

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

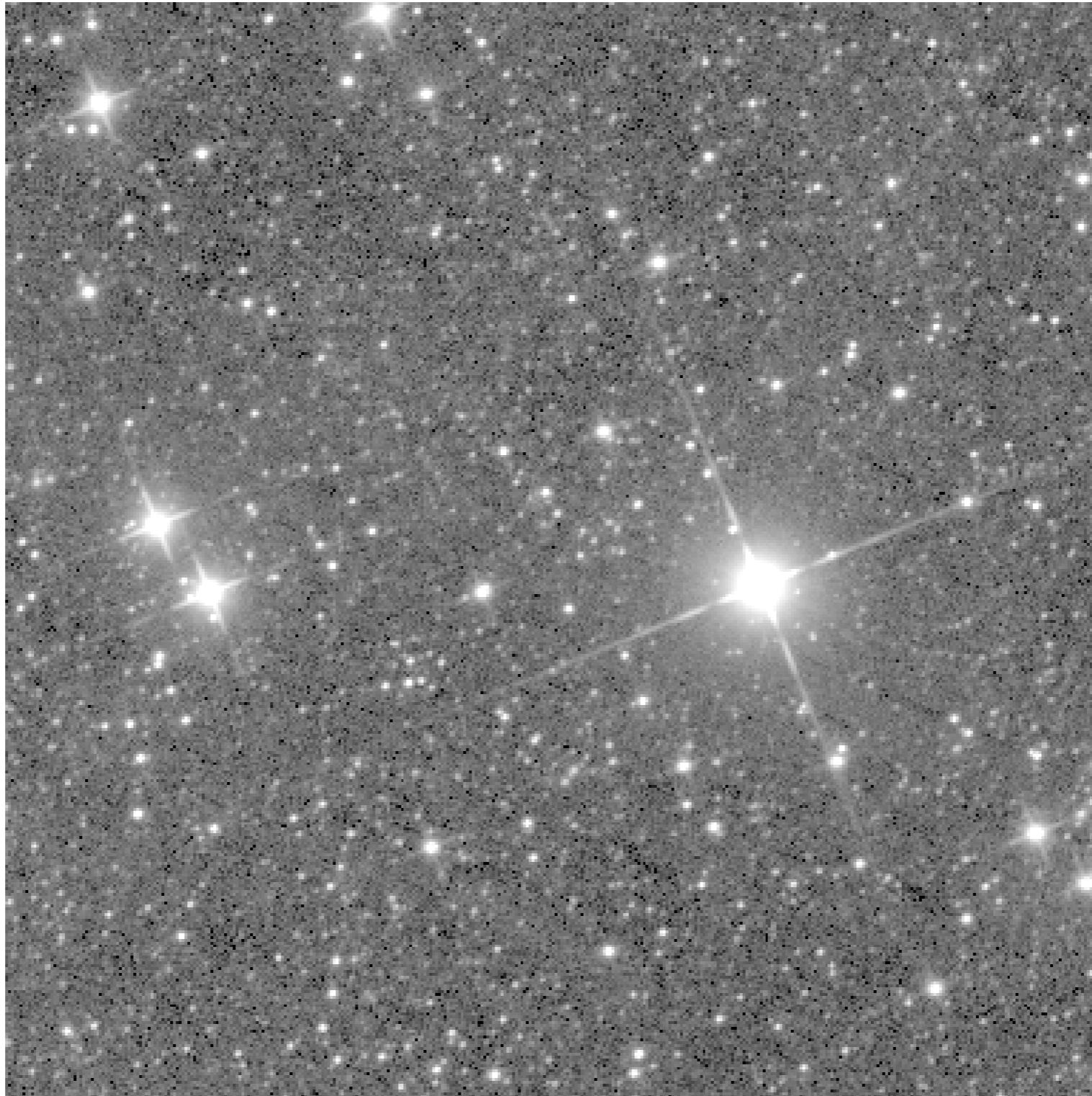
Tom Wilson, STScl

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HotSci, 6/26/19

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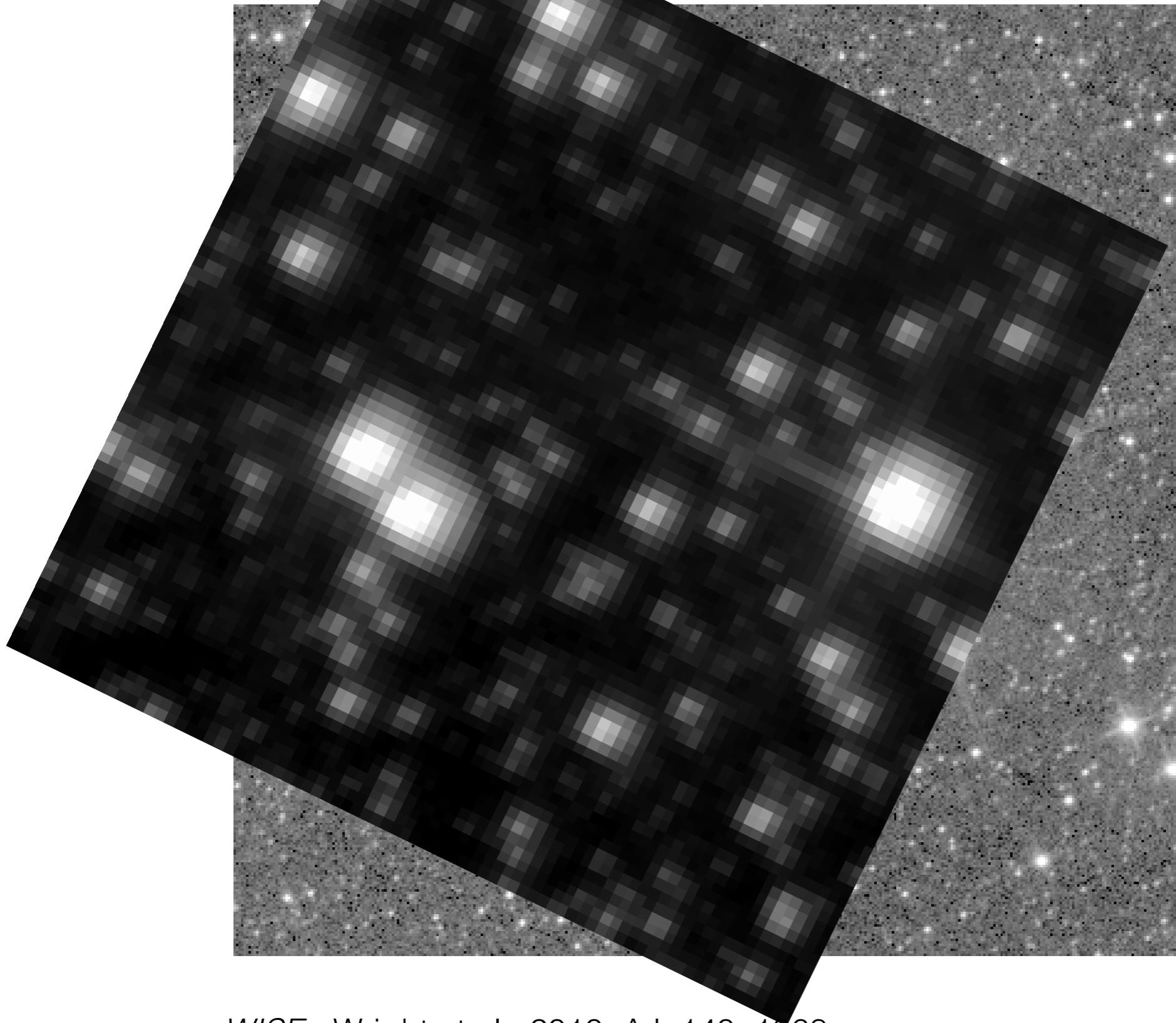
Photometric Observations



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

WISE W1
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Photometric Observations



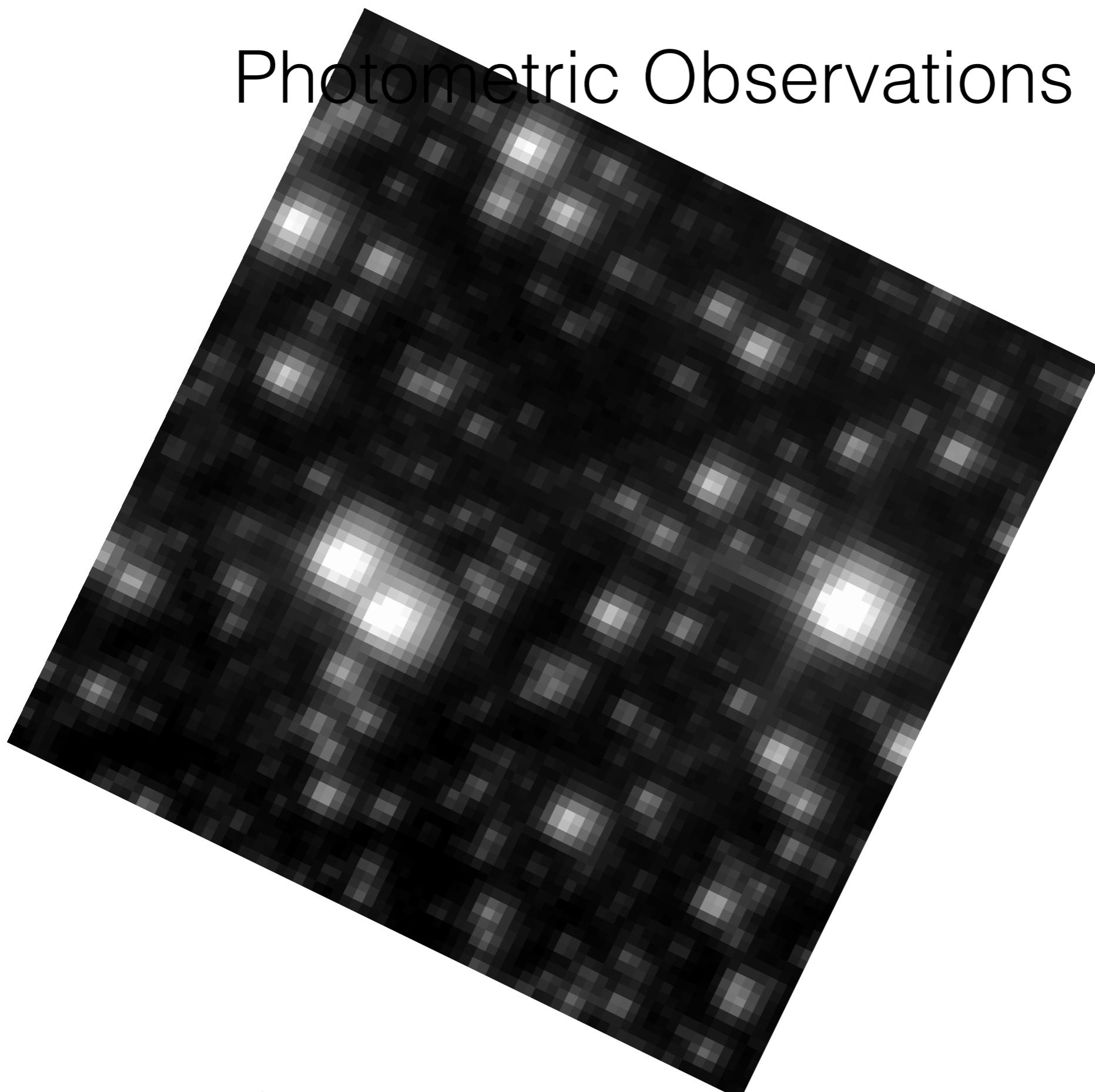
WISE - Wright et al., 2010, AJ, 140, 1868

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

TESS T

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Photometric Observations



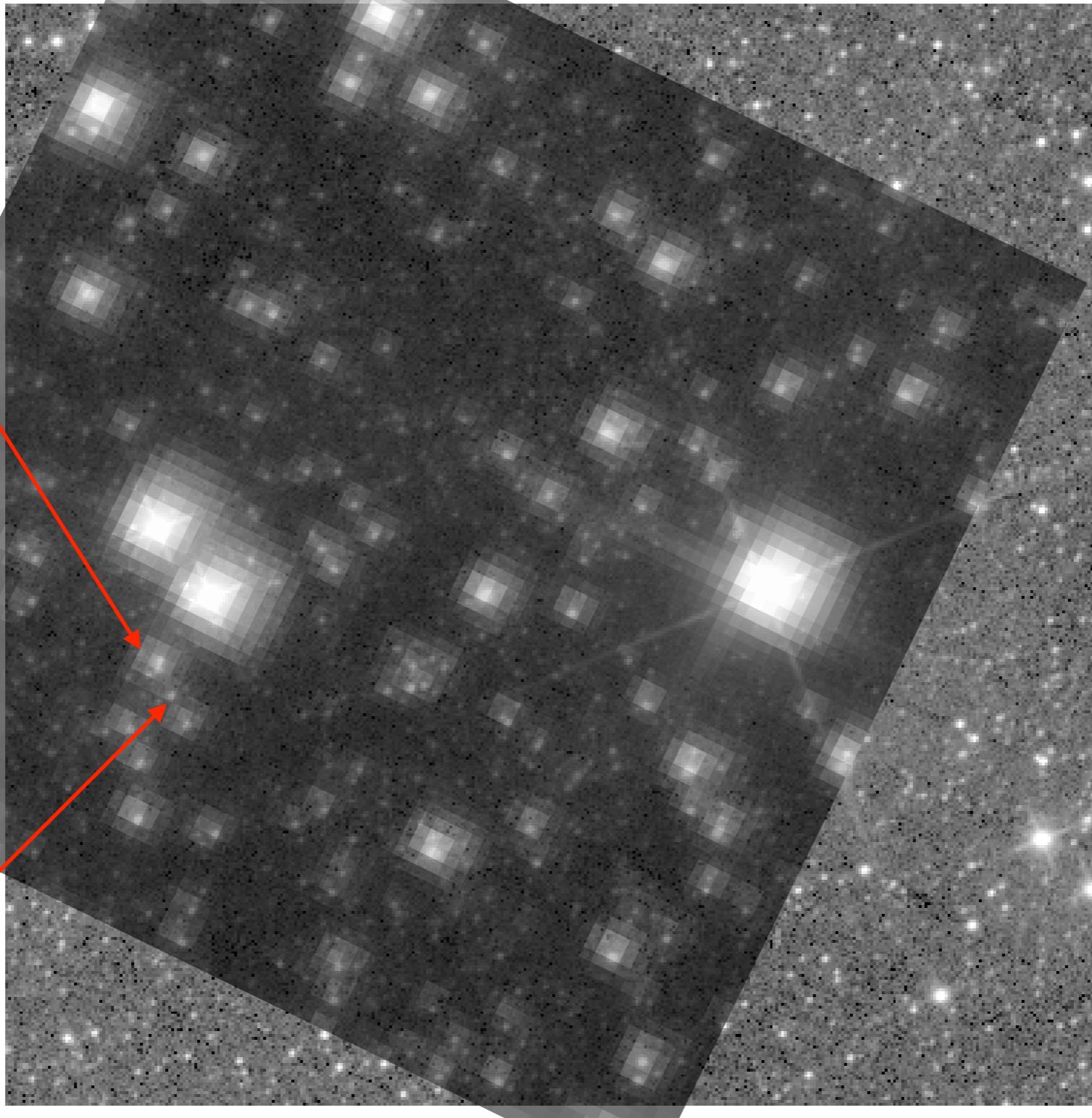
WISE - Wright et al., 2010, AJ, 140, 1868
TESS - Ricker et al., 2015, JATIS, 1, 14003

TESS T
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Photometric Observations

Unresolved
double star
“pair”!

Completely
unresolved
source!

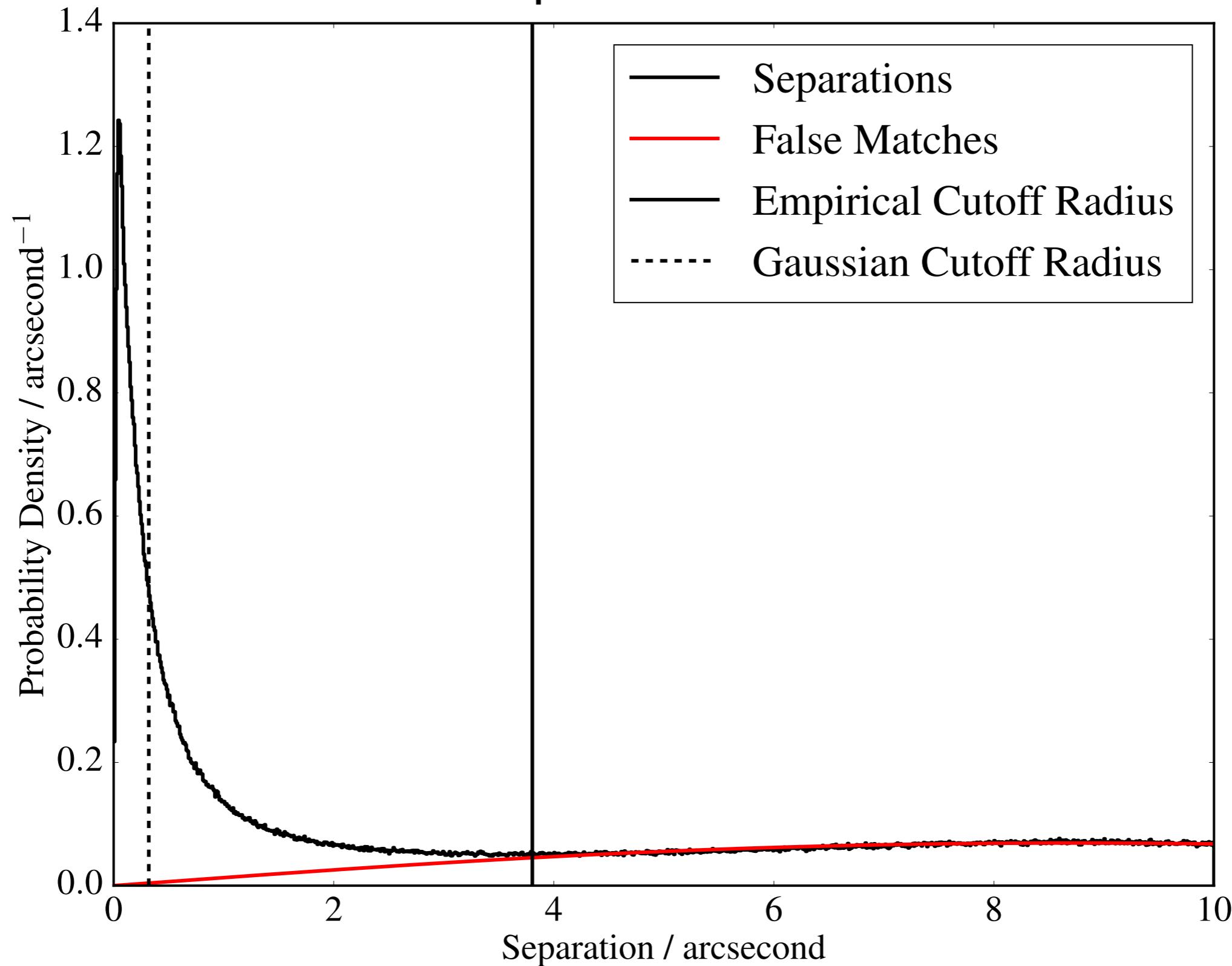


WISE - Wright et al., 2010, AJ, 140, 1868

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

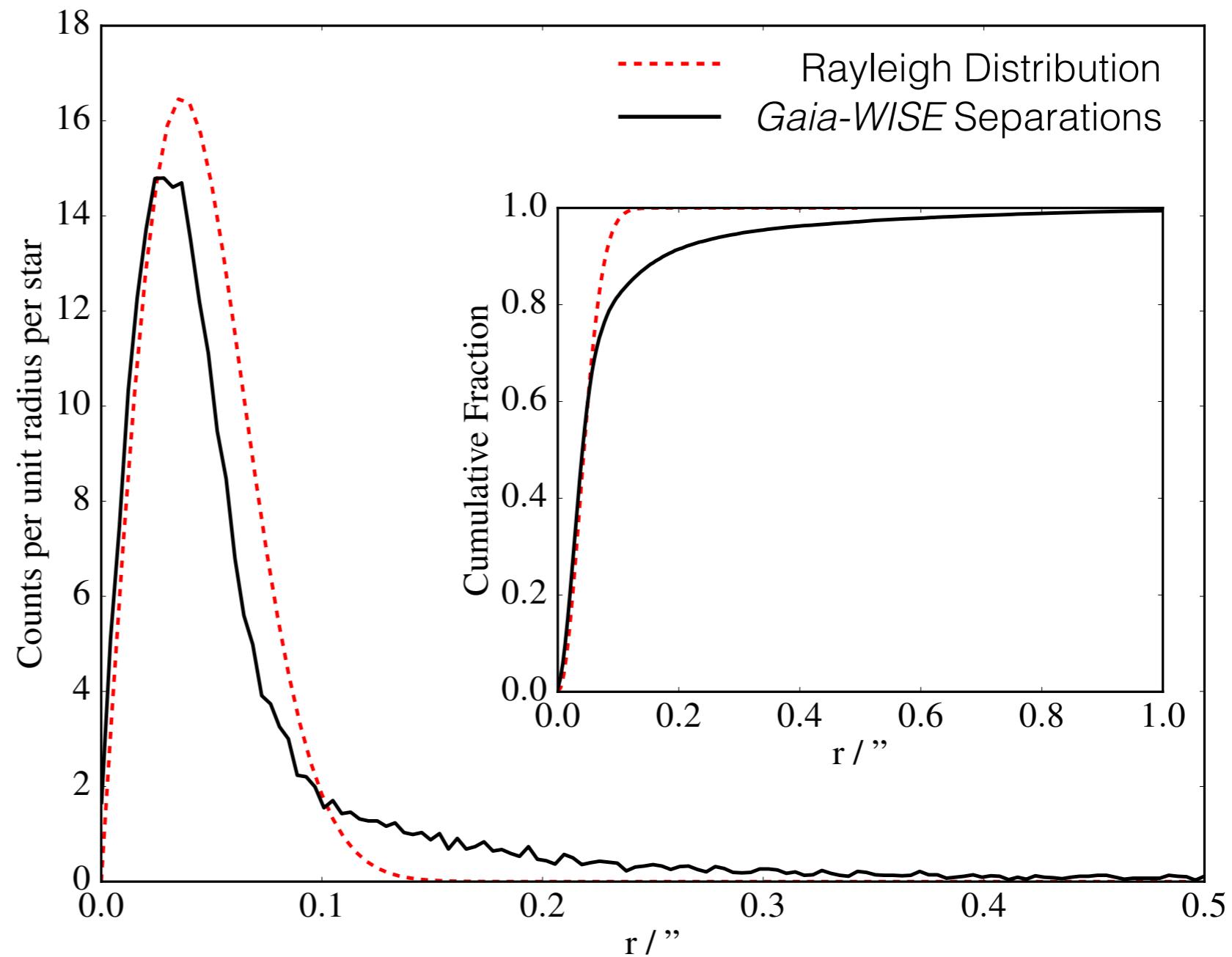
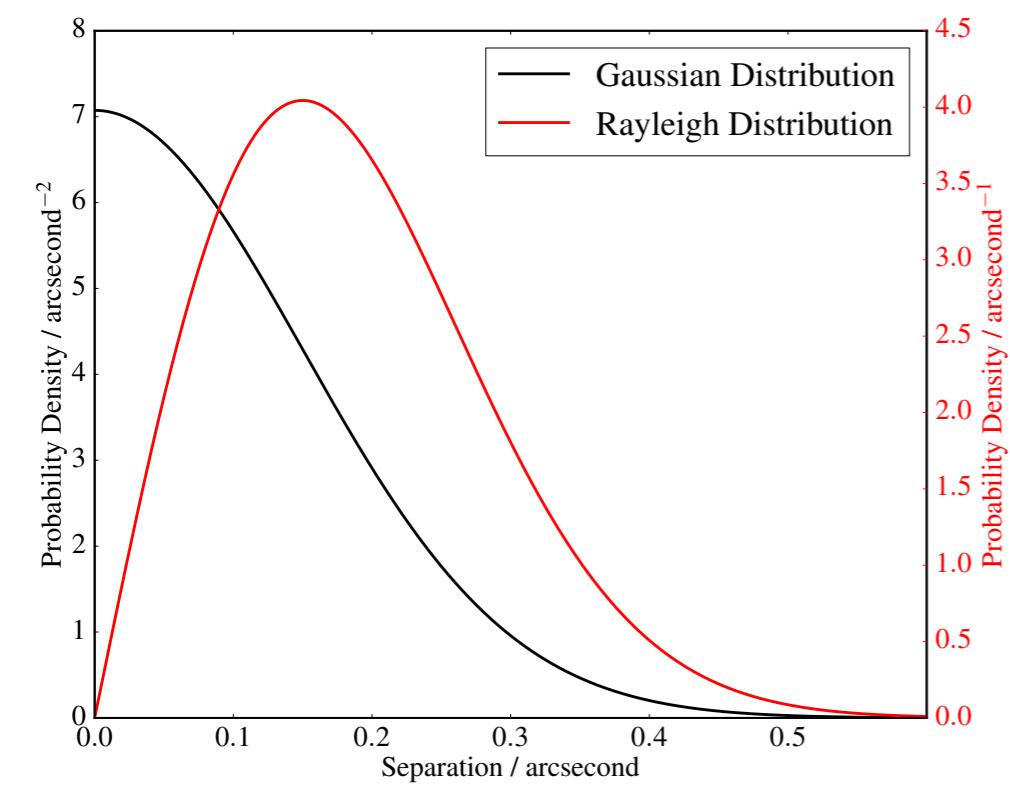
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The Astrometric Uncertainty Function

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



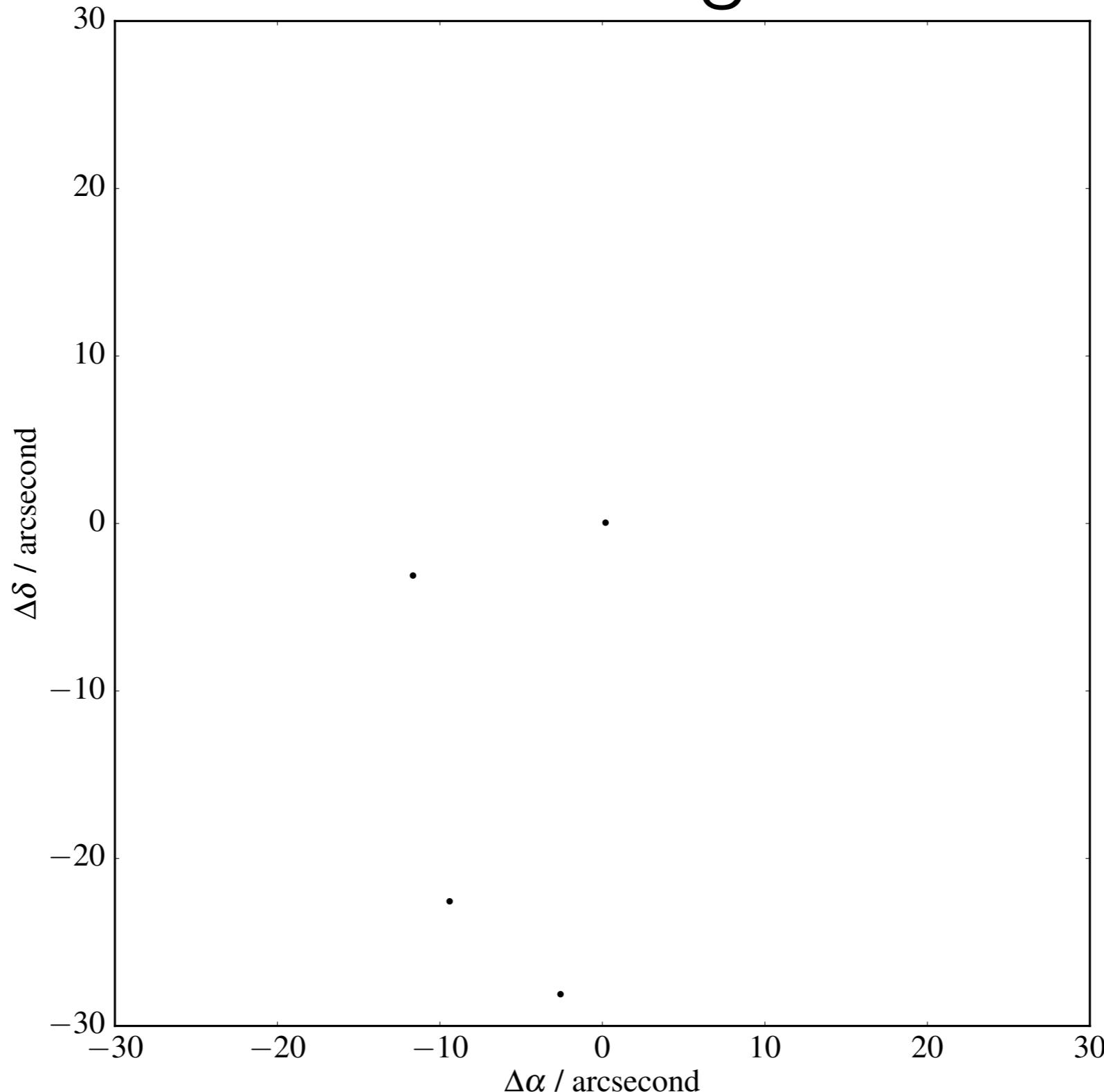
$$g(r, \sigma) = \frac{r}{\sigma^2} e^{-\frac{r^2}{2\sigma^2}}$$



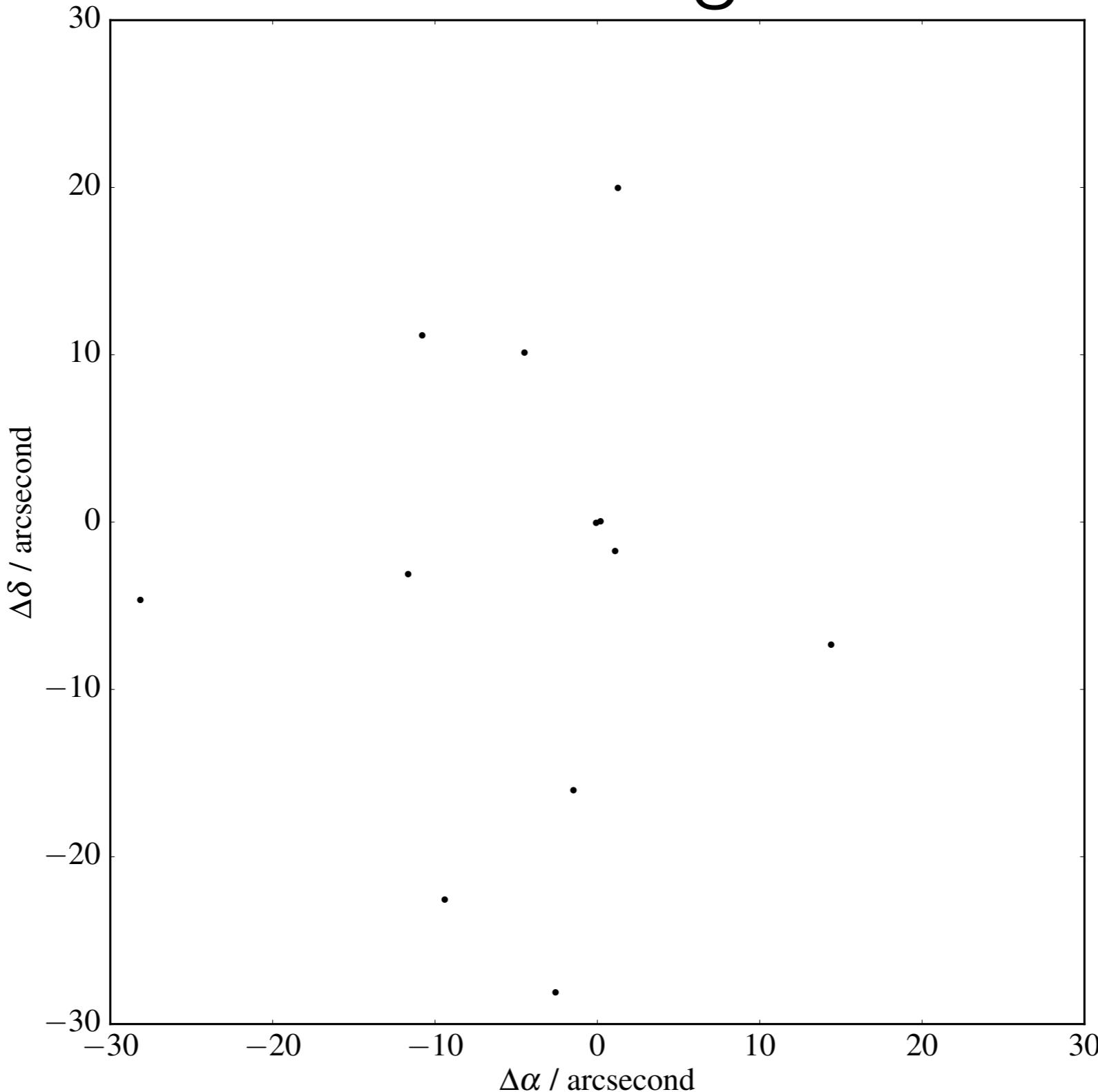
Gaia DR2 - Gaia Collaboration, Brown A. G. A., et al. 2018, A&A, 616, 1
WISE - Wright et al., 2010, AJ, 140, 1868
Wilson & Naylor, 2017, MNRAS, 468, 2517

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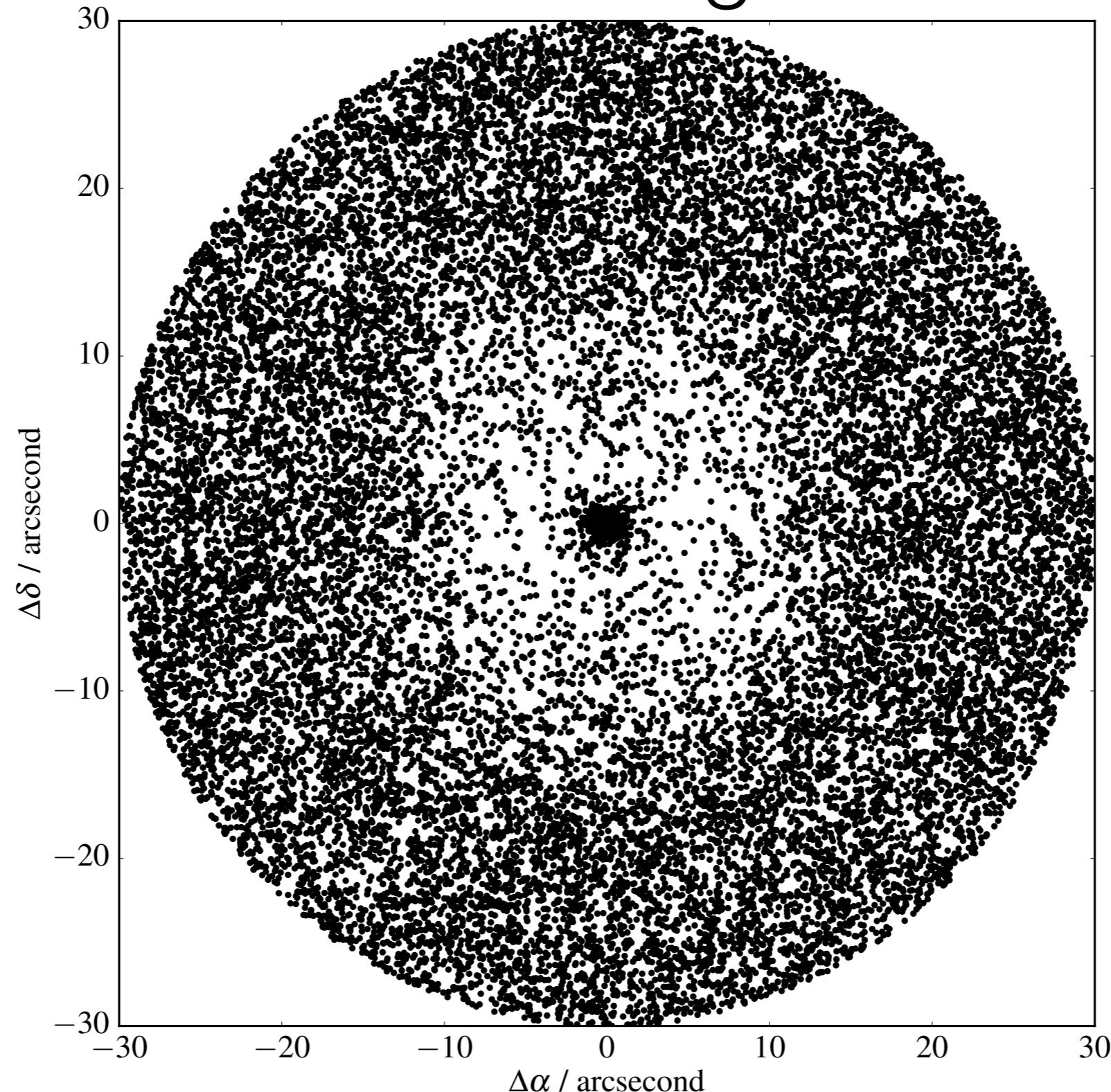
The Astrometric Uncertainty Function: Crowding



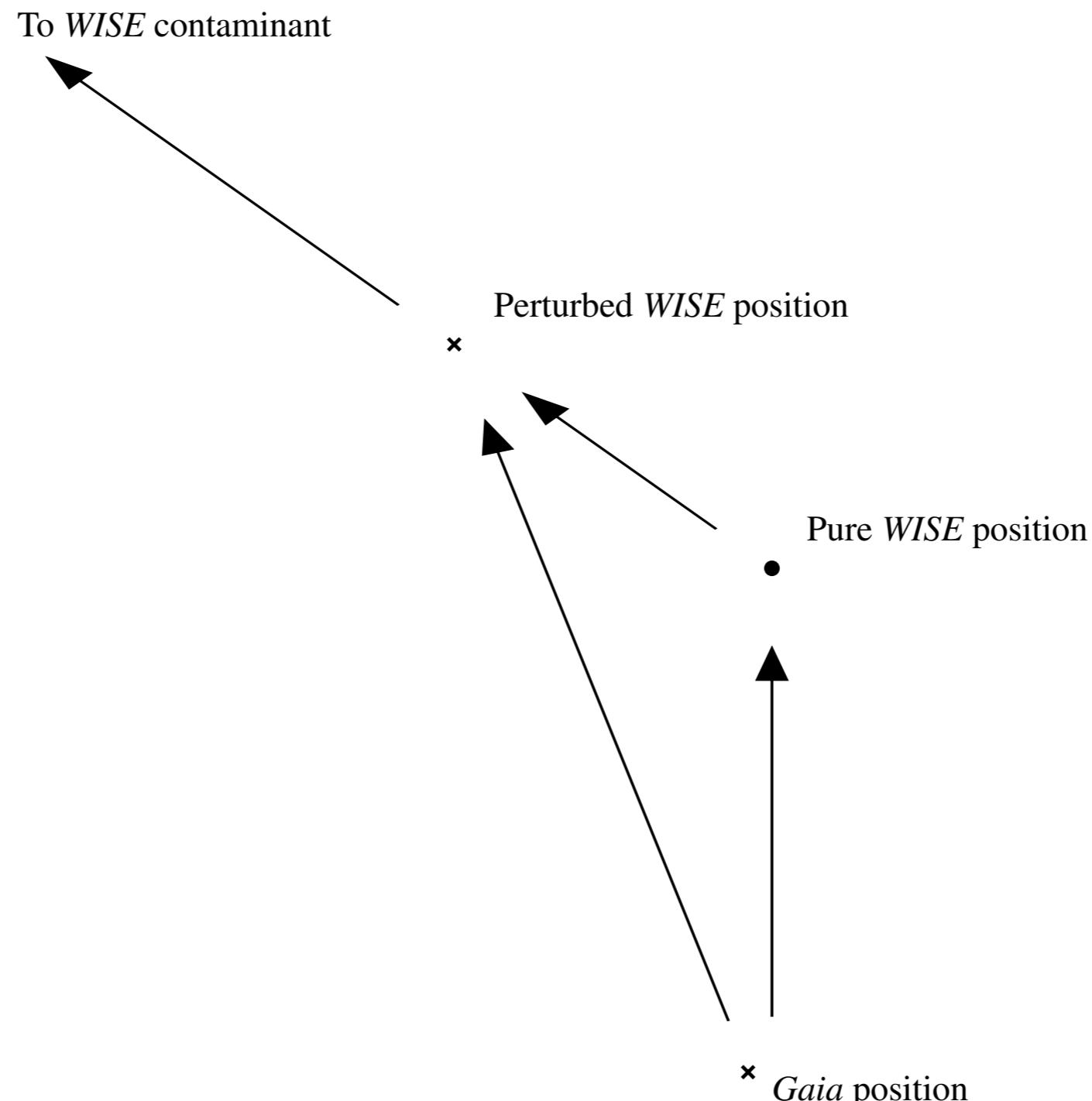
The Astrometric Uncertainty Function: Crowding



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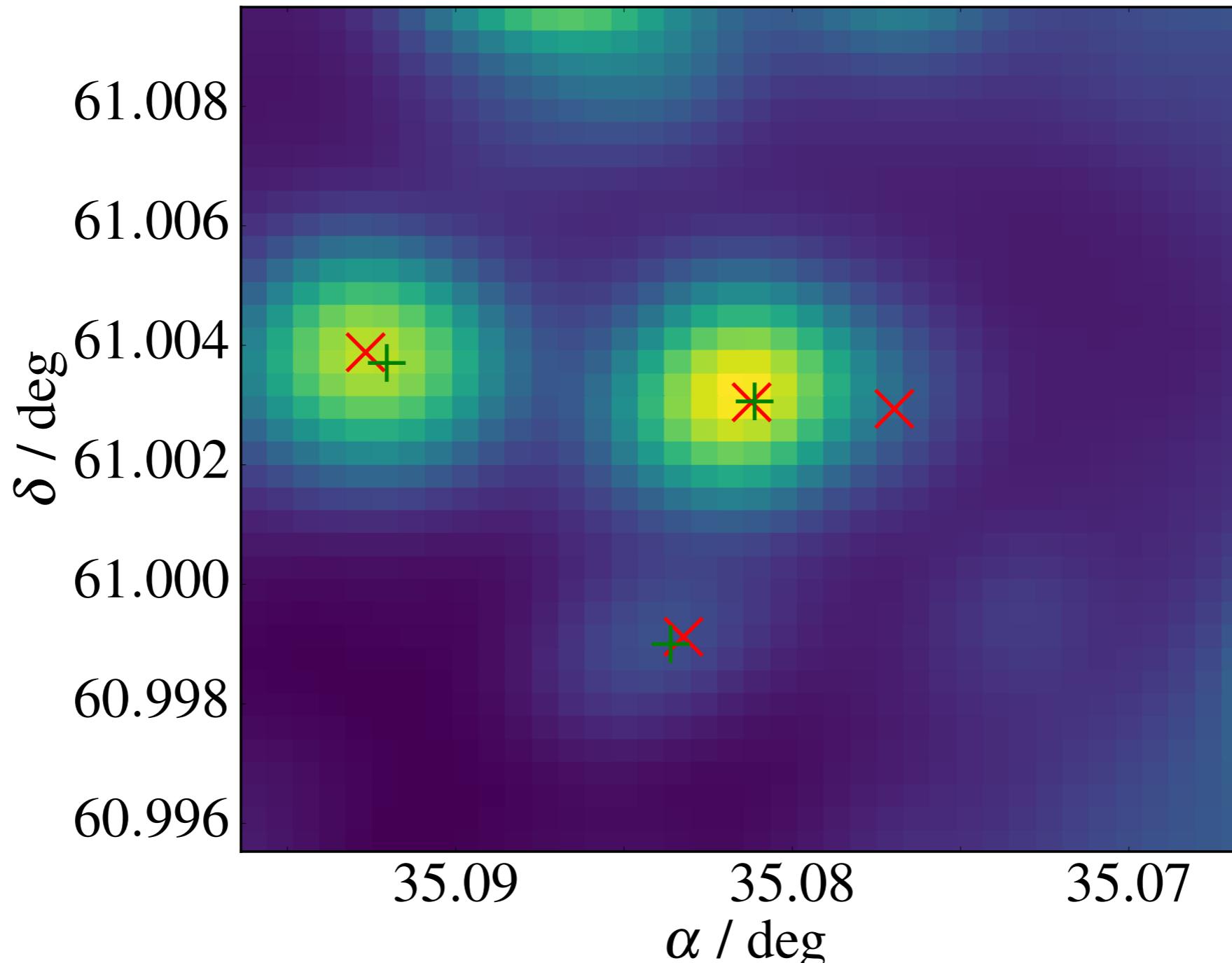


The Astrometric Uncertainty Function: Perturbation



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

✗ *Gaia*
+ *WISE*



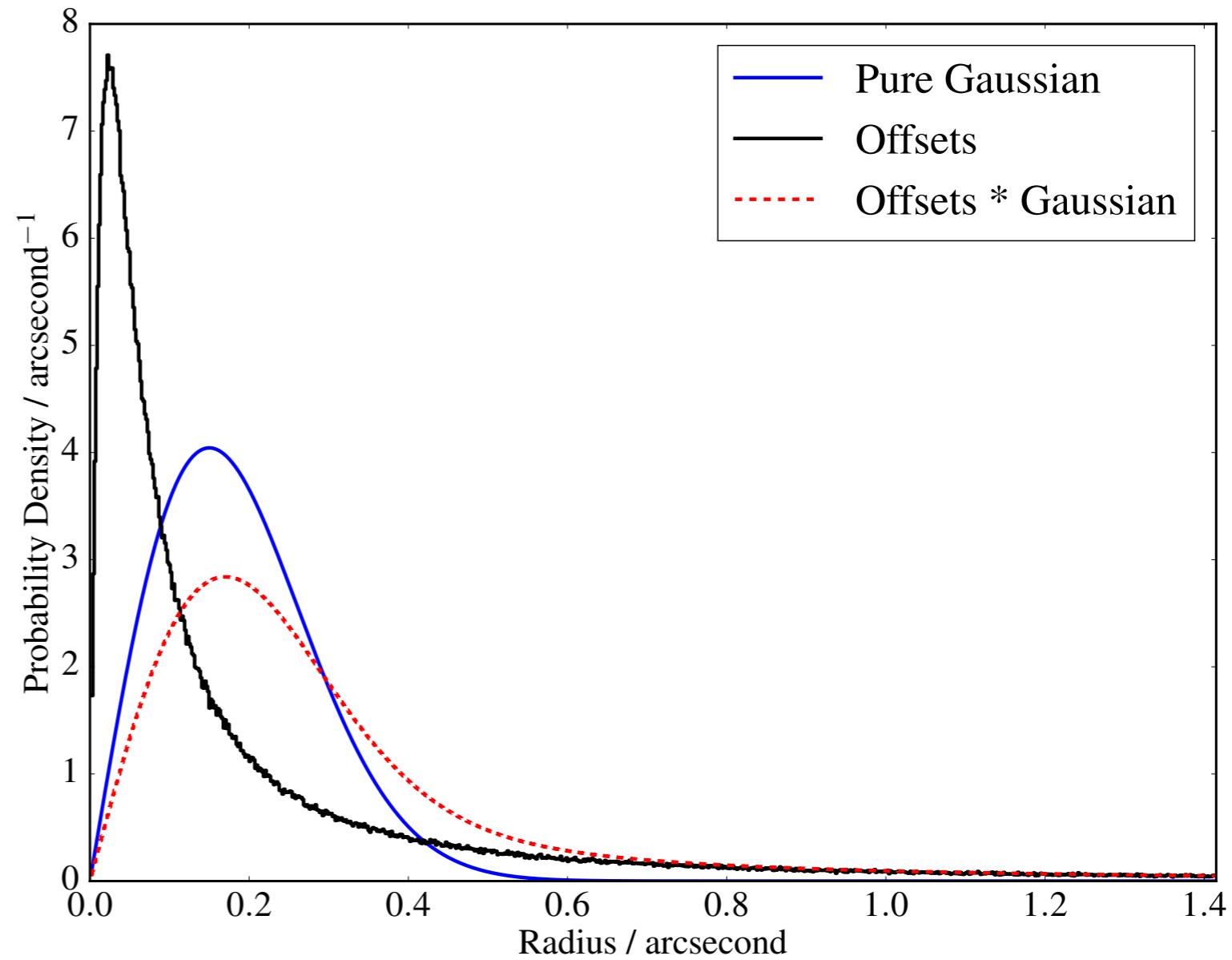
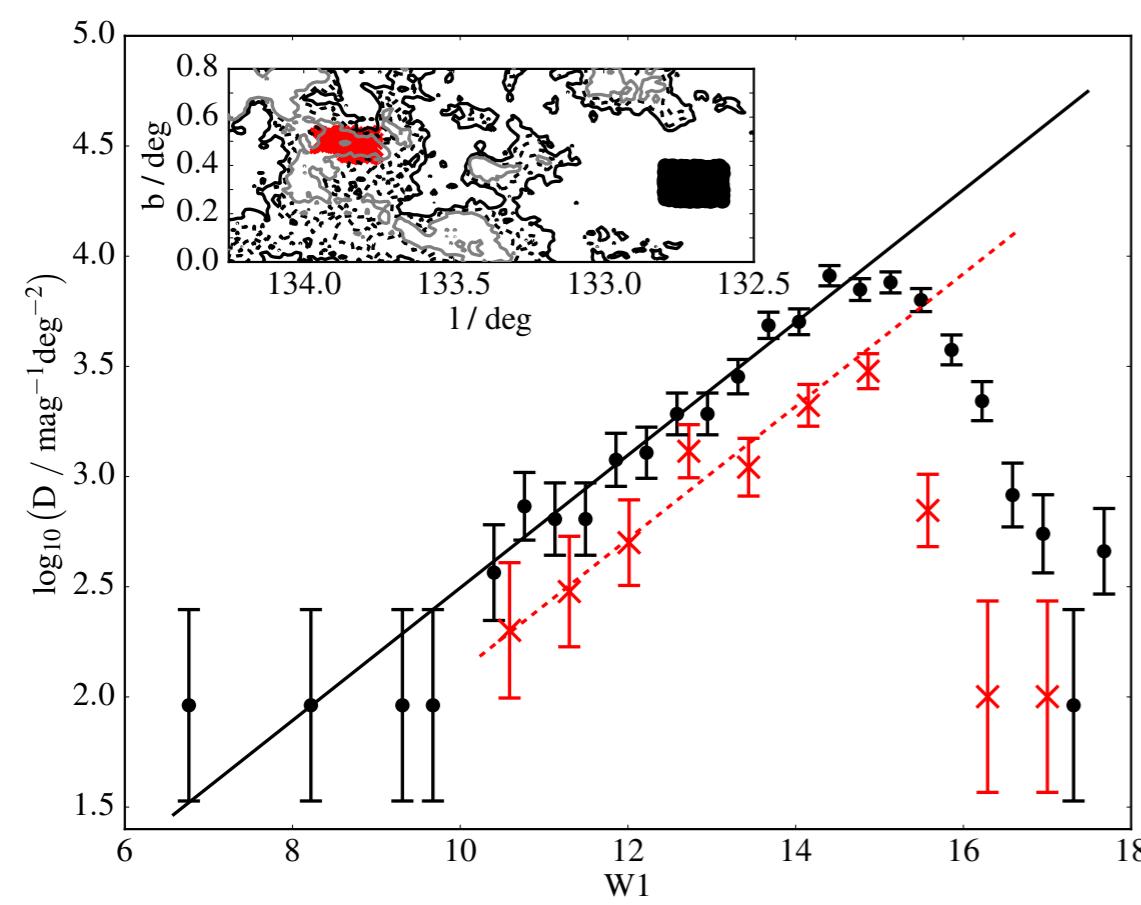
Gaia DR2 - *Gaia* Collaboration, Brown A. G. A., et al. 2018, A&A, 616, 1

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

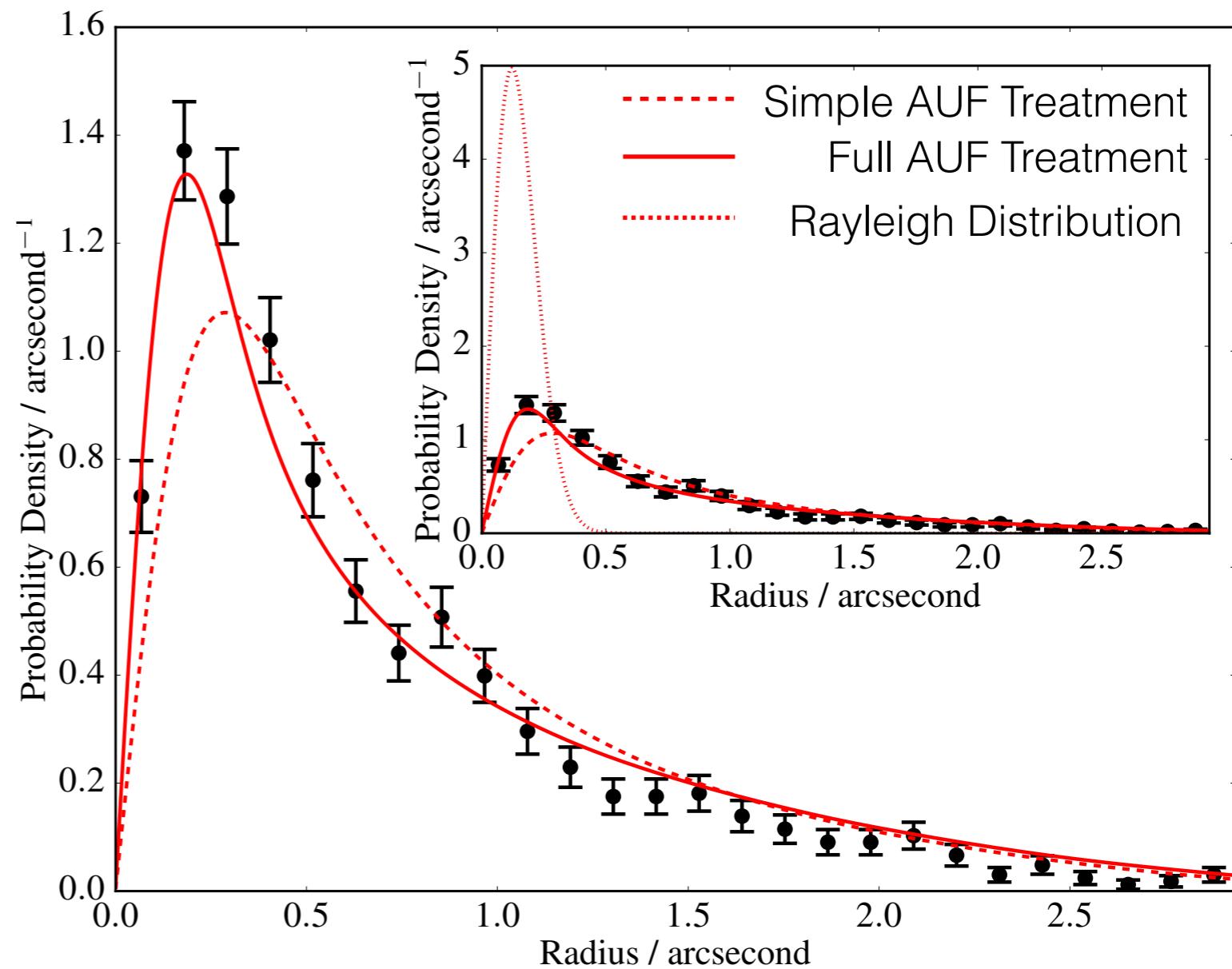
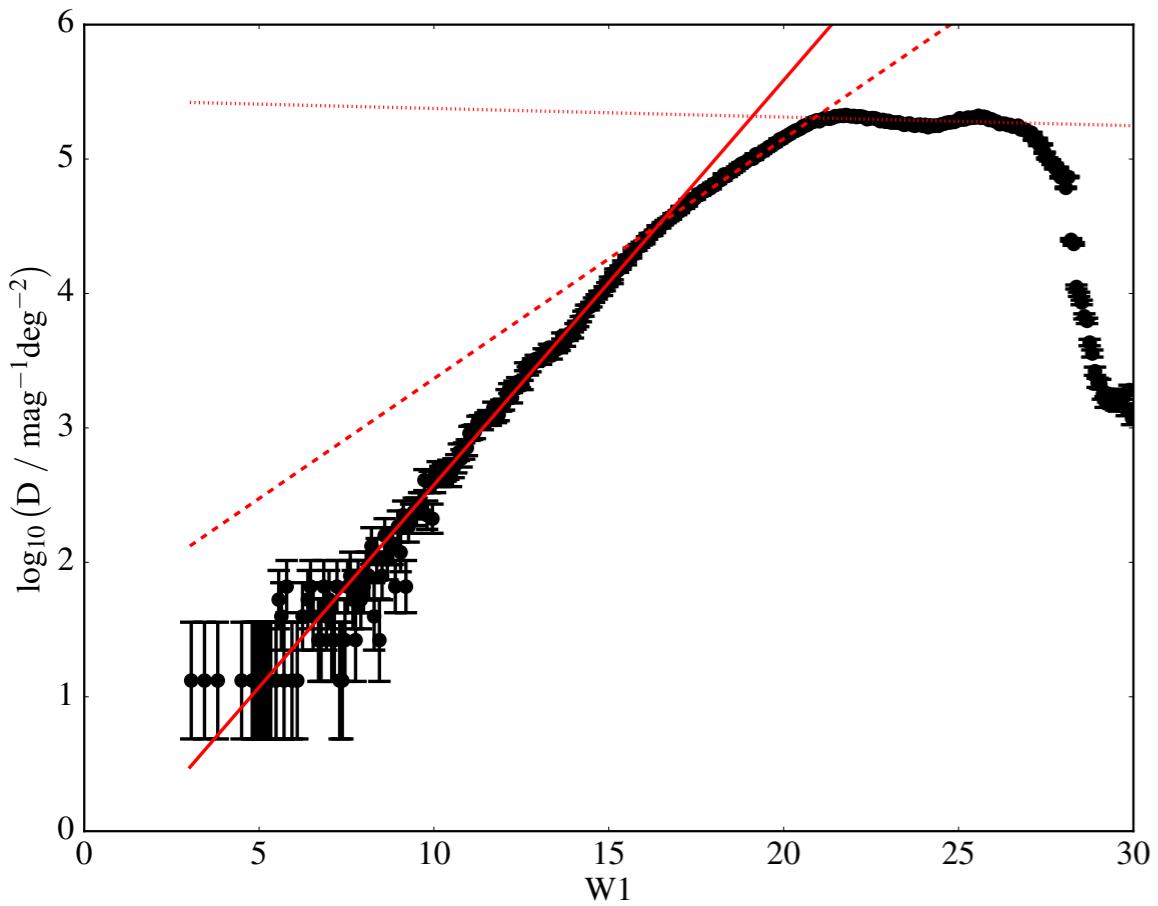
Wilson & Naylor, MNRAS, 2018b, 481, 2148

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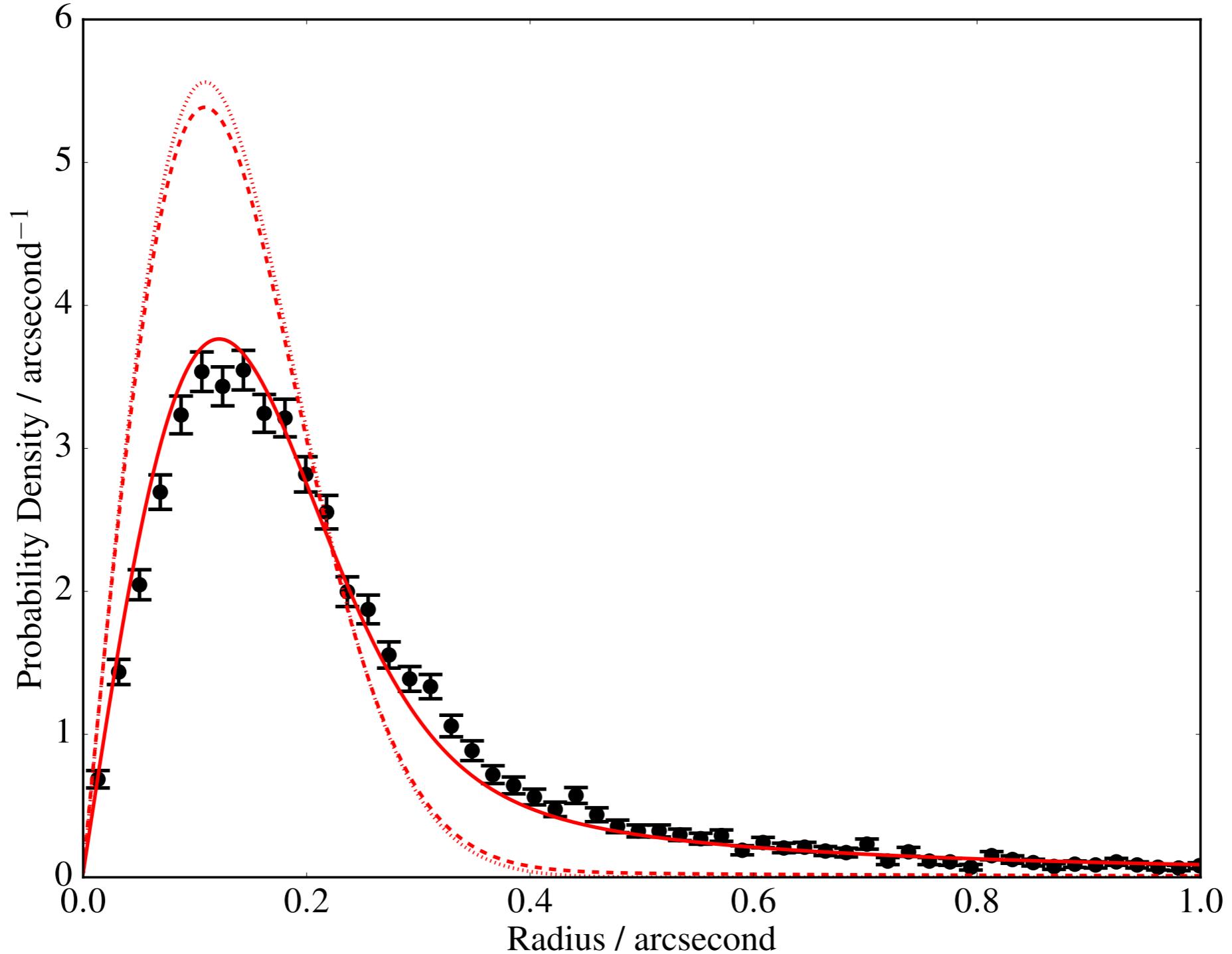
The Astrometric Uncertainty Function: Building Empirical AUFs



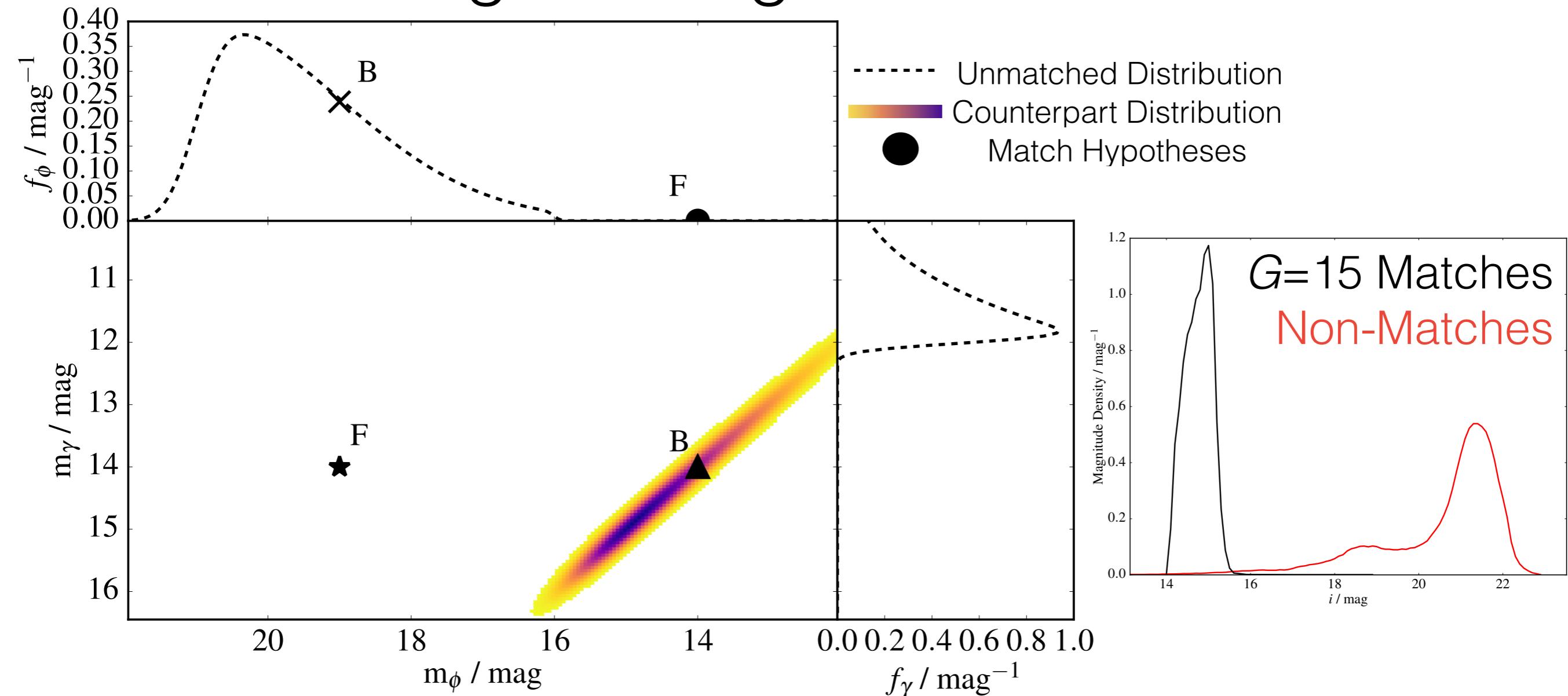
Contamination Effects: Effects Below Sensitivity Limit



Contamination Effects: Galaxy Contamination

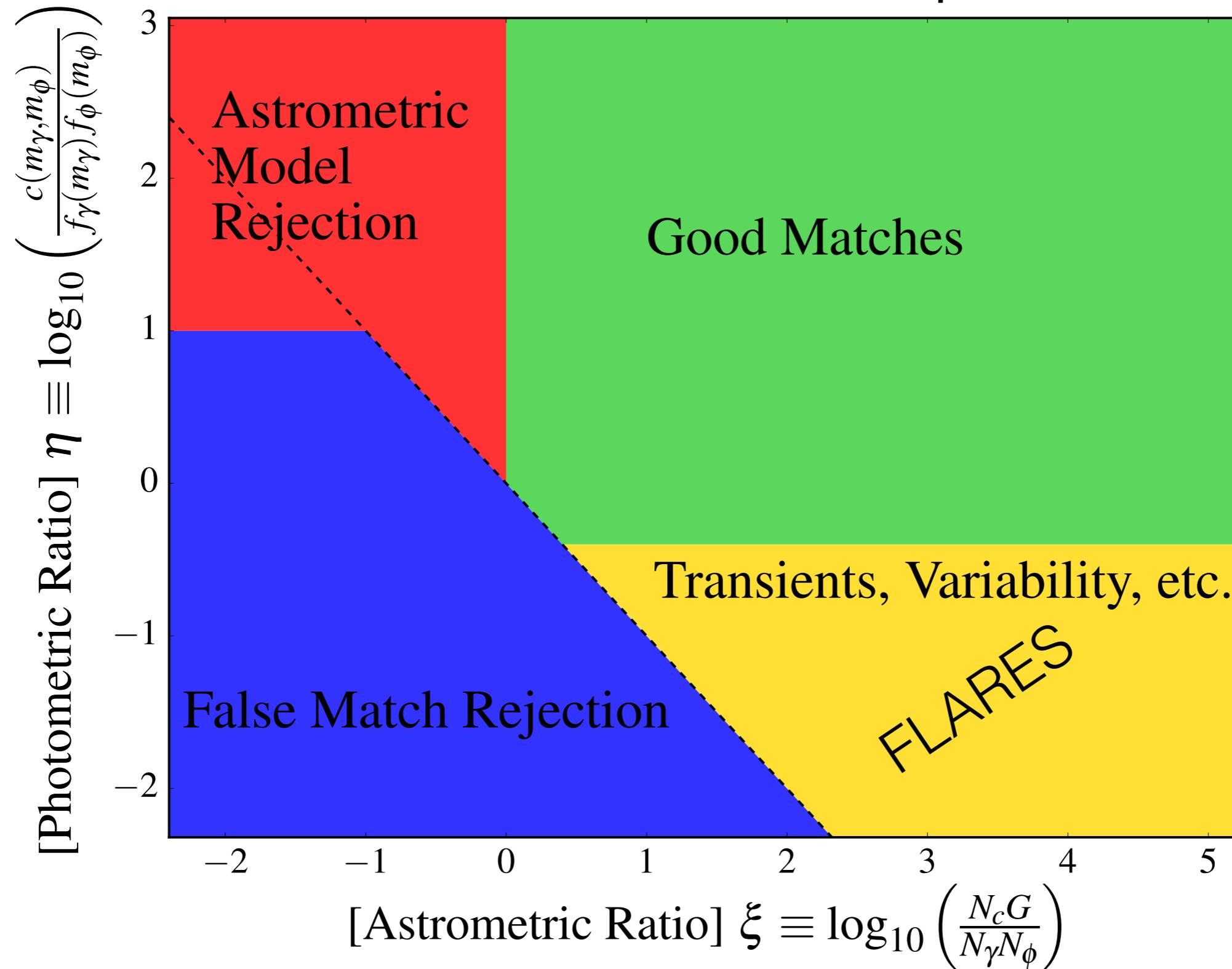


Probability-based Catalogue Matching: Including the Magnitude Information

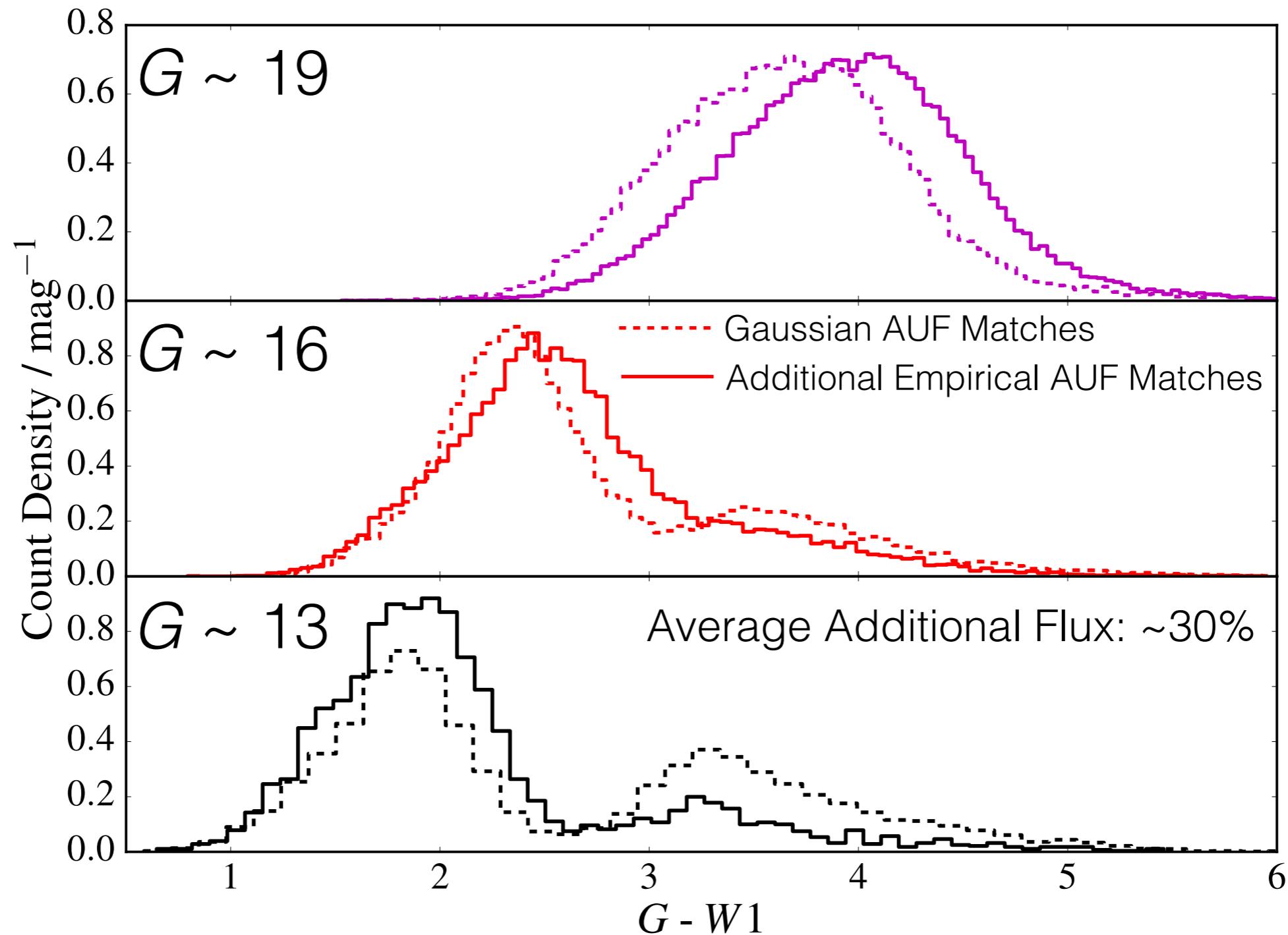


$$g(x_k, y_k, x_l, y_l) = N_c \iint_{-\infty}^{+\infty} h_\gamma(\Delta x_{kl} - x, \Delta y_{kl} - y) h_\phi(x, y) dx dy \\ = N_c \times (h_\gamma * h_\phi)(\Delta x_{kl}, \Delta y_{kl}).$$

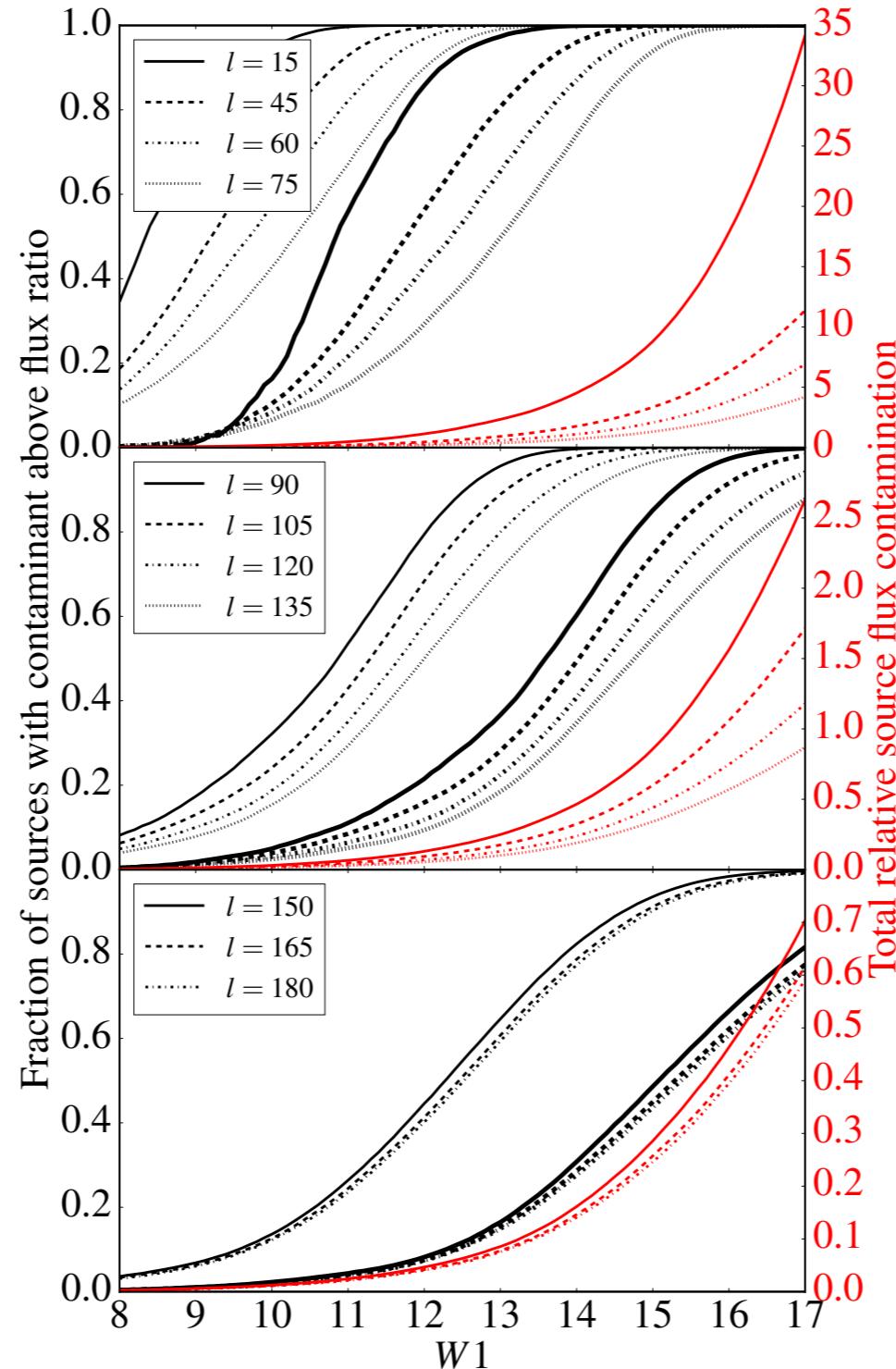
Probability-based Catalogue Matching: The Likelihood Ratio Space



Contamination Effects: Perturbation-Colour Correlation

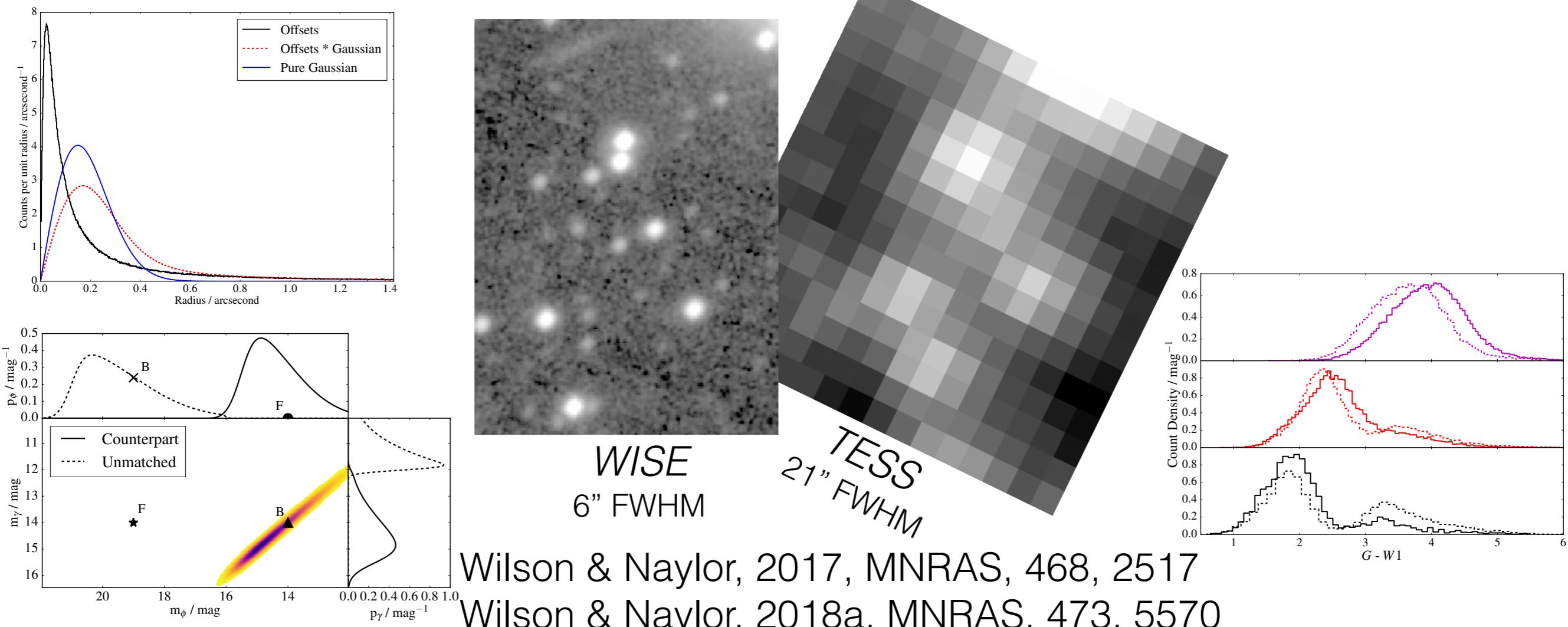


Contamination Effects: Contamination Rates & Amounts



The 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!



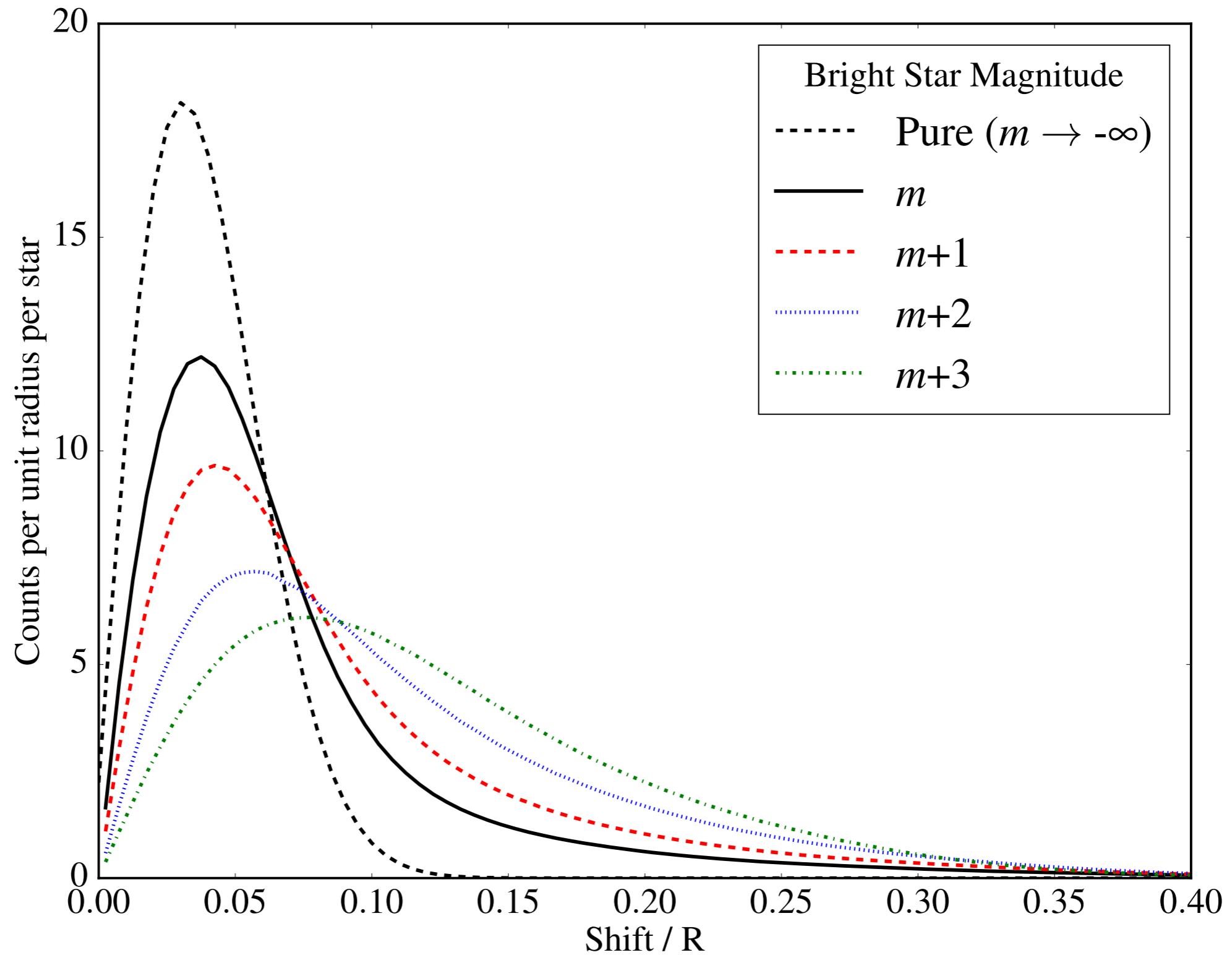
Wilson & Naylor, 2017, MNRAS, 468, 2517

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

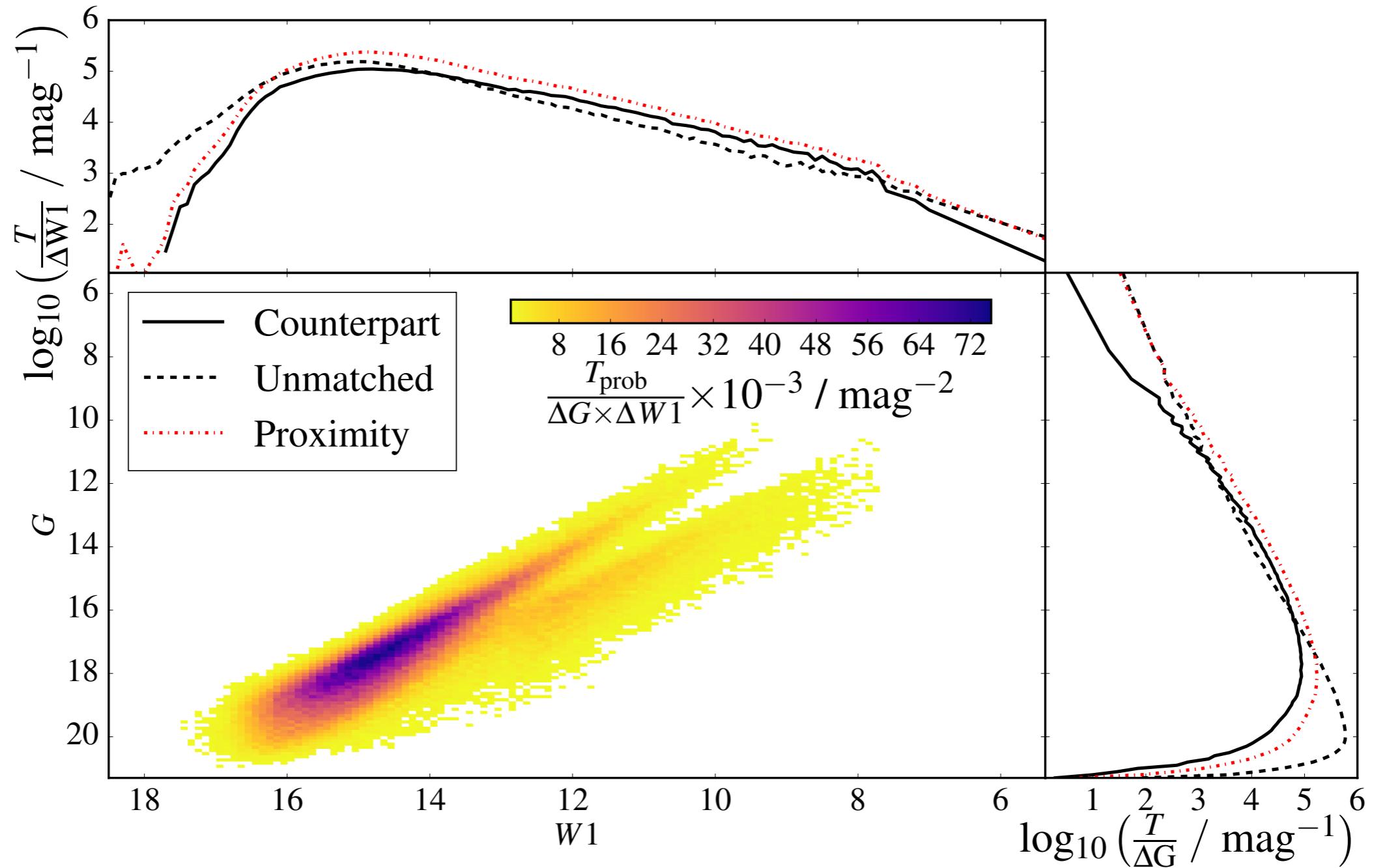
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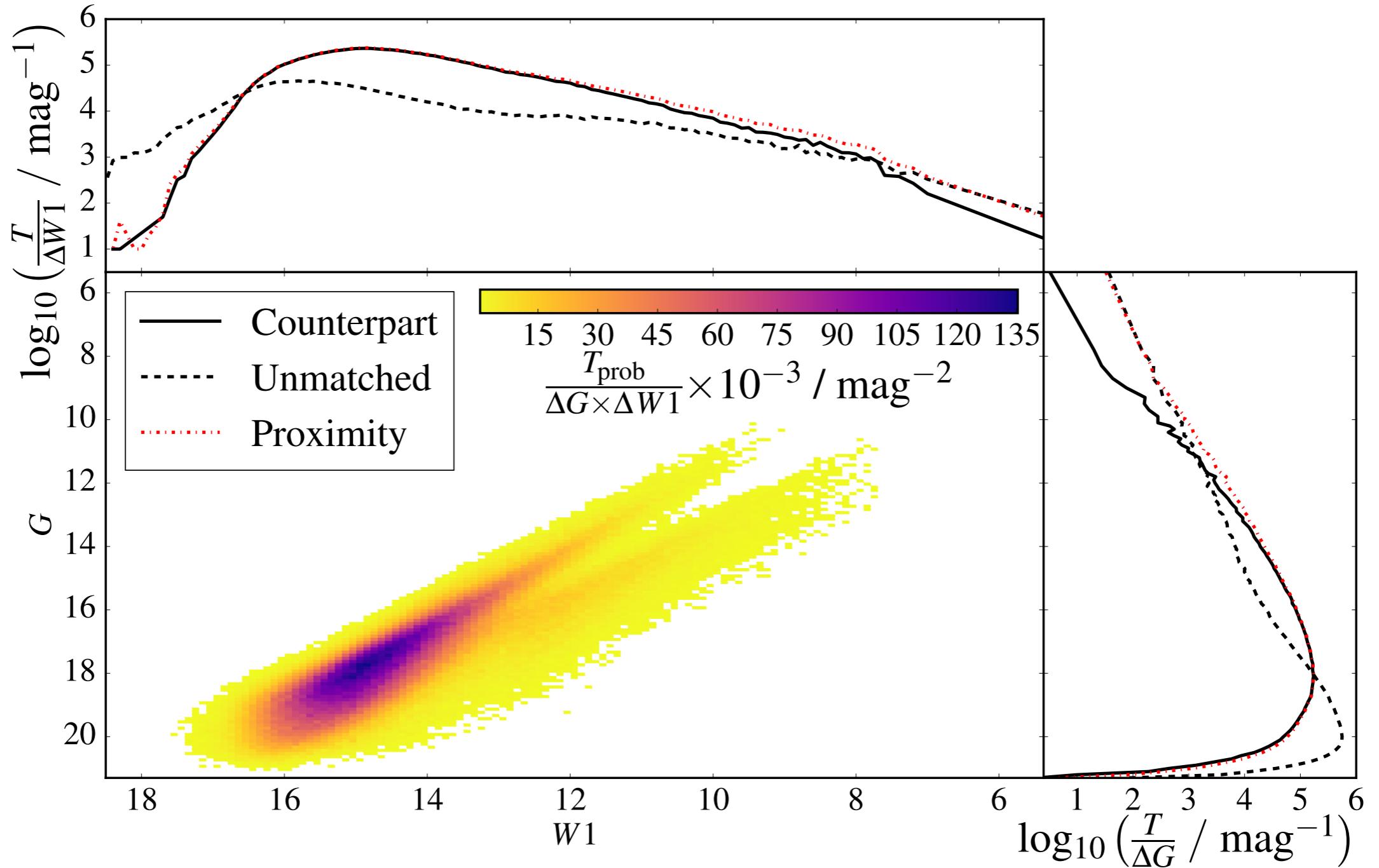
The Astrometric Uncertainty Function: Synthetic Non-Gaussian Tails



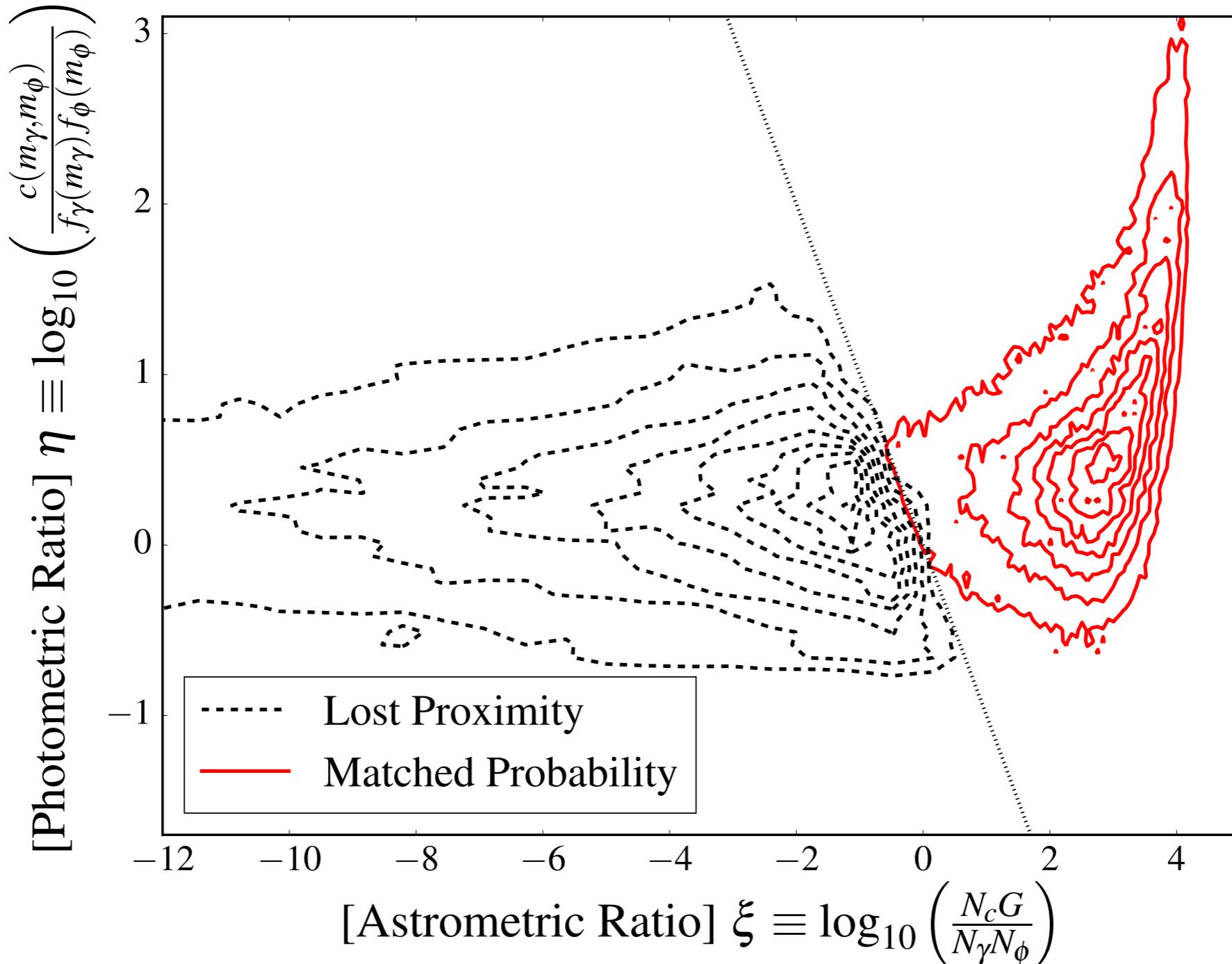
Contamination Effects: *Gaia-WISE* Gaussian Matches



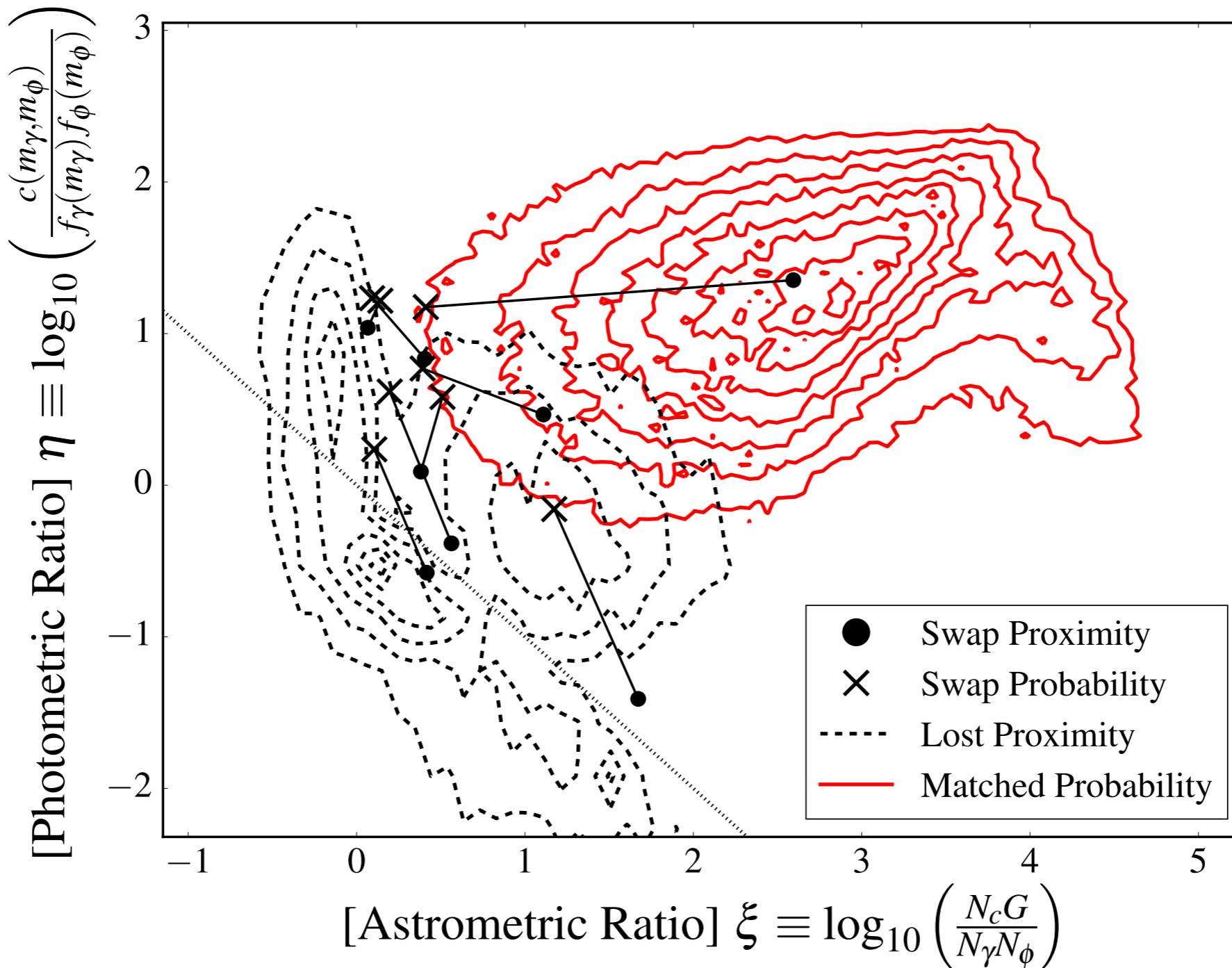
Contamination Effects: *Gaia*-WISE Empirical Matches



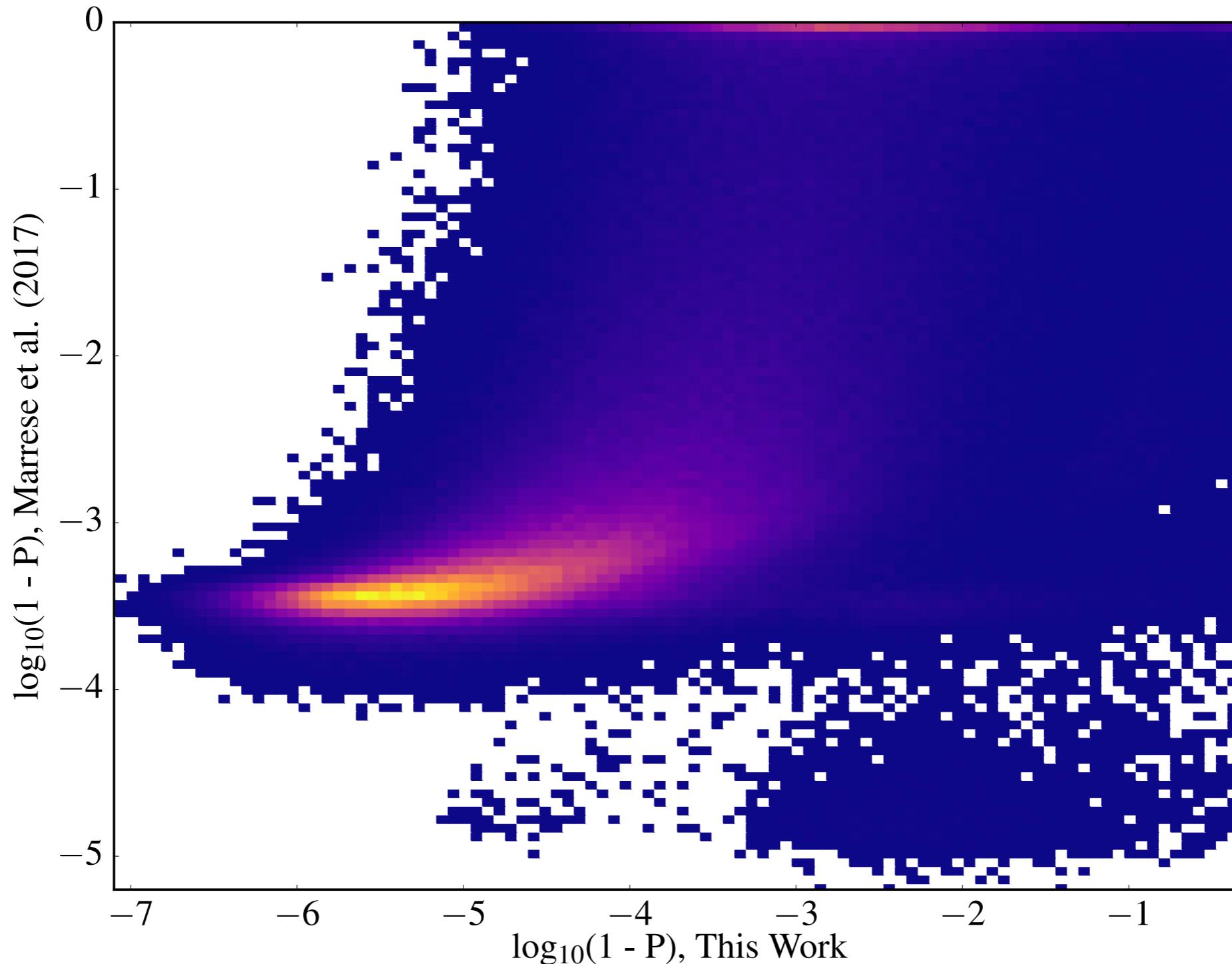
Contamination Effects: Lost Proximity Matches



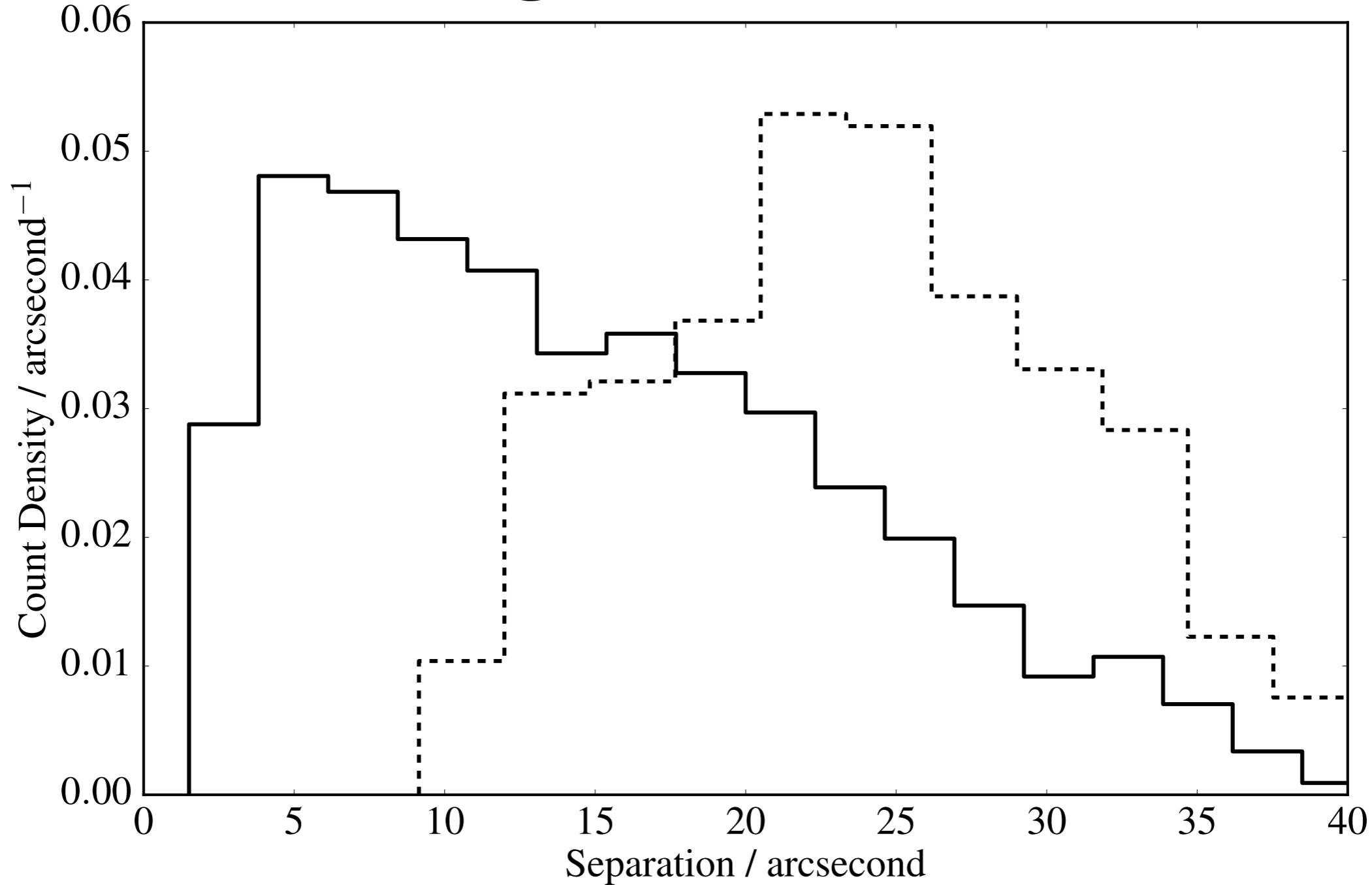
Contamination Effects: Lost Proximity Matches



Contamination Effects: *Gaia* Lost Matches



Contamination Effects: Resolving Contaminants



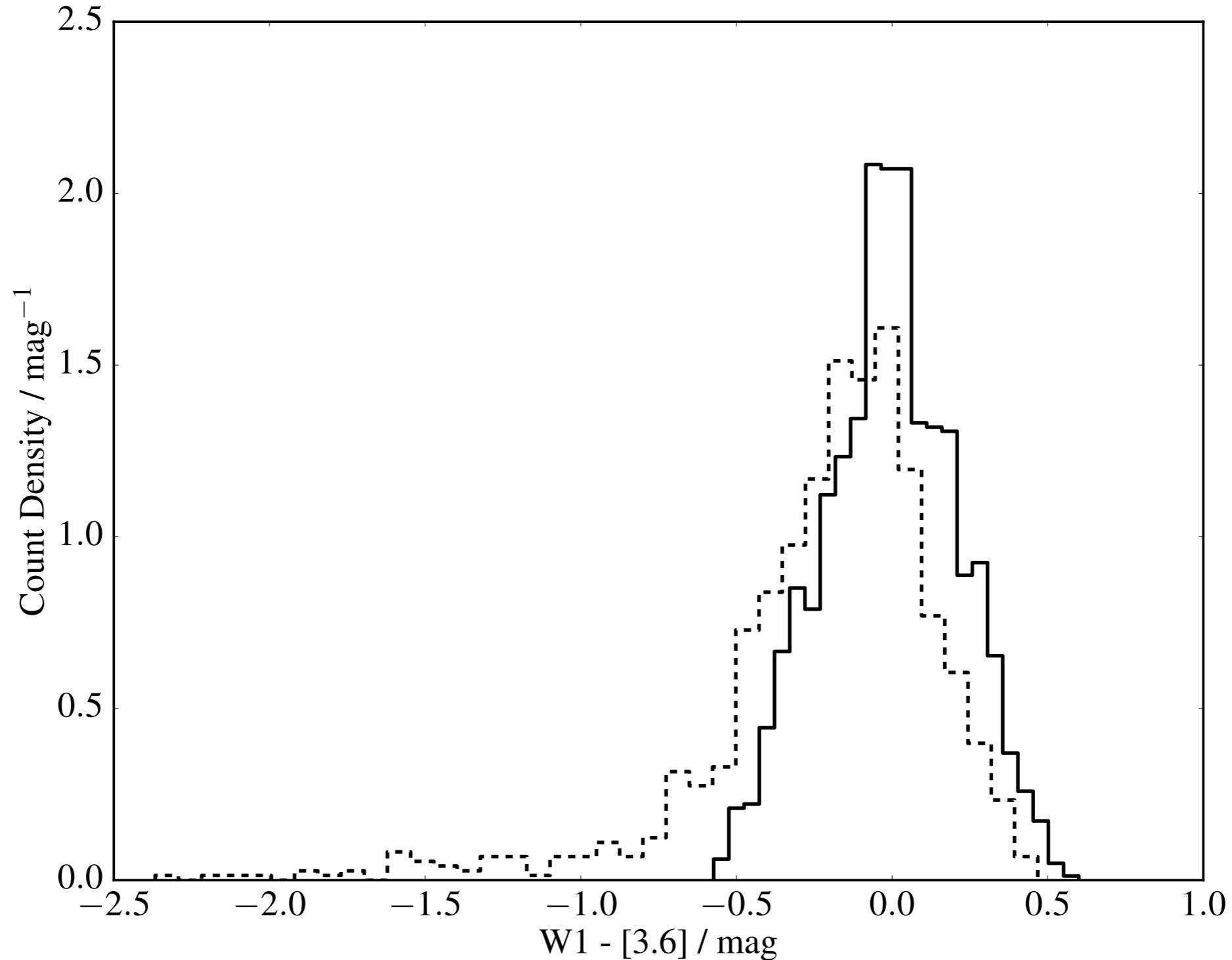
Spitzer - Werner et al., 2004 ,ApJS, 154, 1

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

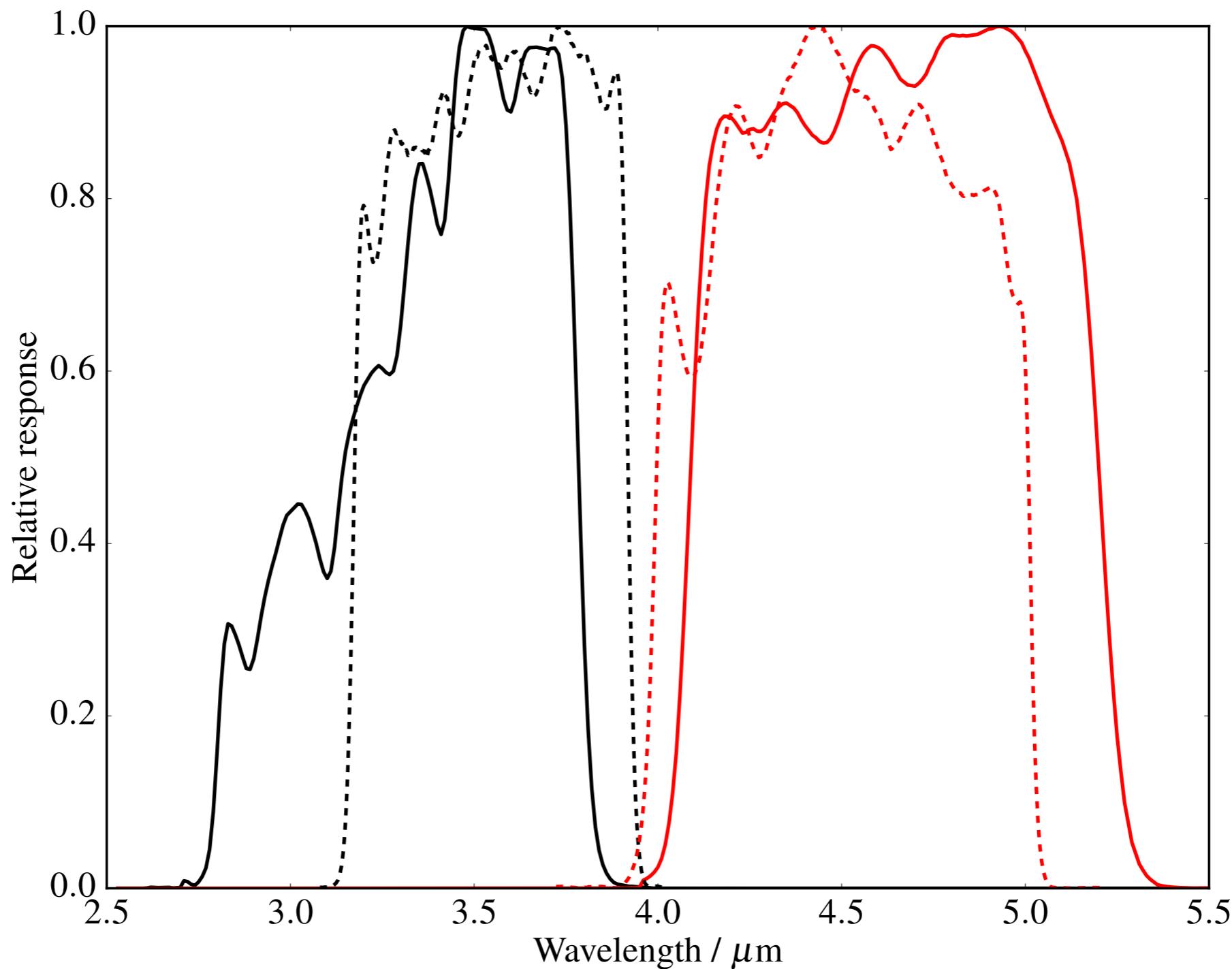
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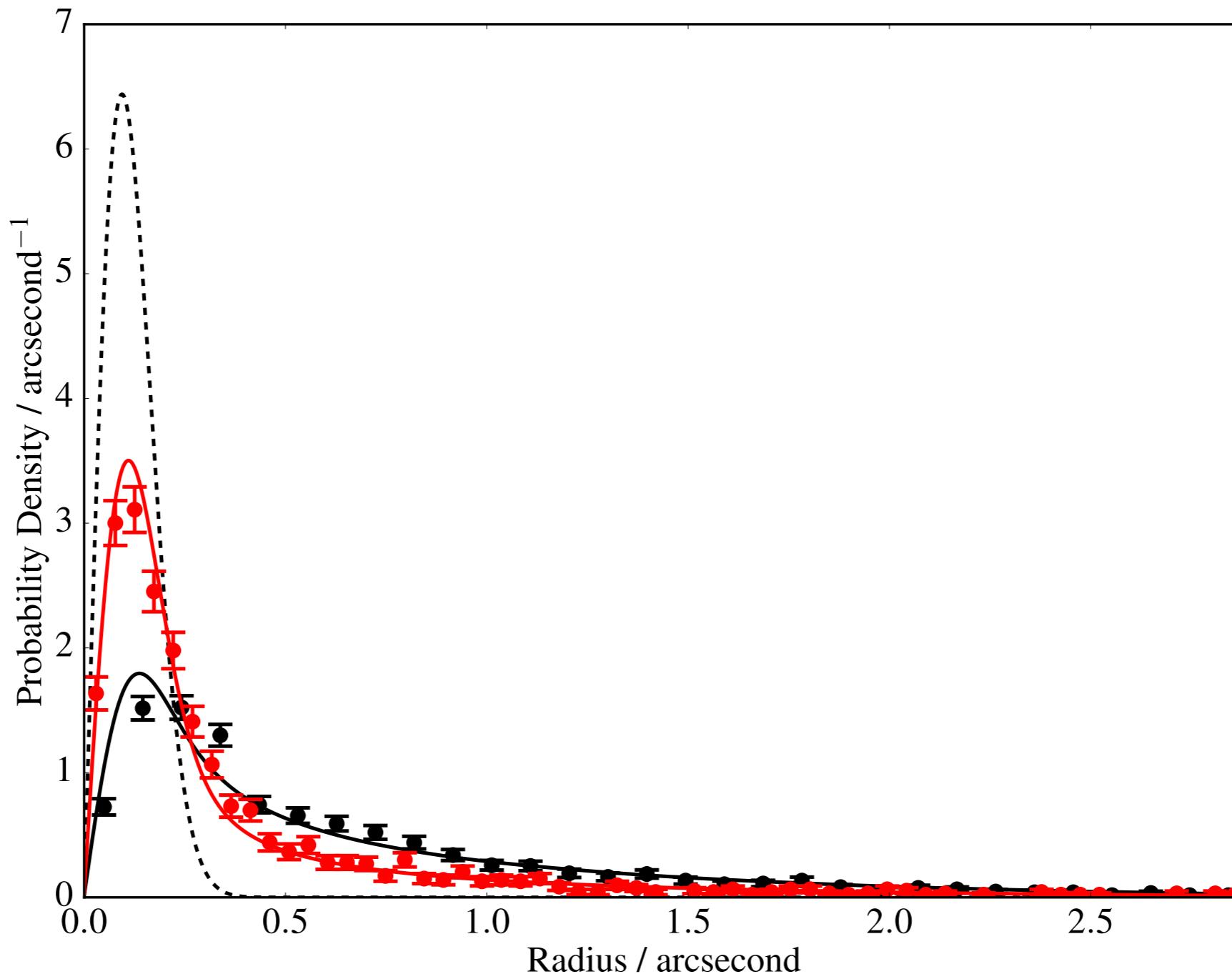
Contamination Effects: Resolving Contaminant Flux



Contamination Effects: Wavelength Coverage



Contamination Effects: Crowding Normalisation



The Astrometric Uncertainty Function: Analytical perturbations

