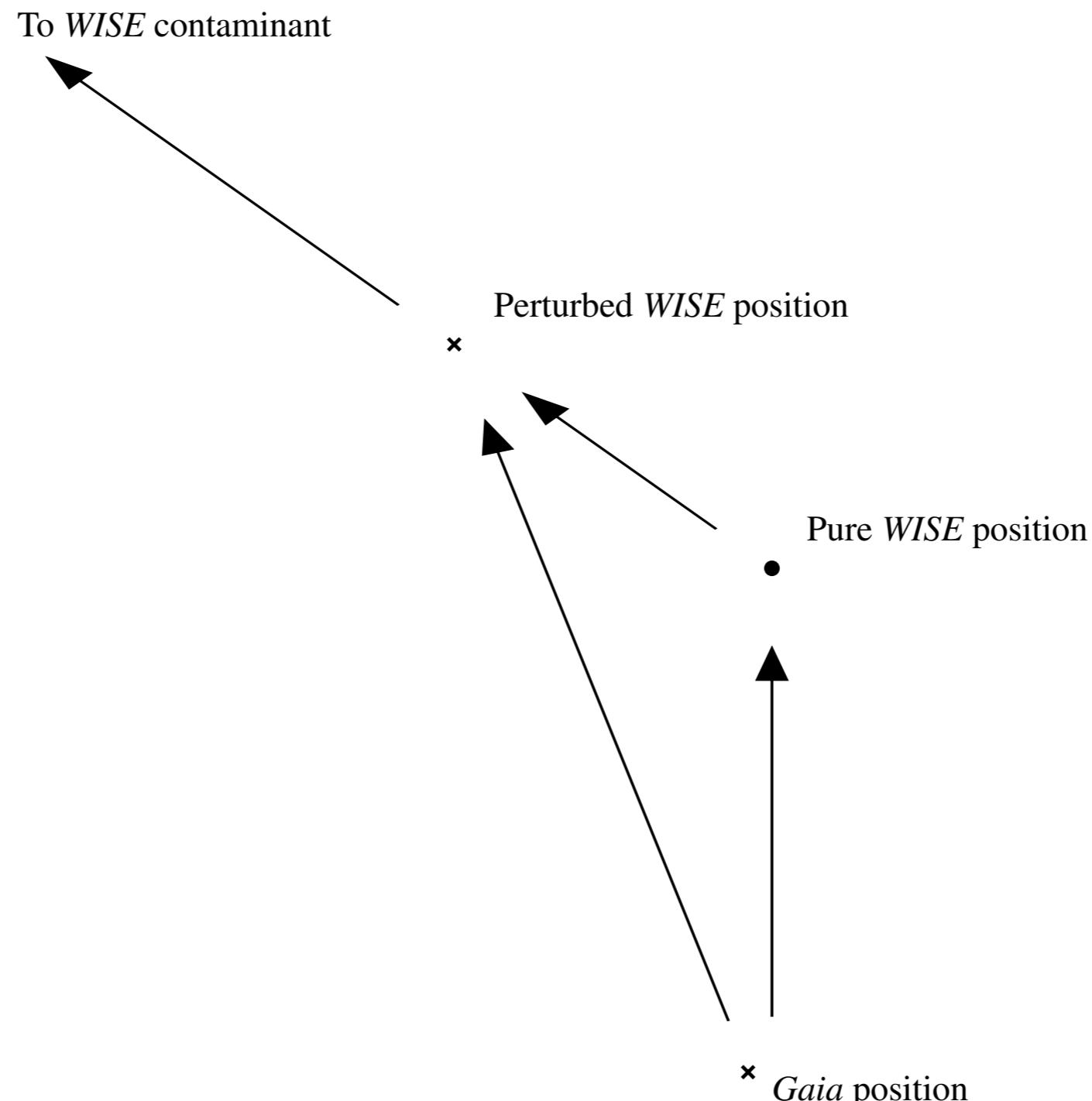
The Astrometric Uncertainty Function: Crowding



The Astrometric Uncertainty Function: Crowding

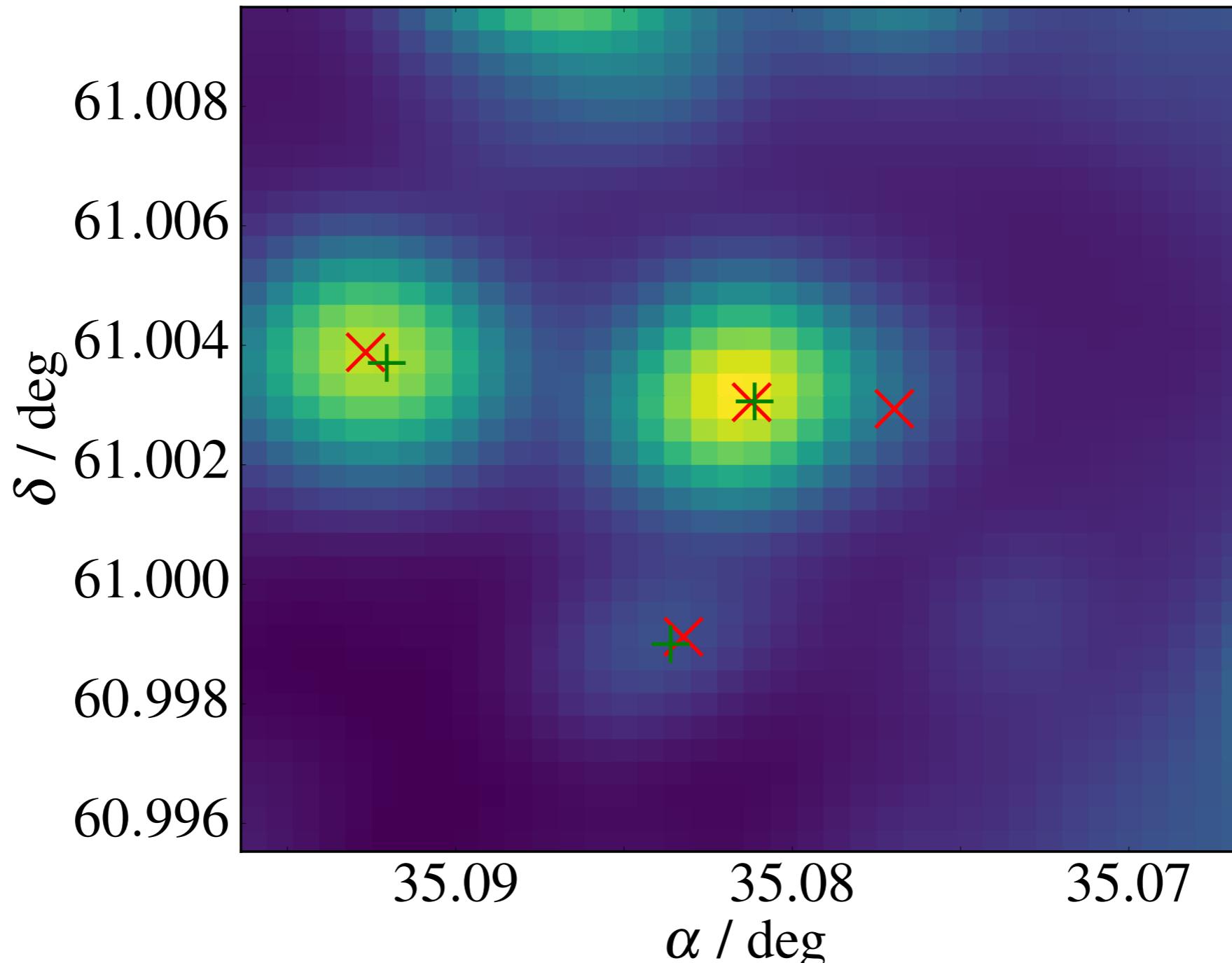


The Astrometric Uncertainty Function: Perturbation



The Astrometric Uncertainty Function: *Gaia-WISE* Resolved Blend

✗ *Gaia*
+ *WISE*



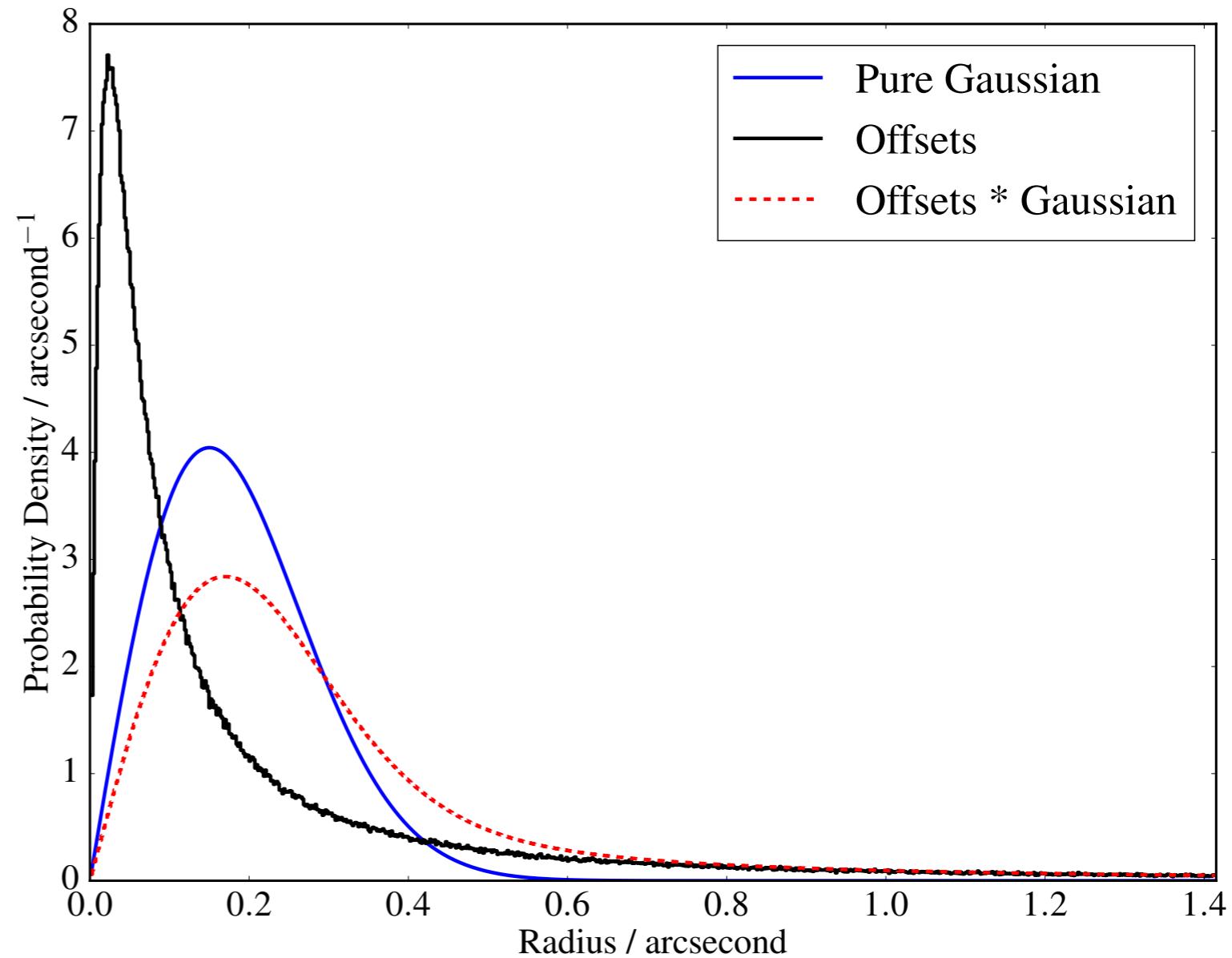
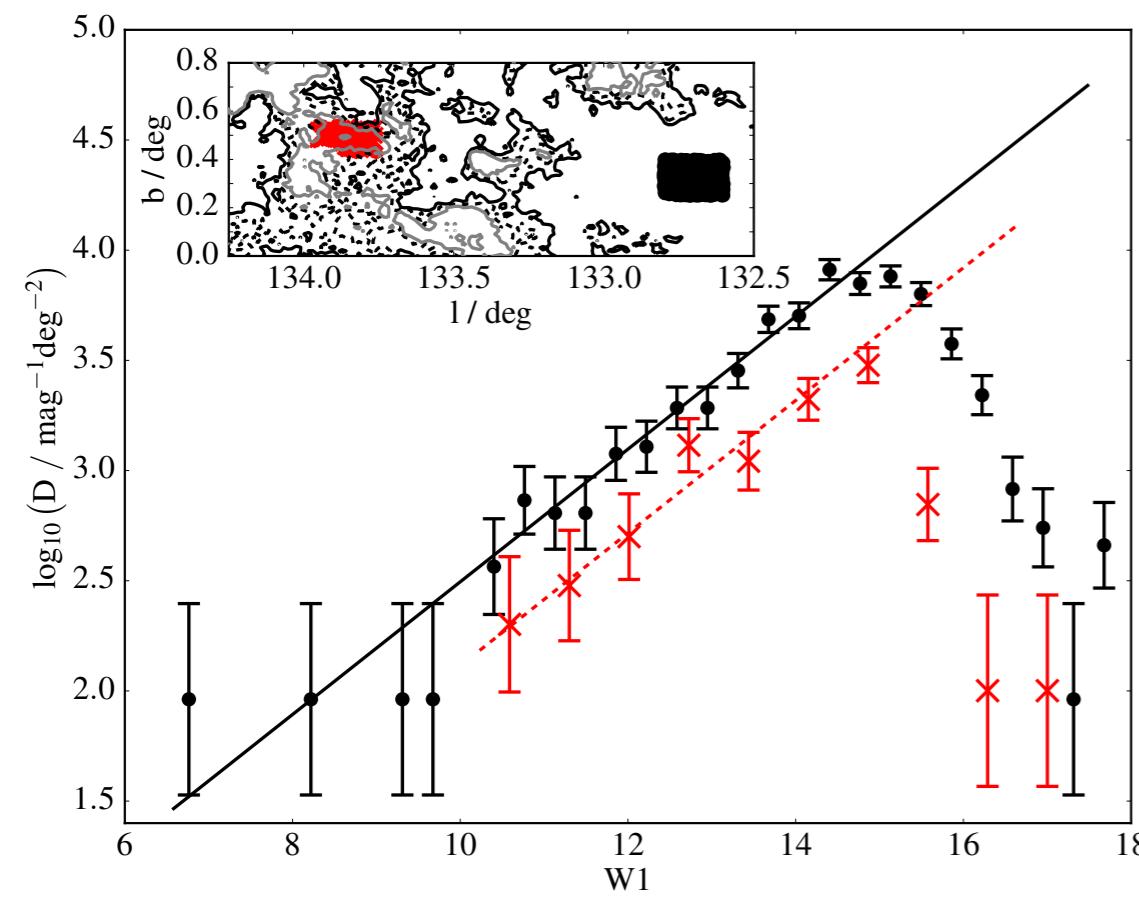
Gaia DR2 - Gaia Collaboration, Brown A. G. A., et al. 2018, A&A, 616, 1

WISE - Wright et al., 2010, AJ, 140, 1868

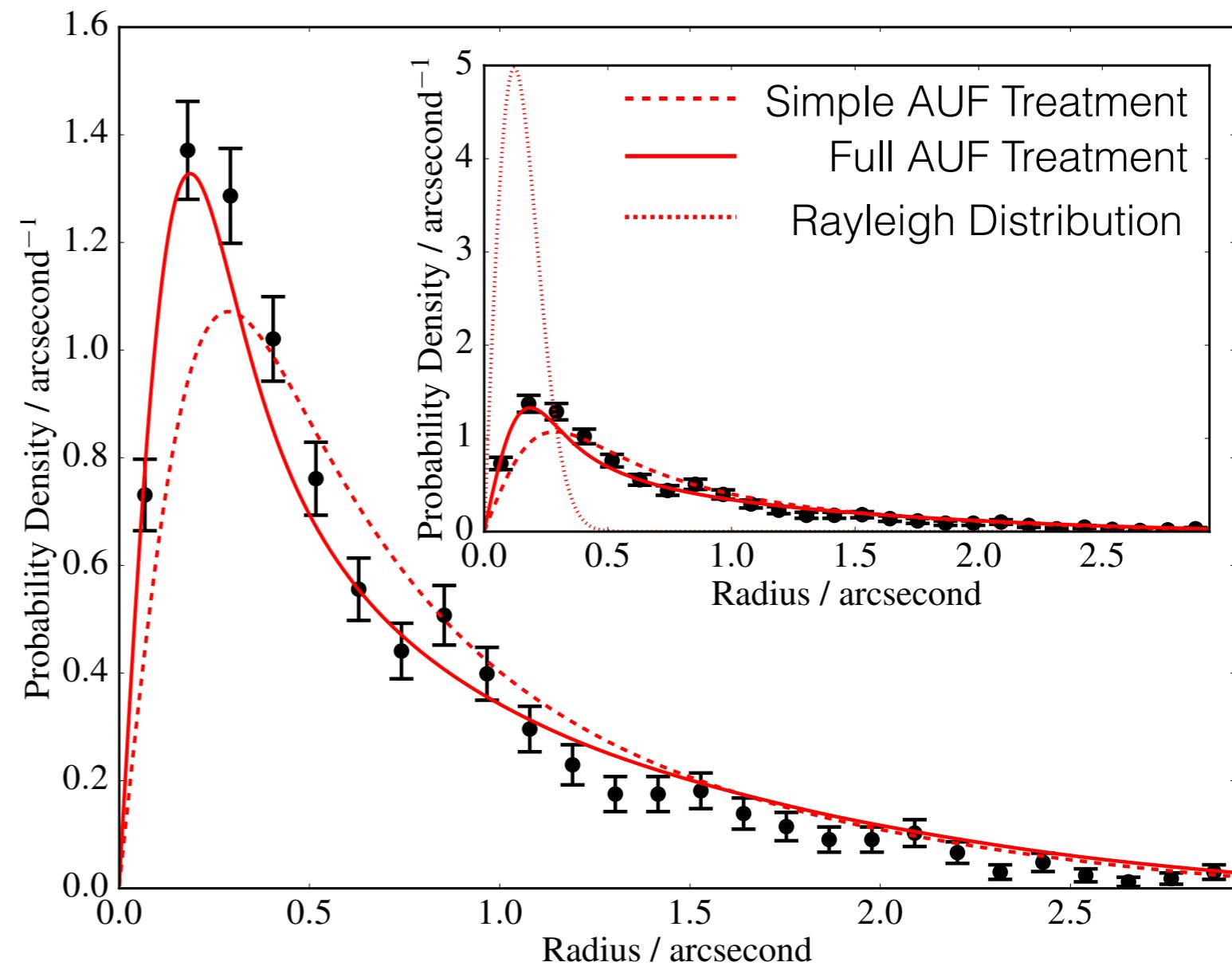
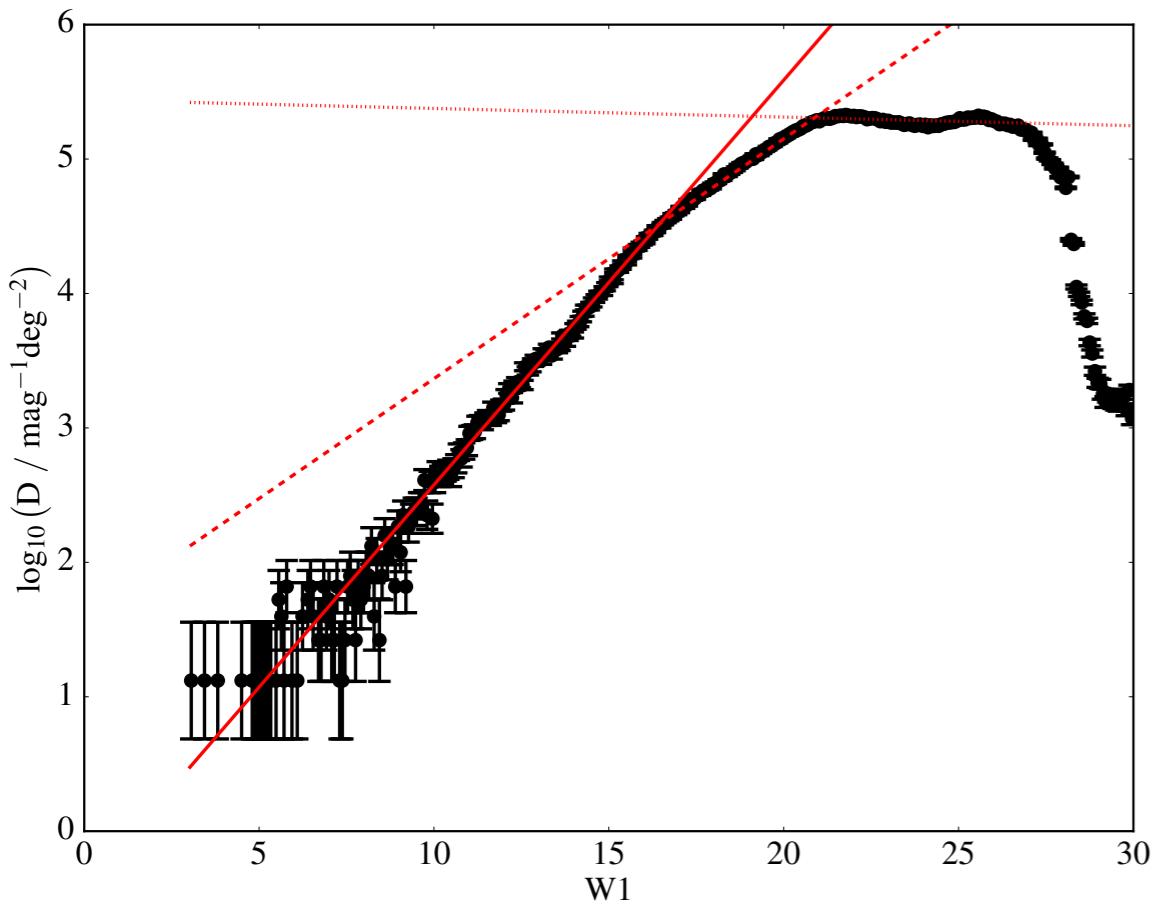
Wilson & Naylor, MNRAS, 2018b, 481, 2148

Tom J Wilson @onoddil

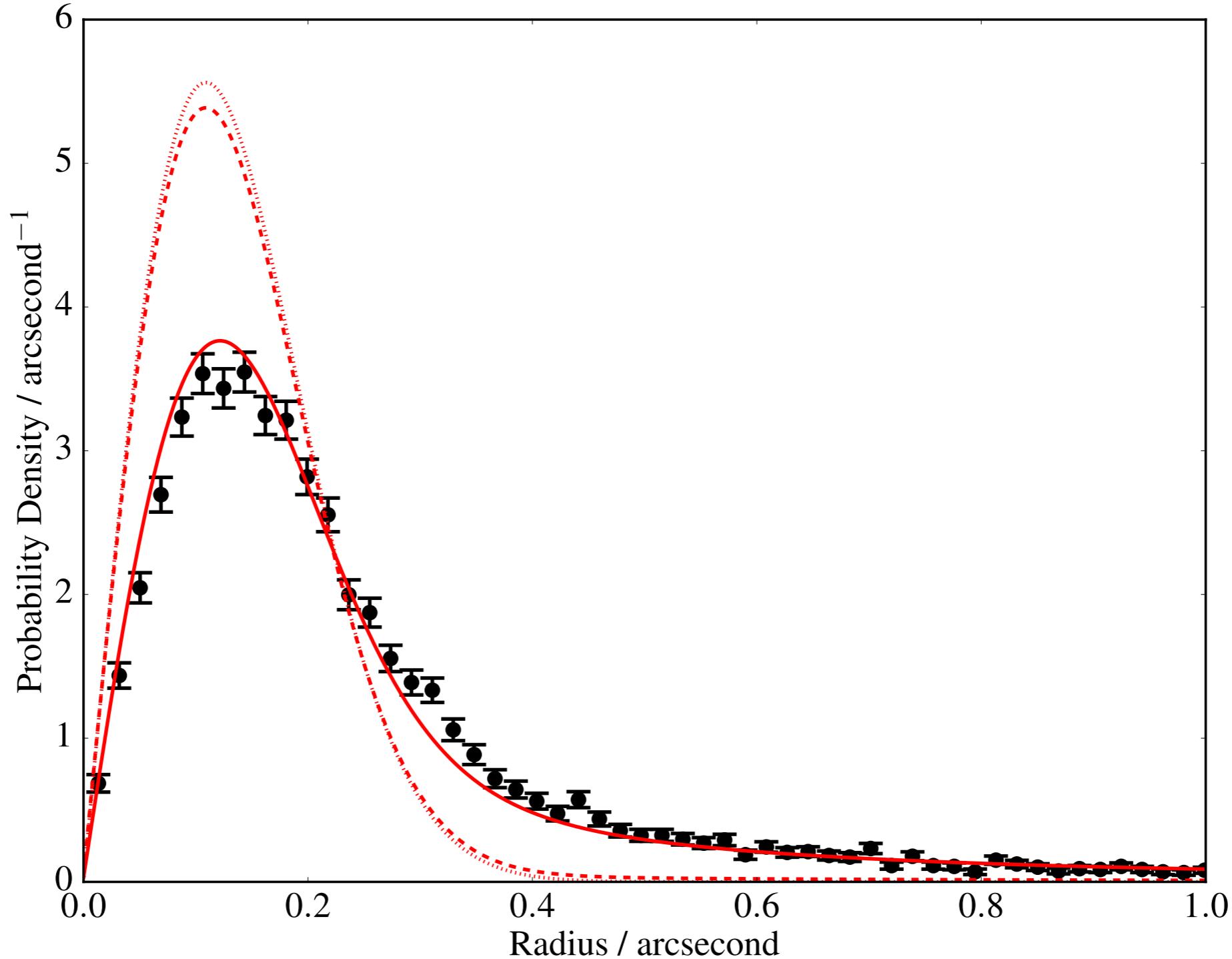
The Astrometric Uncertainty Function: Building Empirical AUFs



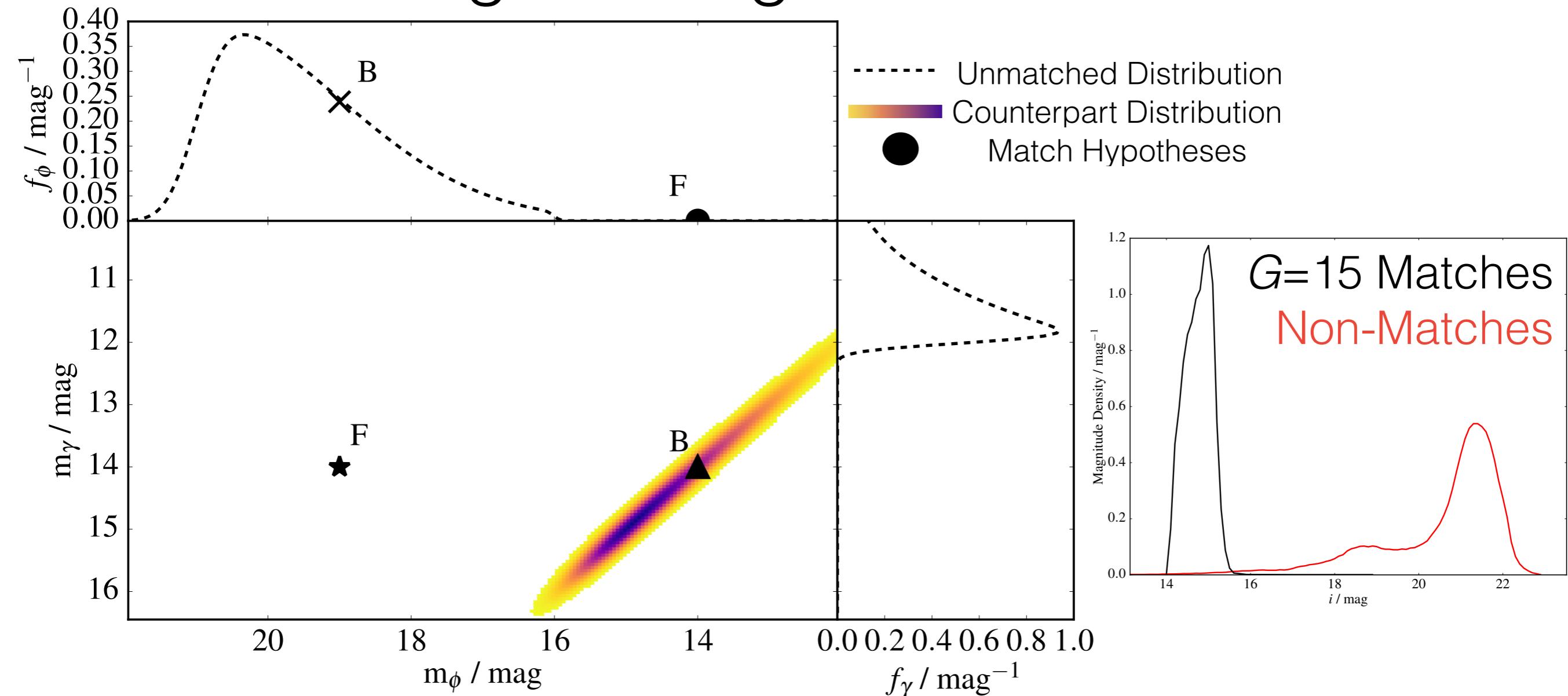
Contamination Effects: Effects Below Sensitivity Limit



Contamination Effects: Galaxy Contamination

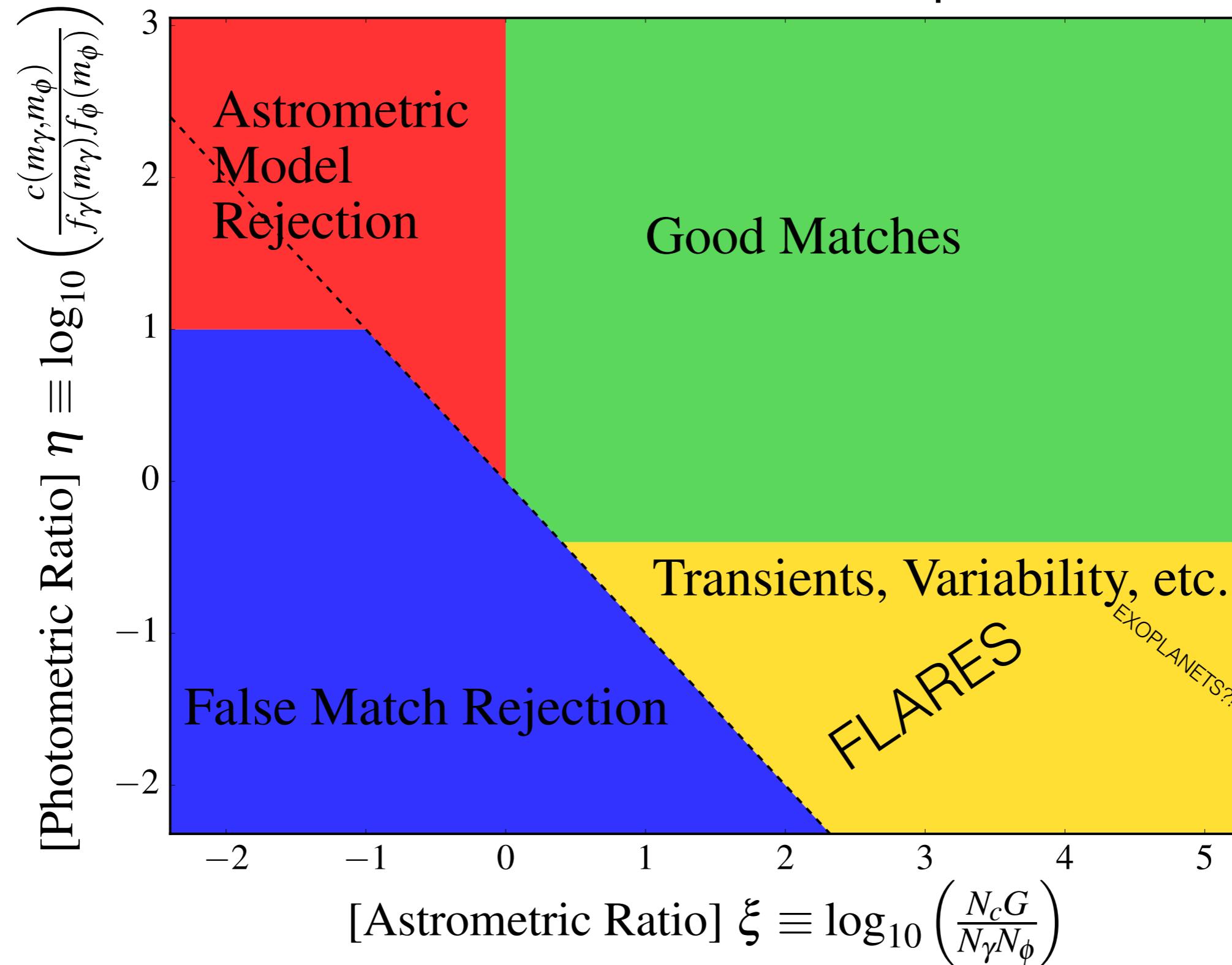


Probability-based Catalogue Matching: Including the Magnitude Information

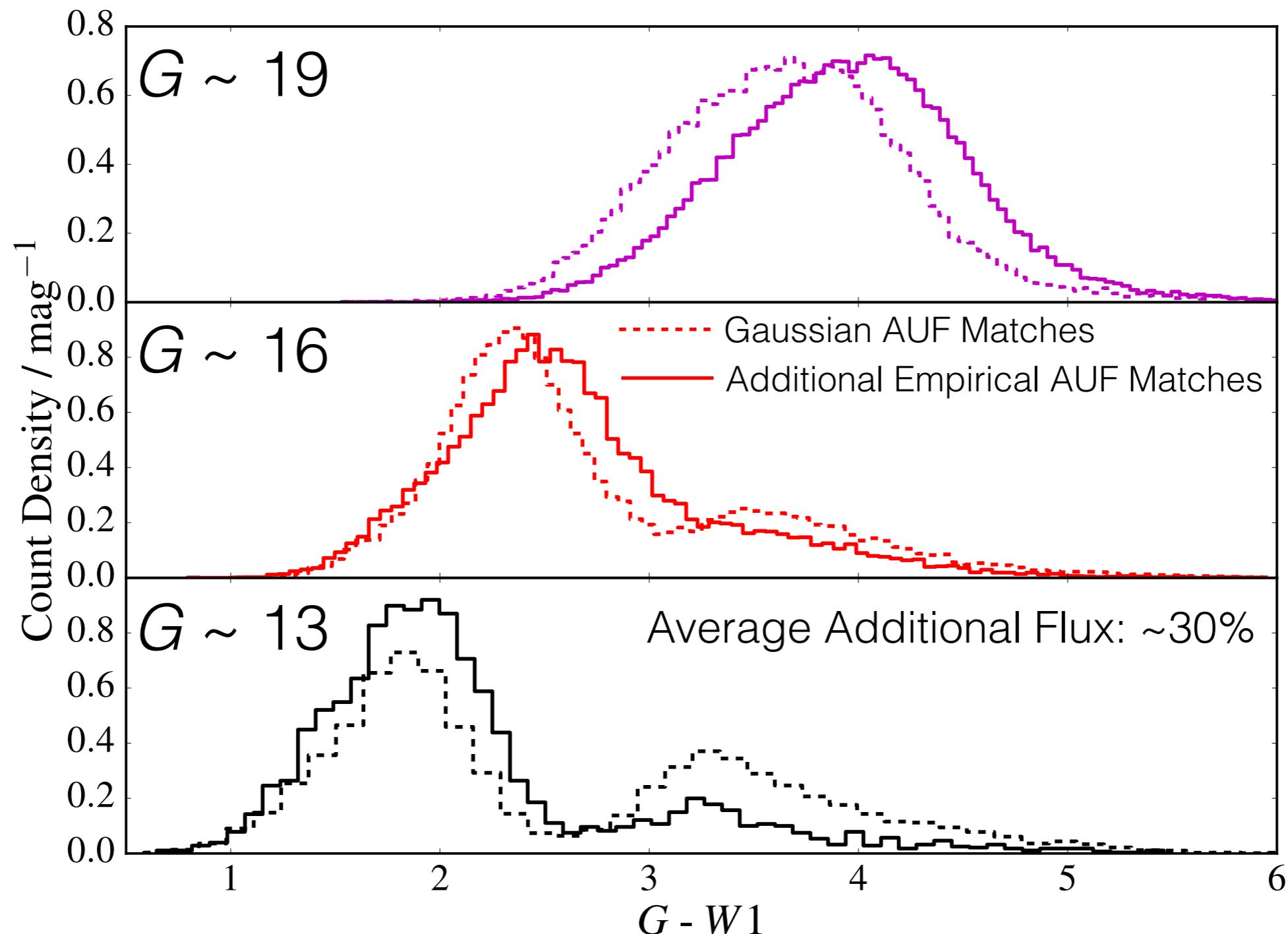


$$g(x_k, y_k, x_l, y_l) = N_c \iint_{-\infty}^{+\infty} h_\gamma(\Delta x_{kl} - x, \Delta y_{kl} - y) h_\phi(x, y) dx dy \\ = N_c \times (h_\gamma * h_\phi)(\Delta x_{kl}, \Delta y_{kl}).$$

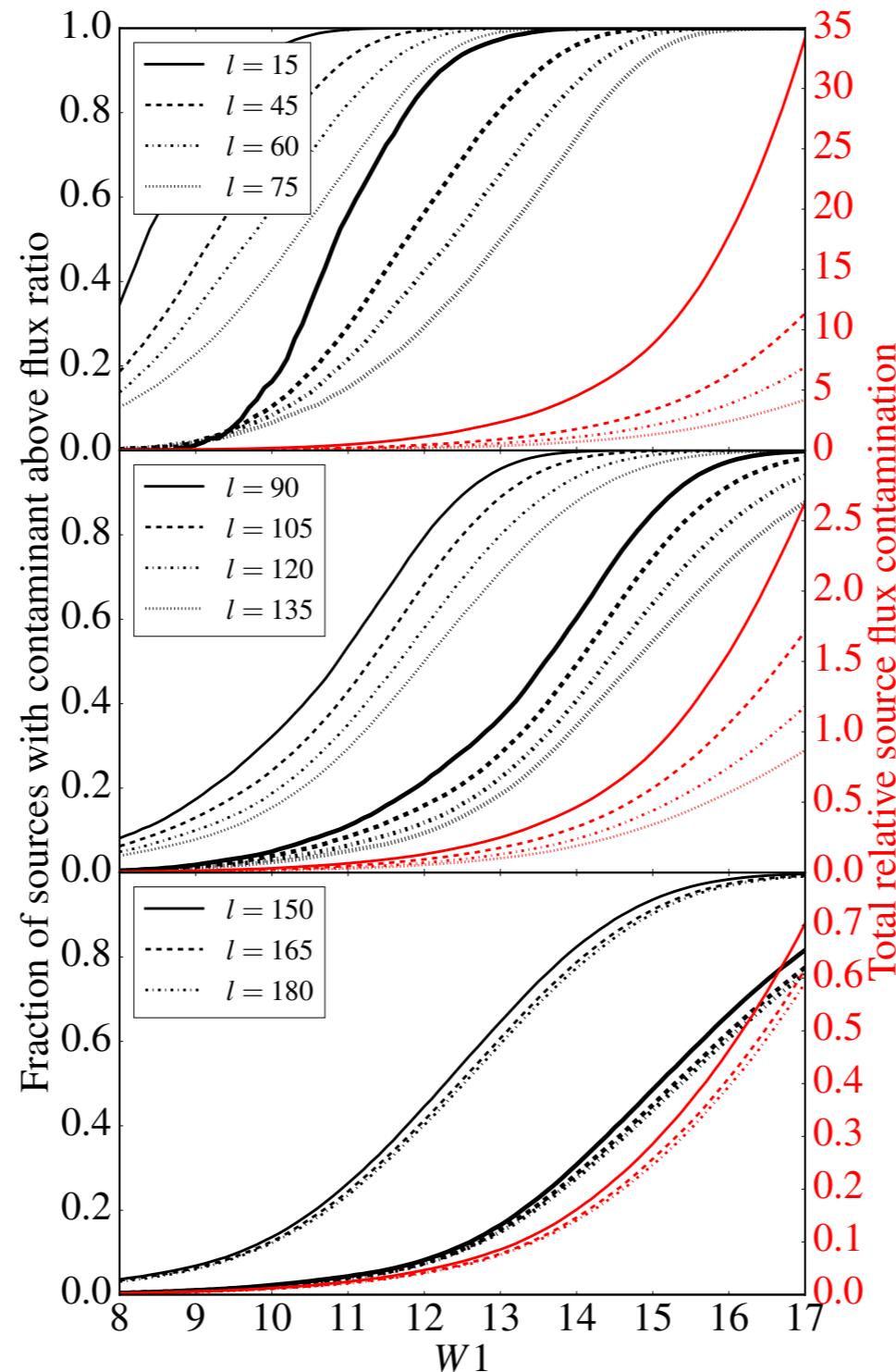
Probability-based Catalogue Matching: The Likelihood Ratio Space



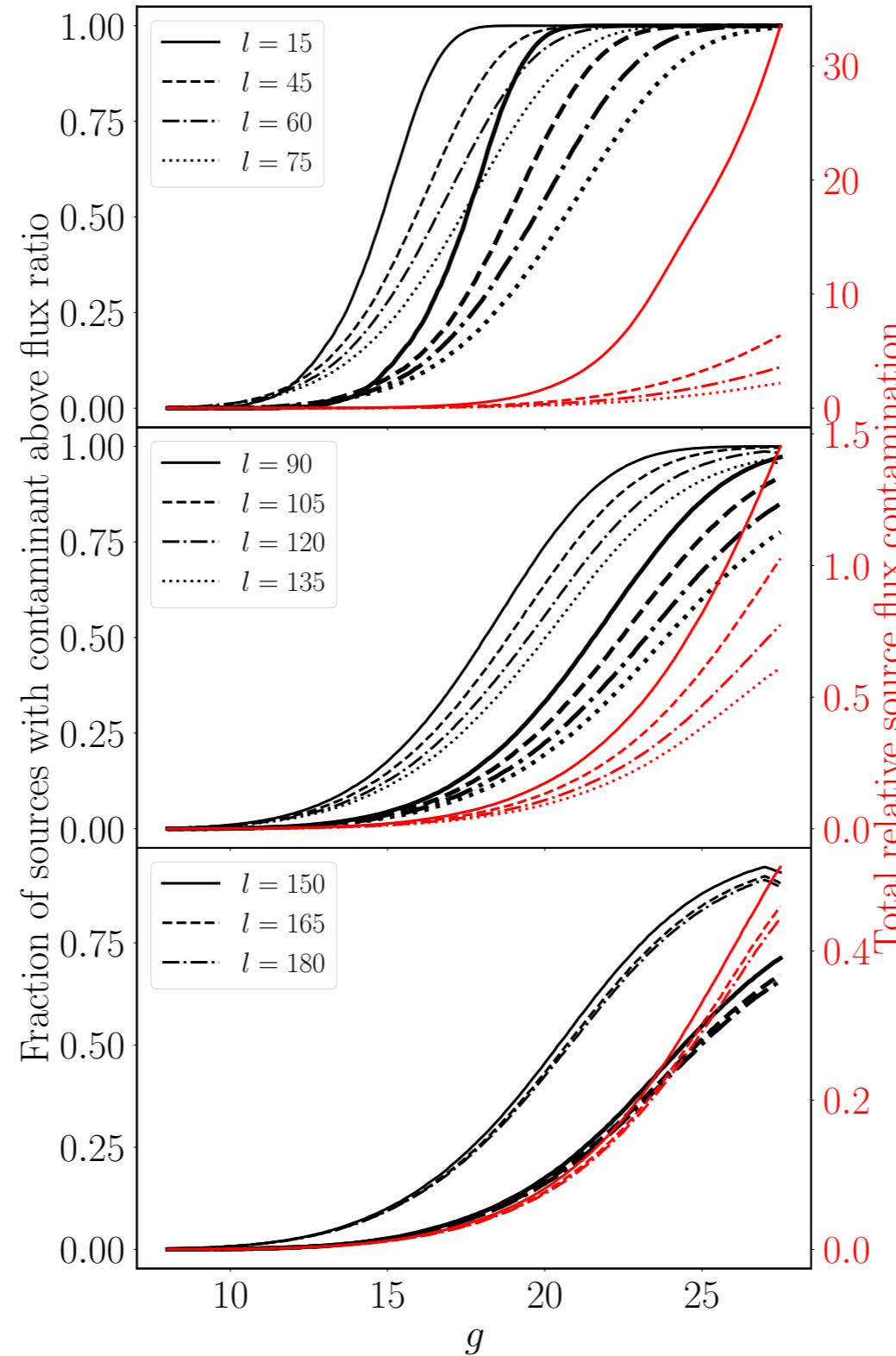
Contamination Effects: Perturbation-Colour Correlation



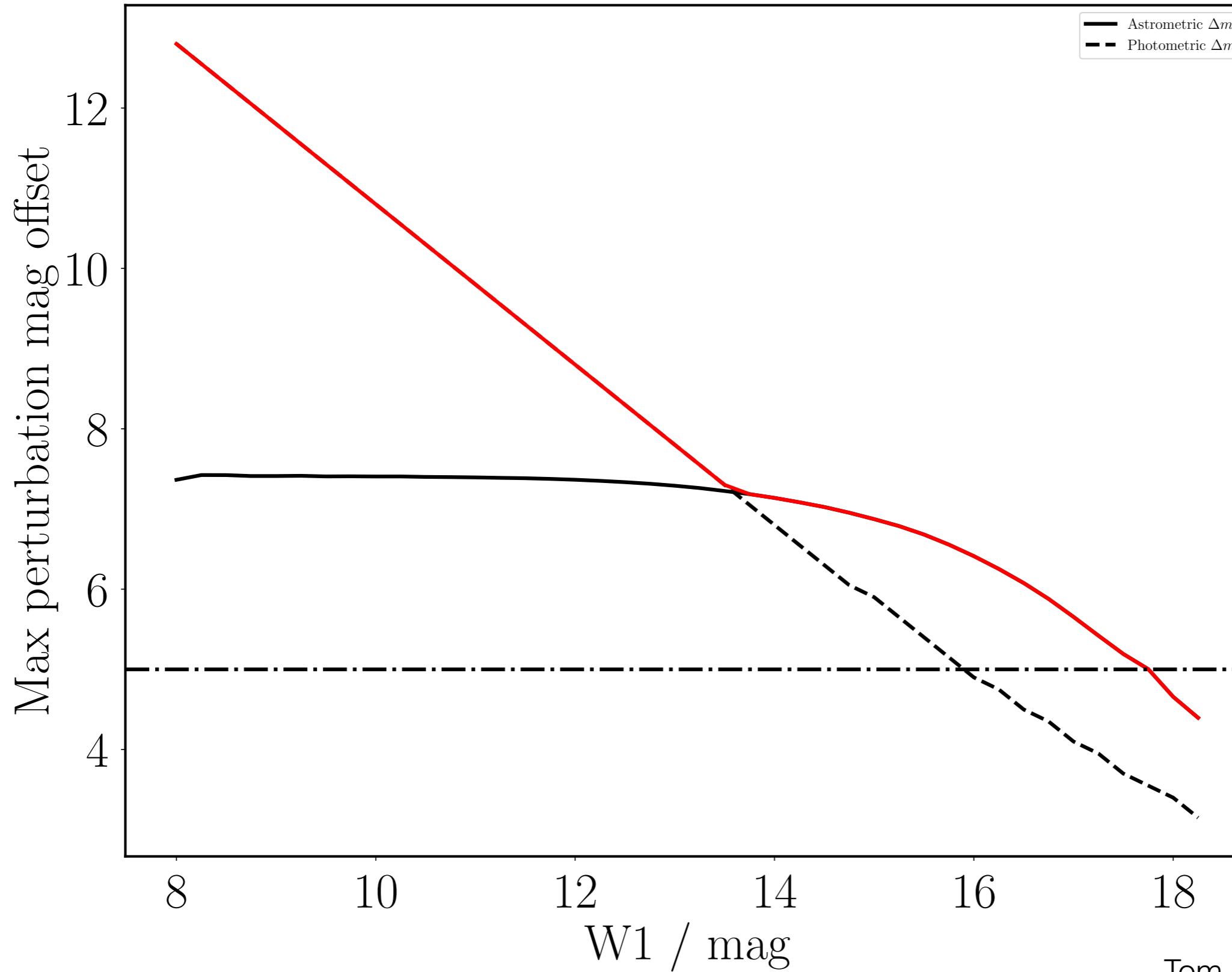
Contamination Effects: Contamination Rates & Amounts



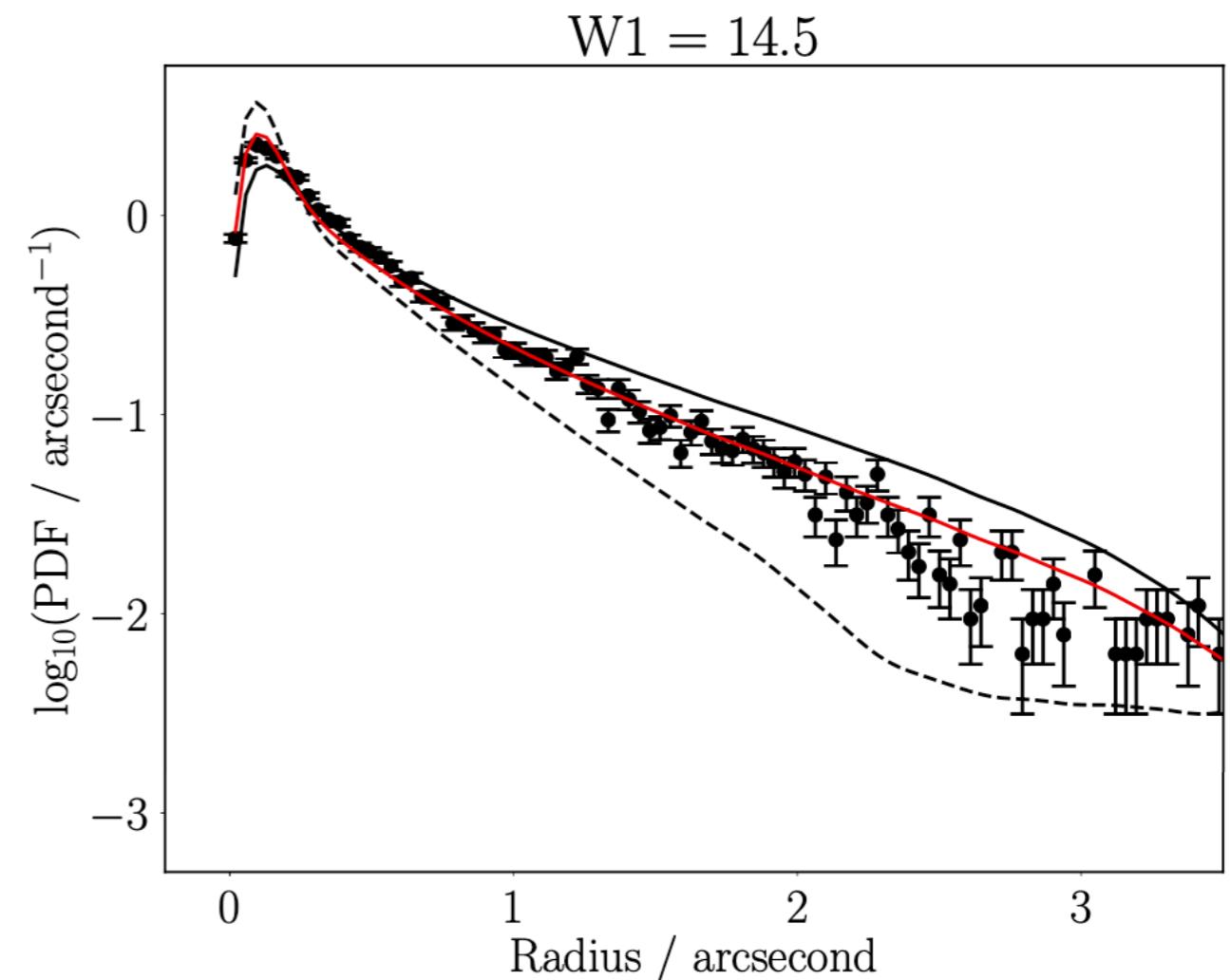
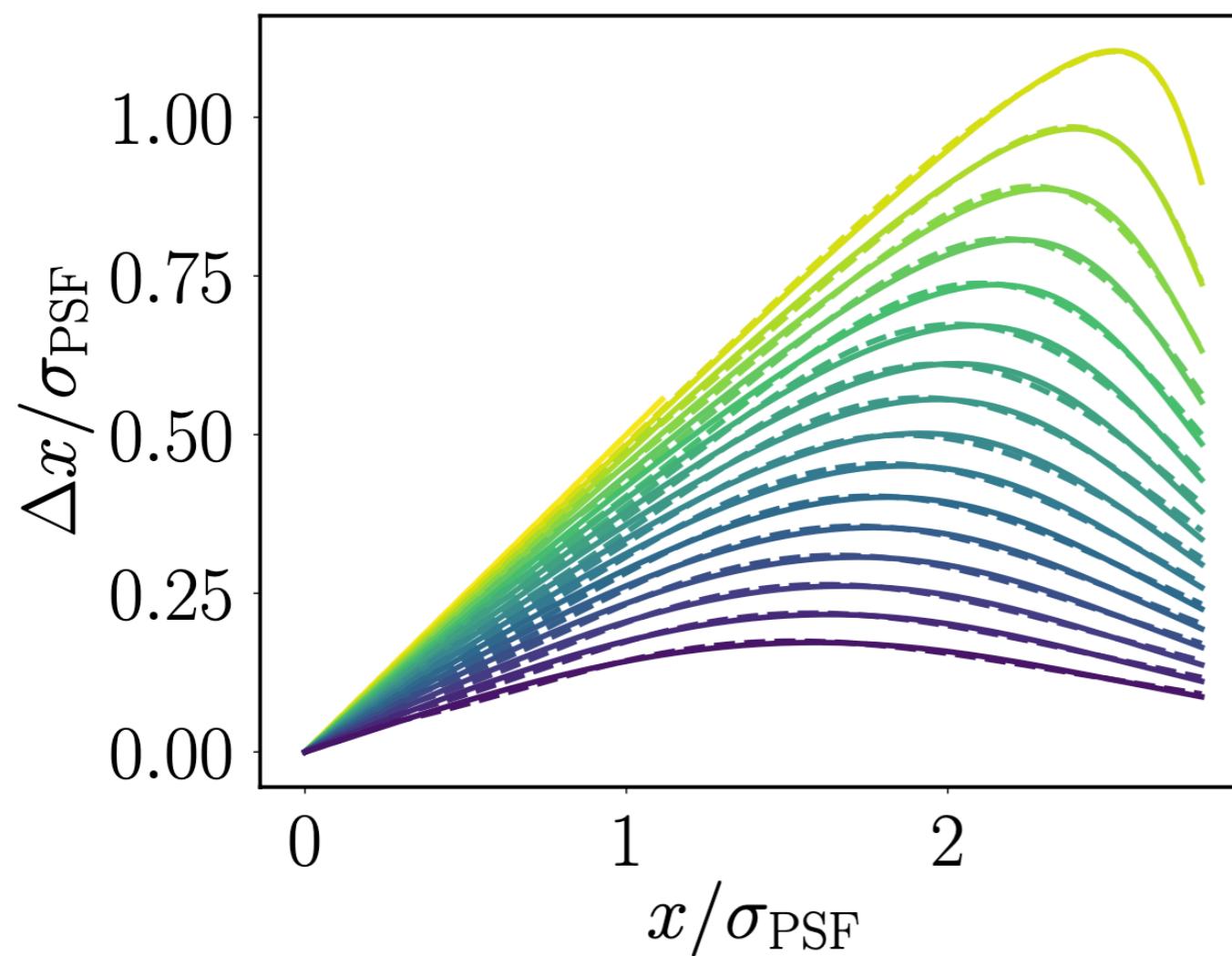
The Astrometric Uncertainty Function: Considering Vera C. Rubin Observatory's LSST



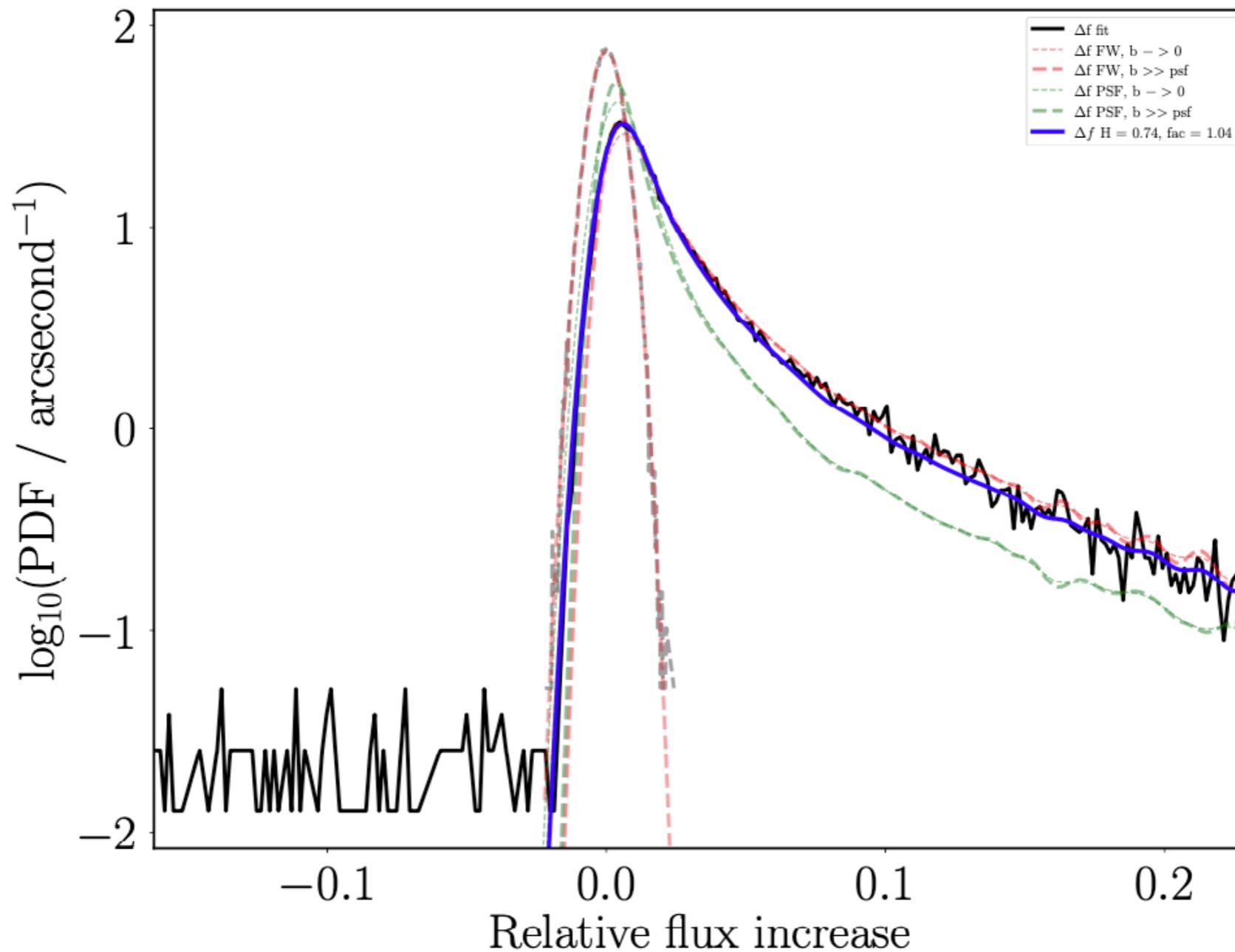
The Astrometric Uncertainty Function and LSST: A Crisis of Completeness Limit



The Astrometric Uncertainty Function and LSST: Probing the Faintest Sources



The Astrometric Uncertainty Function and LSST: Improving the “Photometric Contamination Function”



The Astrometric Uncertainty Function and LSST: Extensions to Cross-Match Algorithm

where

$$P(H_{kl}|D) = \frac{P(H_{kl})P(S_{\gamma\phi}^{kl}) \prod_{i,j|v_{kl}} P(U_{\gamma\phi}^{ij})}{P(H_0) \prod_{i,j} P(U_{\gamma\phi}^{ij}) + \sum_s \sum_t P(H_{st})P(S_{\gamma\phi}^{st}) \prod_{i,j|v_{st}} P(U_{\gamma\phi}^{ij})}$$

$$P(H_{kl}) = \prod_{j \in D_{\gamma k}} X_{\gamma kj} \prod_{j \in D_{\phi l}} X_{\phi lj} \prod_{i \neq k} \prod_{j \in D_{\gamma i}} 1 - X_{\gamma ij} \prod_{i \neq l} \prod_{j \in D_{\phi i}} 1 - X_{\phi ij},$$

$$P(H_0) = \prod_i \prod_{j \in D_{\gamma i}} 1 - X_{\gamma ij} \prod_i \prod_{j \in D_{\phi i}} 1 - X_{\phi ij},$$

The Astrometric Uncertainty Function and LSST: Open Source Code Development



Onoddil / macauff

Code Issues 5 Pull requests Actions Projects Wiki Security Insights Settings

This branch is 13 commits ahead of master.

Onoddil Added region parameters for photometric likelihoods c and f, and exte... 8818637 12 days ago 16 commits

.github/workflows Added github actions workflow 24 days ago

docs Initial set up of documentation, folder structure, unit tests etc. 24 days ago

macauff Added region parameters for photometric likelihoods c and f, and ext... 12 days ago

.gitignore Initial set up of documentation, folder structure, unit tests etc. 24 days ago

LICENSE Initial commit 28 days ago

MANIFEST.in Updated name of project 14 days ago

README.md Initial commit 28 days ago

pyproject.toml Initial set up of documentation, folder structure, unit tests etc. 24 days ago

setup.cfg Initial set up of documentation, folder structure, unit tests etc. 24 days ago

setup.py Updated name of project 14 days ago

tox.ini Initial set up of documentation, folder structure, unit tests etc. 24 days ago

README.md

macauff

The python package for Matching Across Catalogues using the Astrometric Uncertainty Function and Flux

About

The python package for Matching Across Catalogues using the Astrometric Uncertainty Function and Flux

Readme

BSD-3-Clause License

Releases

No releases published

Create a new release

Packages

No packages published

Publish your first package

Languages

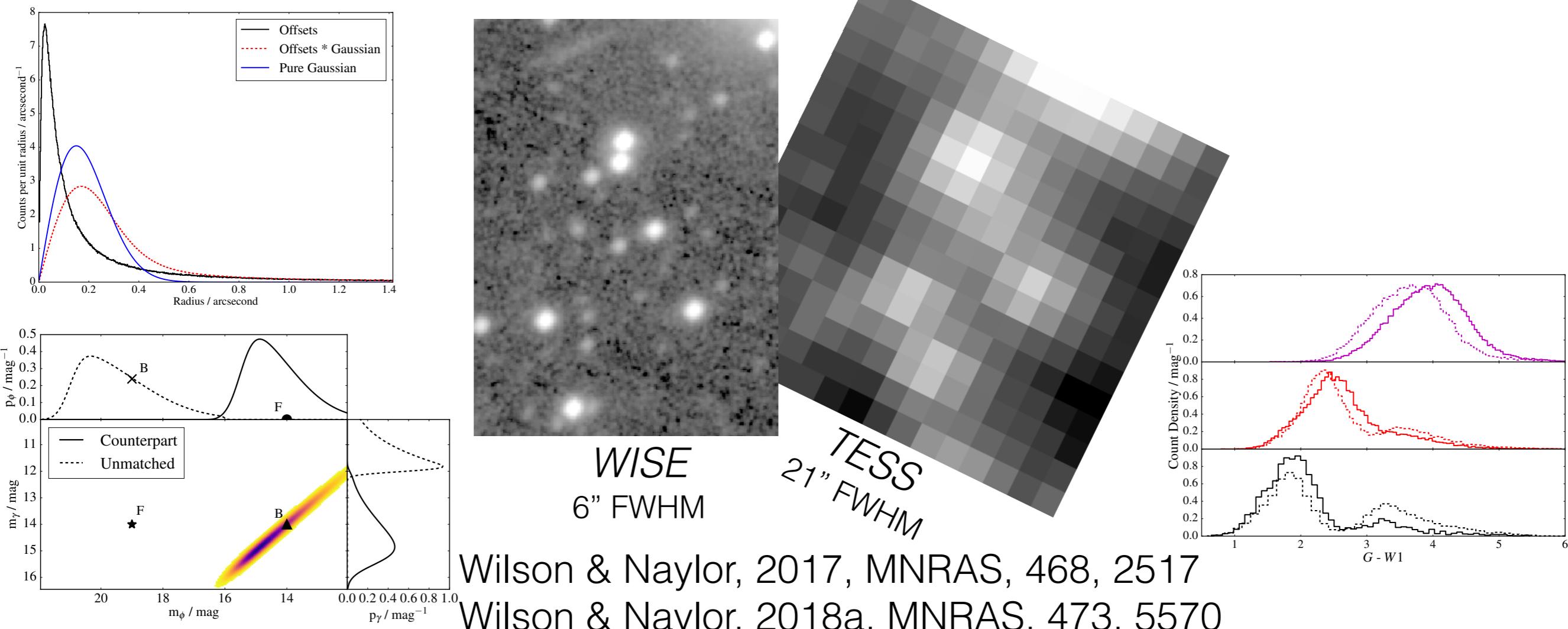
Python 100.0%

A GitHub repository page for the 'macauff' package. The repository has 5 issues, 2 branches, and 0 tags. The 'Code' tab is selected. A message indicates the branch is 13 commits ahead of master. The commit history shows initial setup and documentation work by Onoddil. The repository page includes sections for About, Releases, Packages, and Languages, all currently empty or inactive.

Tom J Wilson @onoddil

The Effects of Unresolved Contaminant Stars on the Cross-Matching of Photometric Catalogues: Conclusions

- Blended star contamination causes positional shifts
- *WISE* objects are up to 30% flux contaminated, with *WFIRST* and *LSST* suffering similar blending in the future
- Disentangle this information with proper treatment in the cross-match to a higher angular resolution dataset — important work yet to be done!



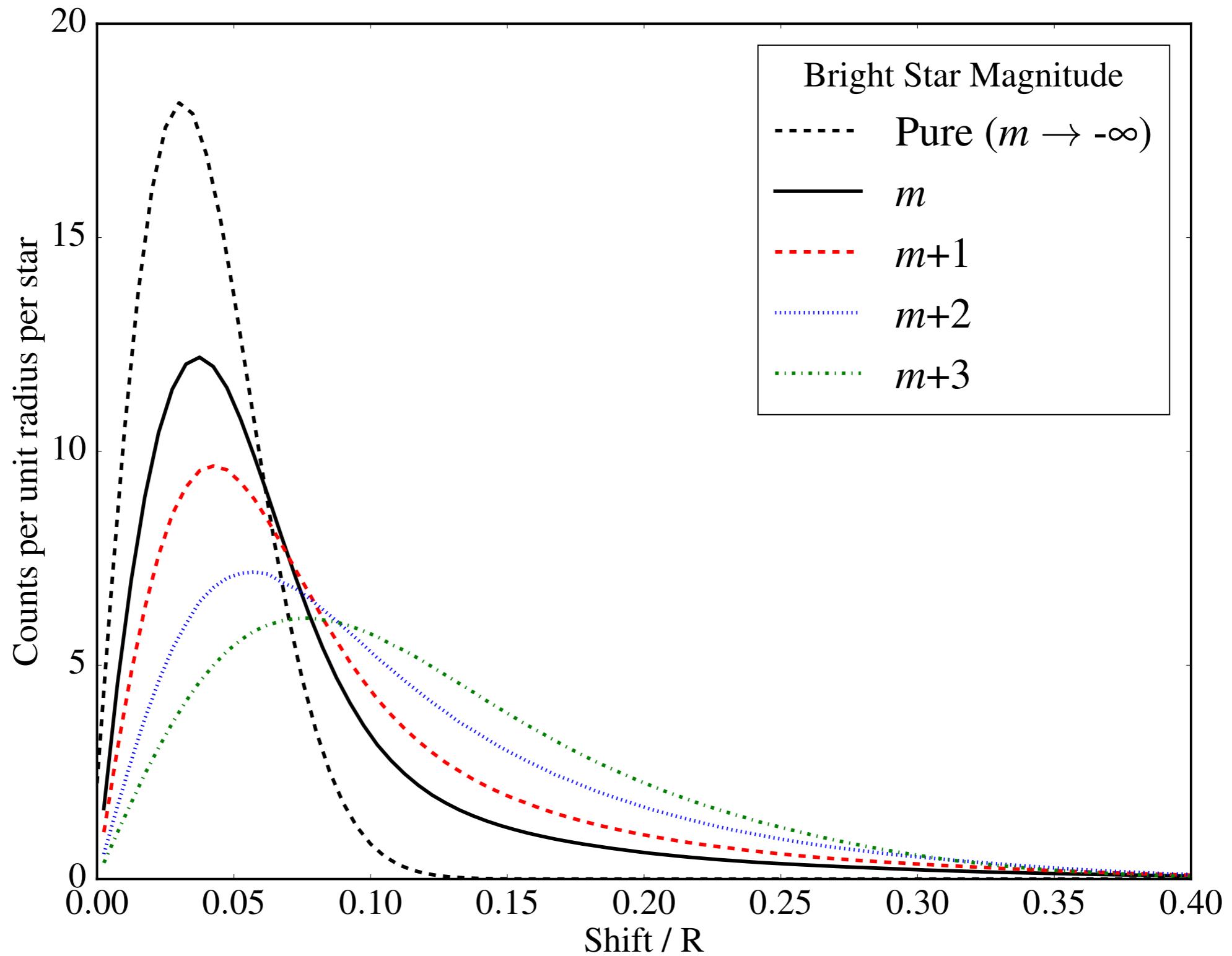
Wilson & Naylor, 2017, MNRAS, 468, 2517

Wilson & Naylor, 2018a, MNRAS, 473, 5570

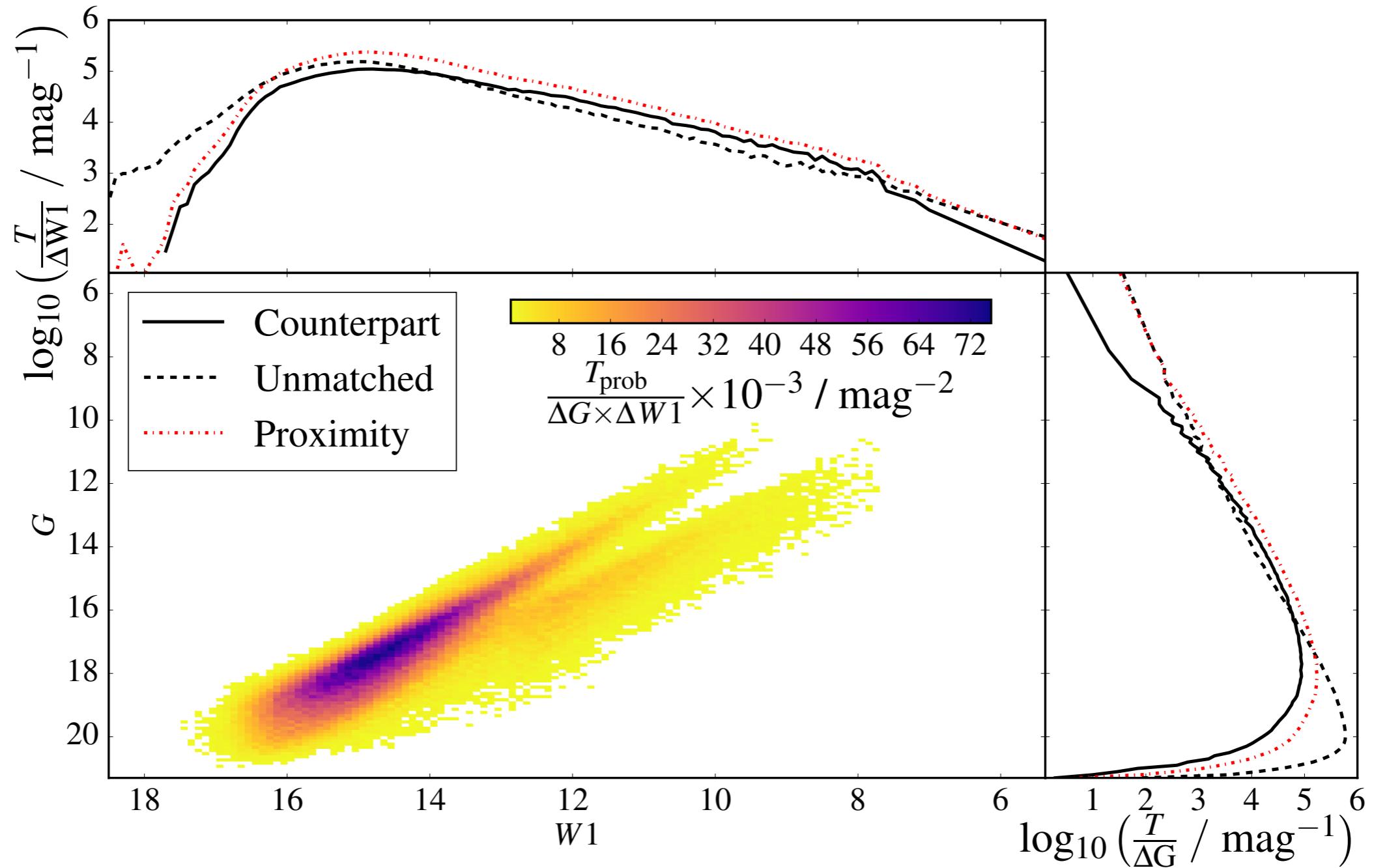
Wilson & Naylor, 2018b, MNRAS, 481, 2148

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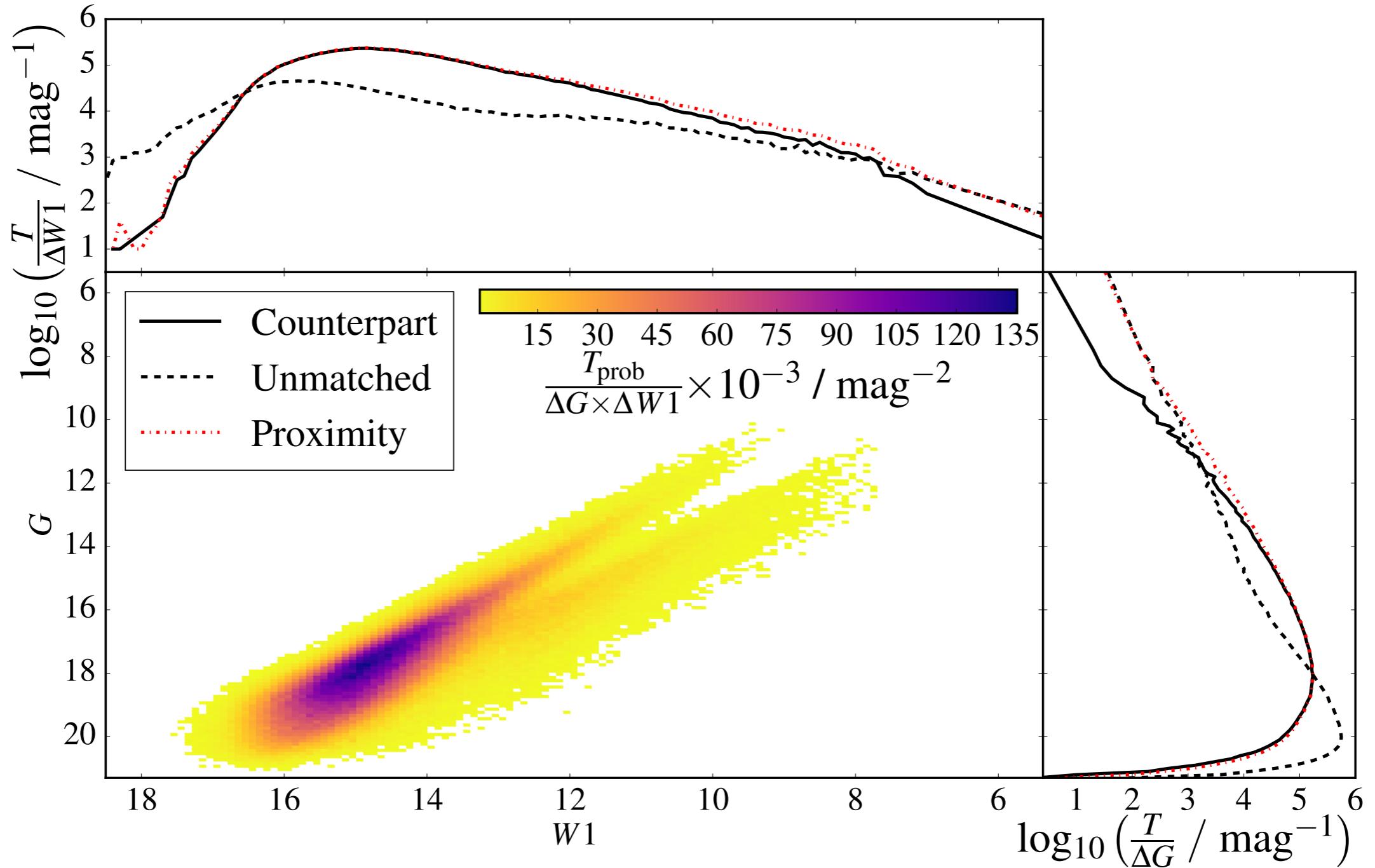
The Astrometric Uncertainty Function: Synthetic Non-Gaussian Tails



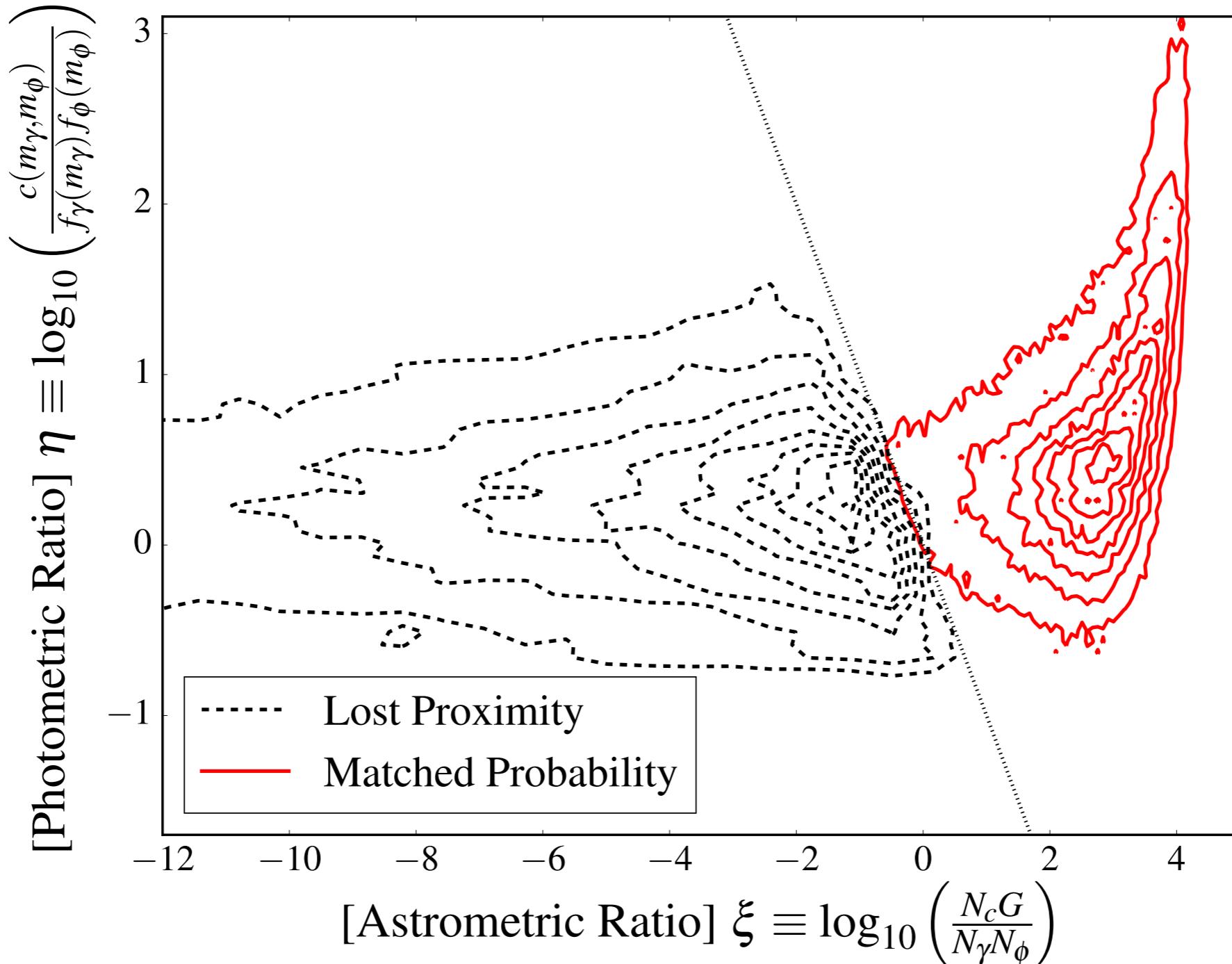
Contamination Effects: *Gaia-WISE* Gaussian Matches



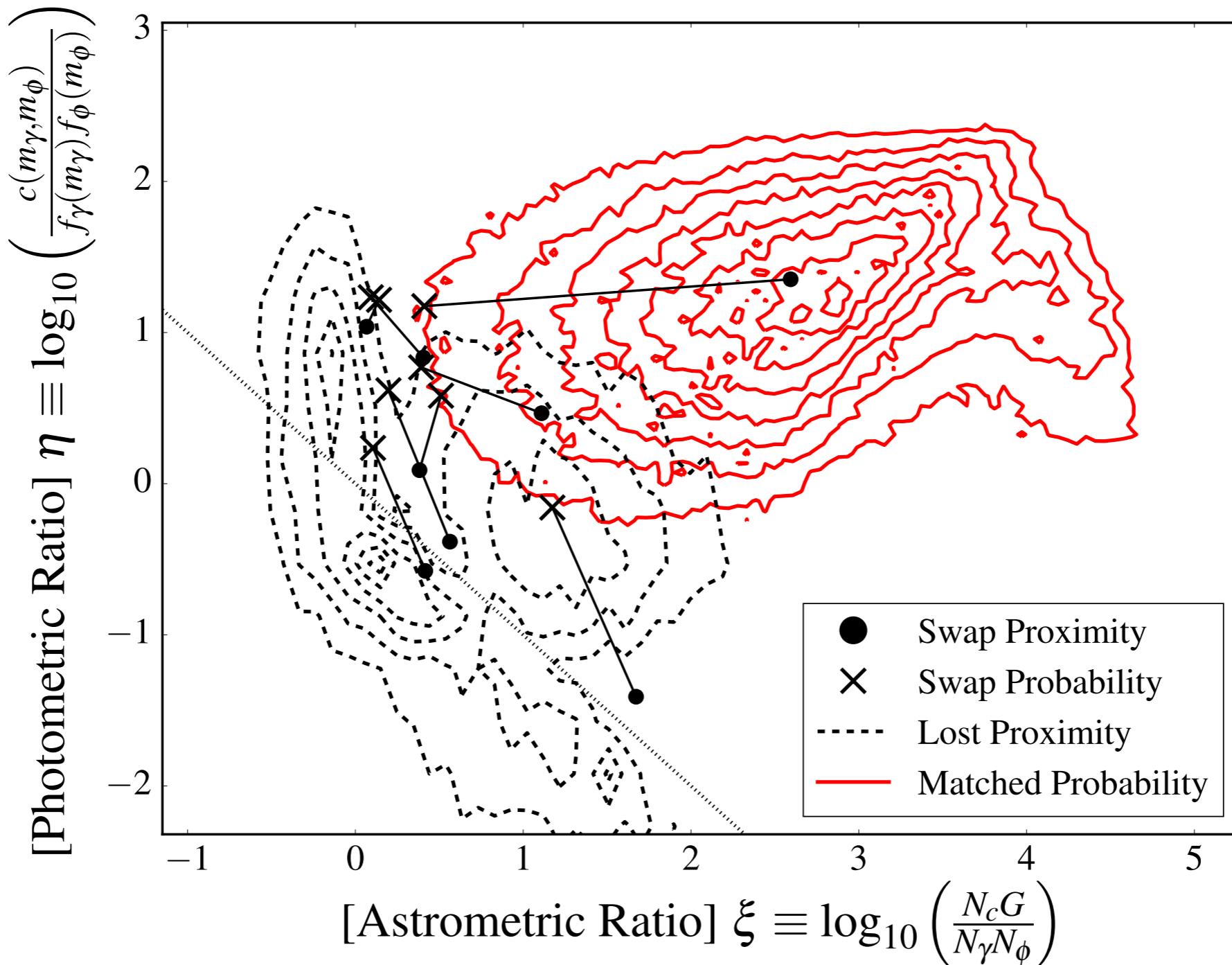
Contamination Effects: *Gaia*-WISE Empirical Matches



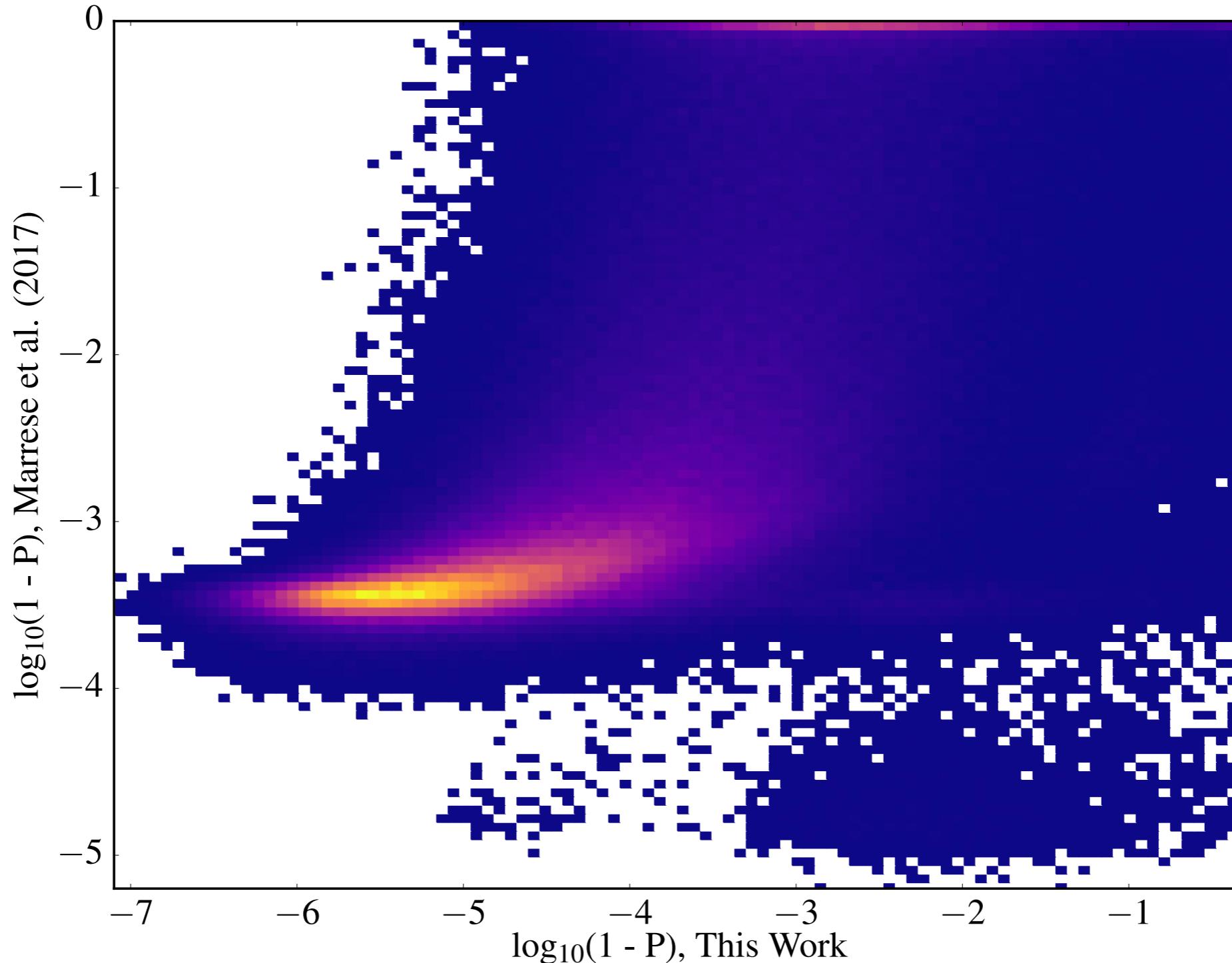
Contamination Effects: Lost Proximity Matches



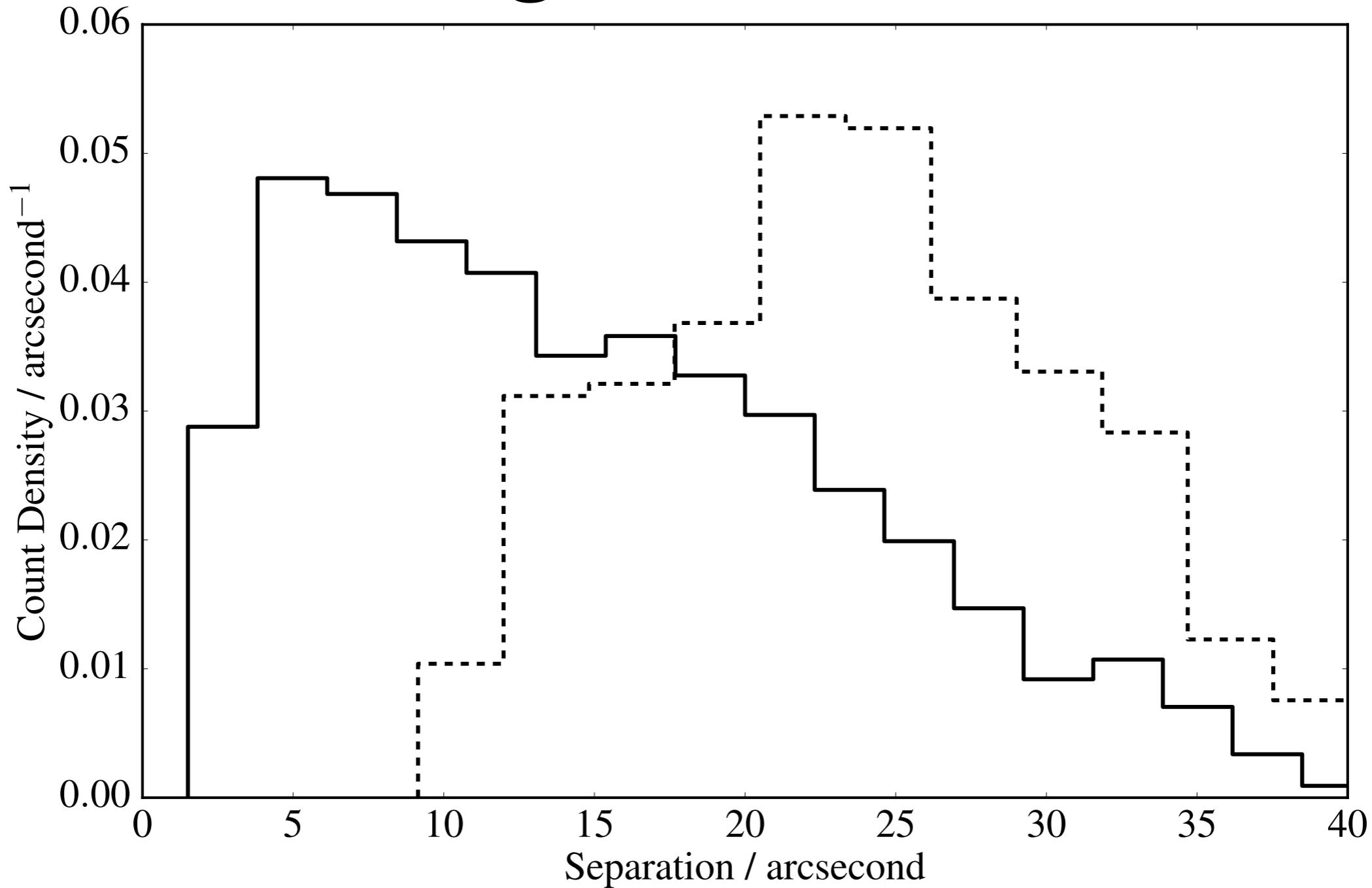
Contamination Effects: Lost Proximity Matches



Contamination Effects: *Gaia* Lost Matches



Contamination Effects: Resolving Contaminants



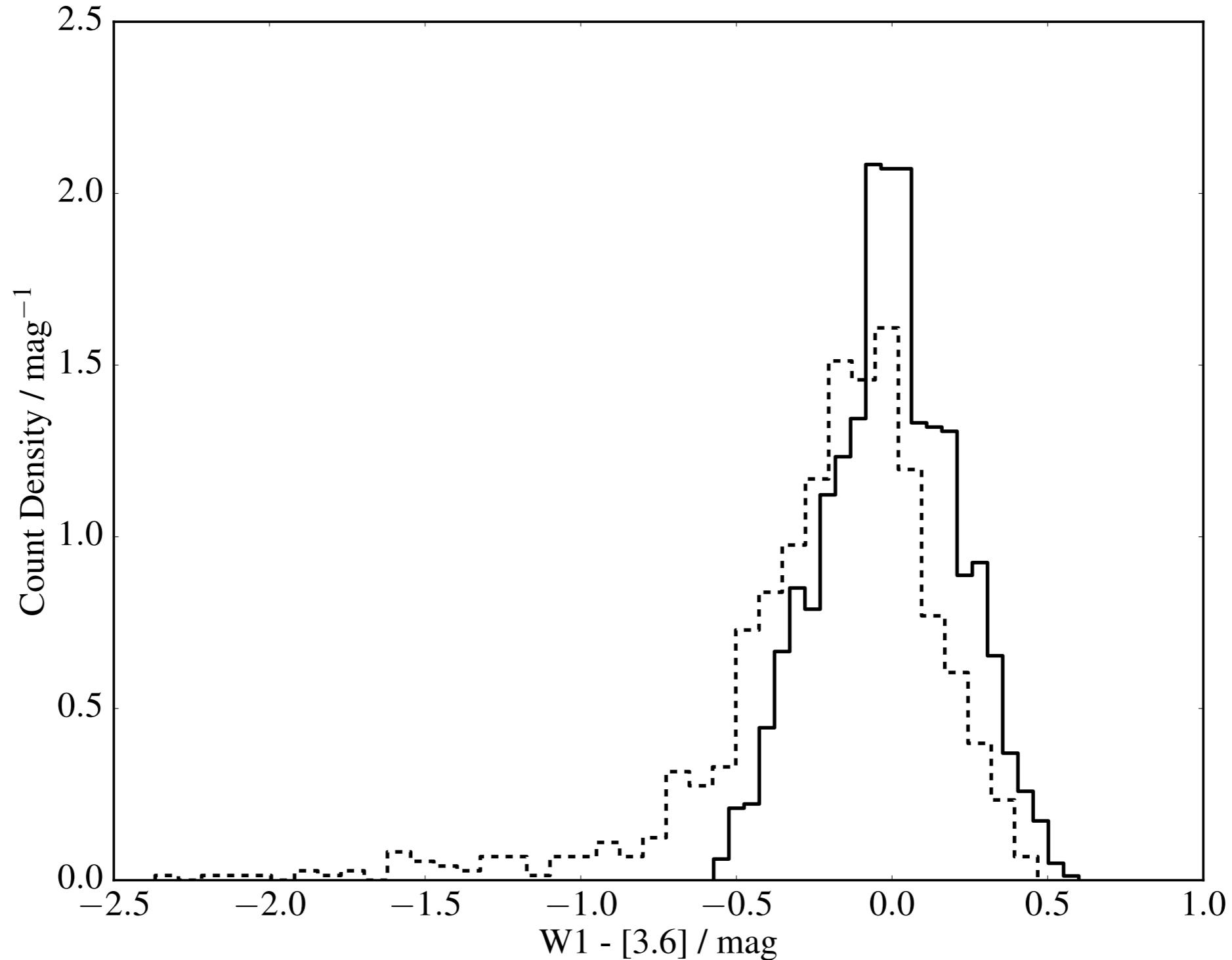
Spitzer - Werner et al., 2004 ,ApJS, 154, 1

IRAC - Fazio et al., 2004, ApJS, 154, 10

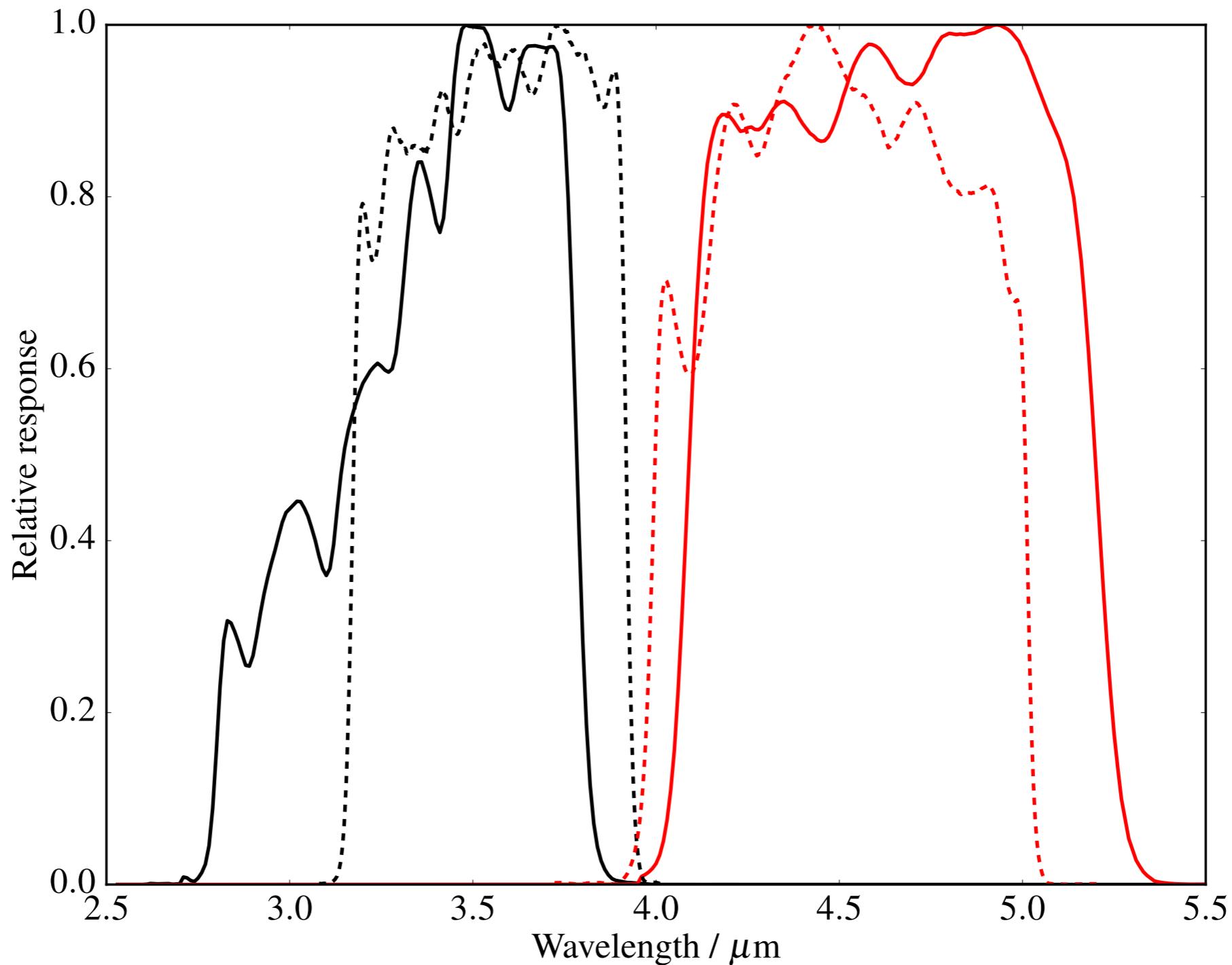
Wilson & Naylor, MNRAS, 2018b, 481, 2148

Tom J Wilson @onoddil

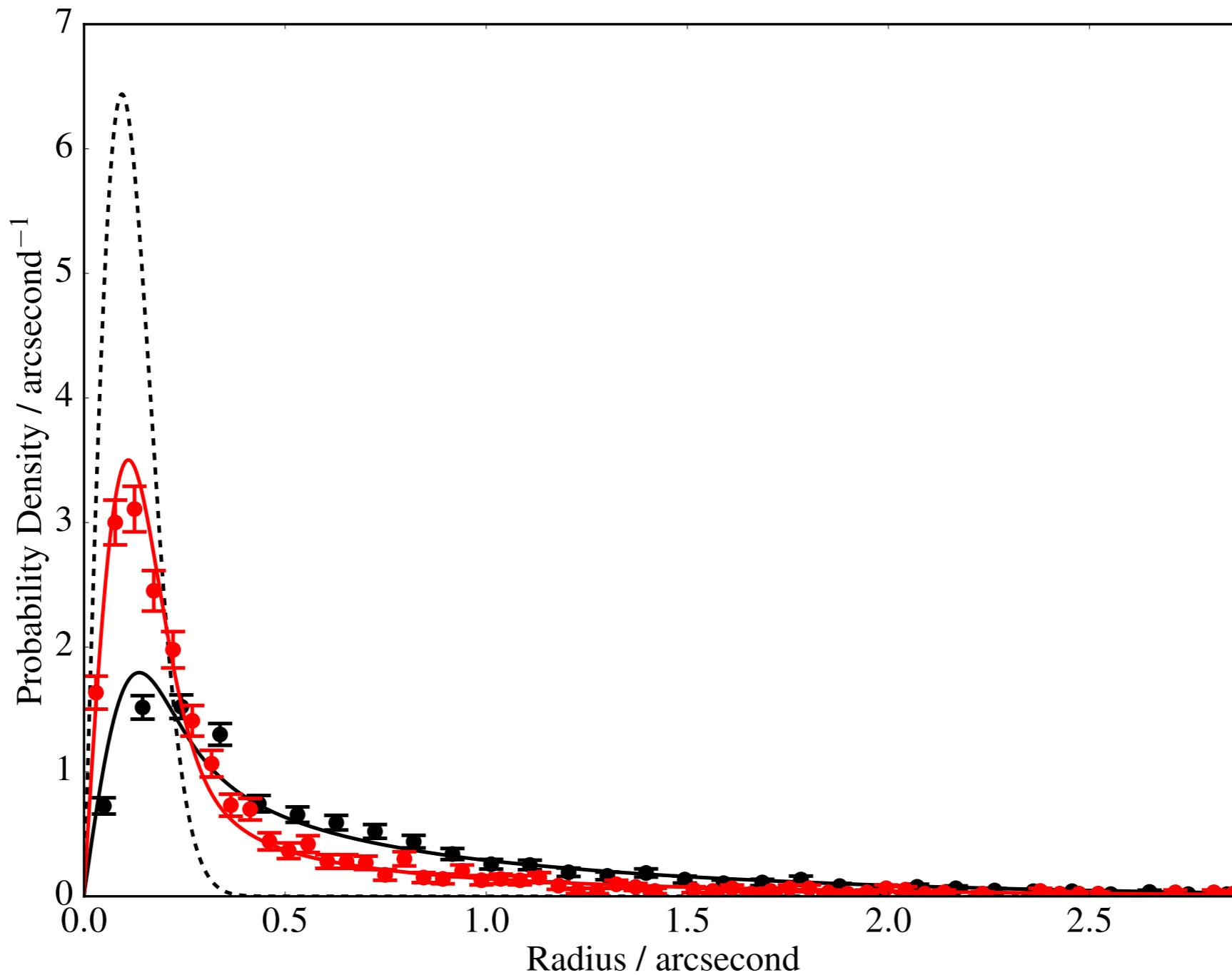
Contamination Effects: Resolving Contaminant Flux



Contamination Effects: Wavelength Coverage



Contamination Effects: Crowding Normalisation



The Astrometric Uncertainty Function: Analytical perturbations

