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

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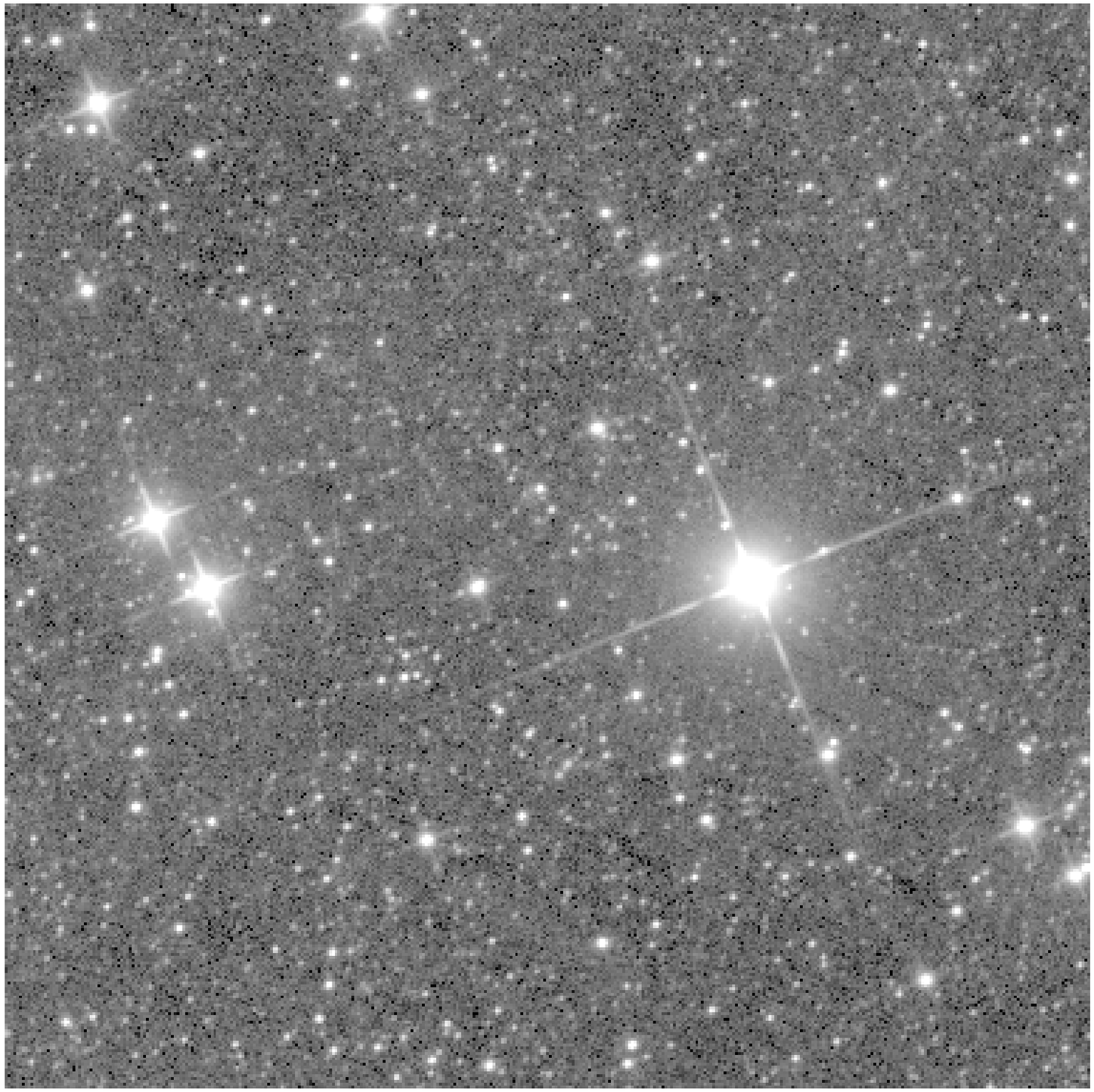
TESS Data Workshop, 2/12/19

Photometric Observations



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

WISE W1
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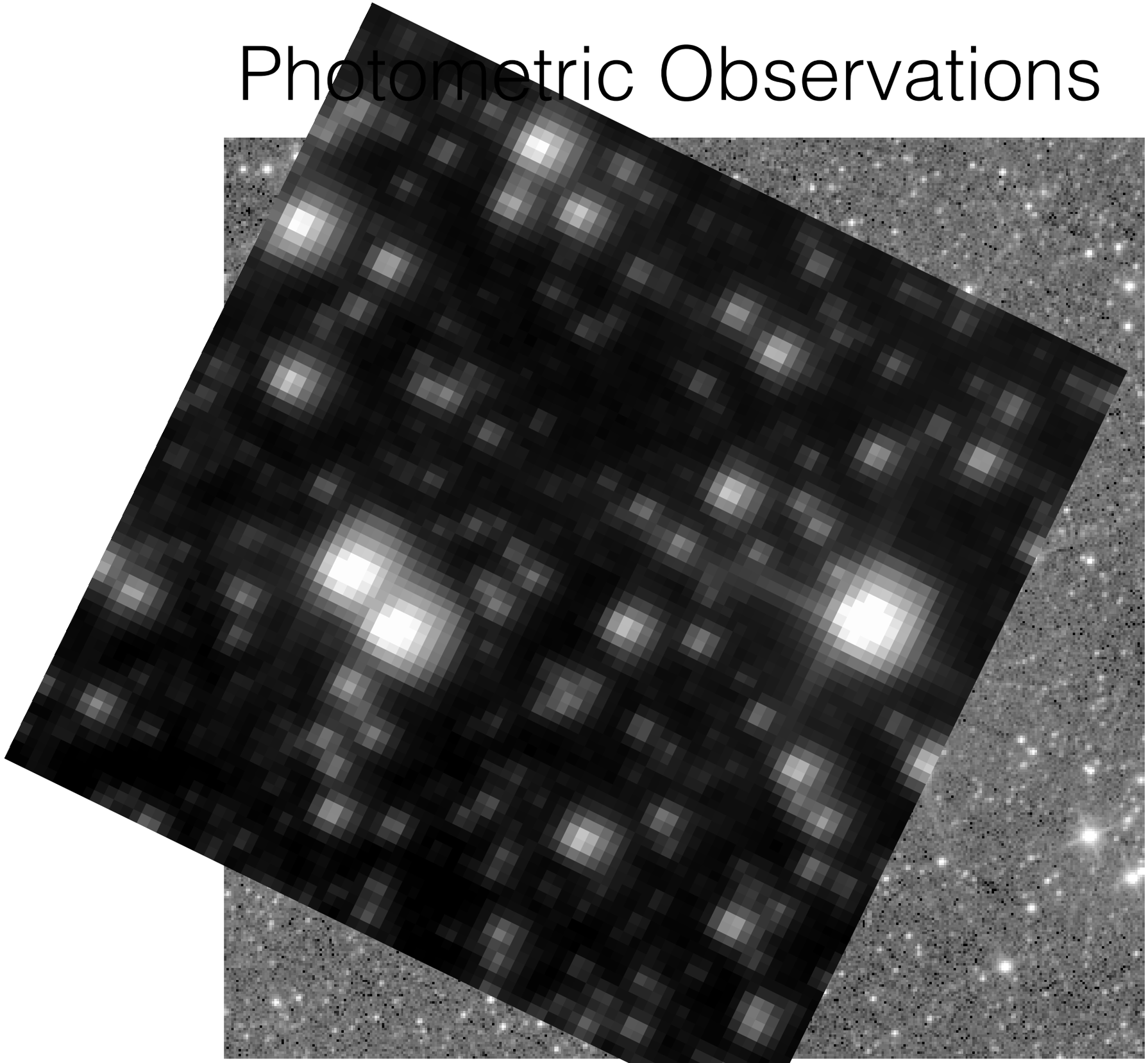
Photometric Observations



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

TESS T
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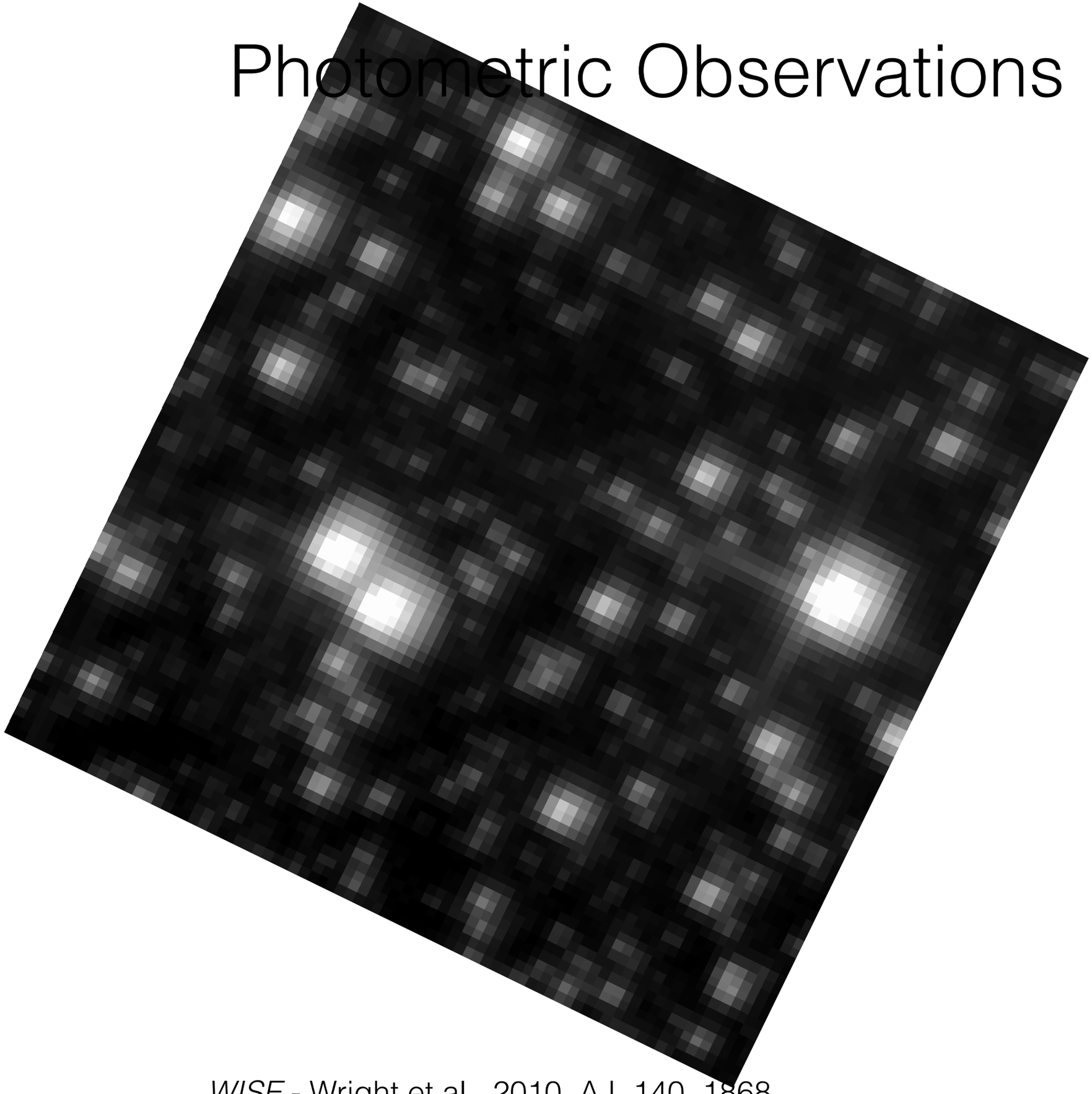
Photometric Observations



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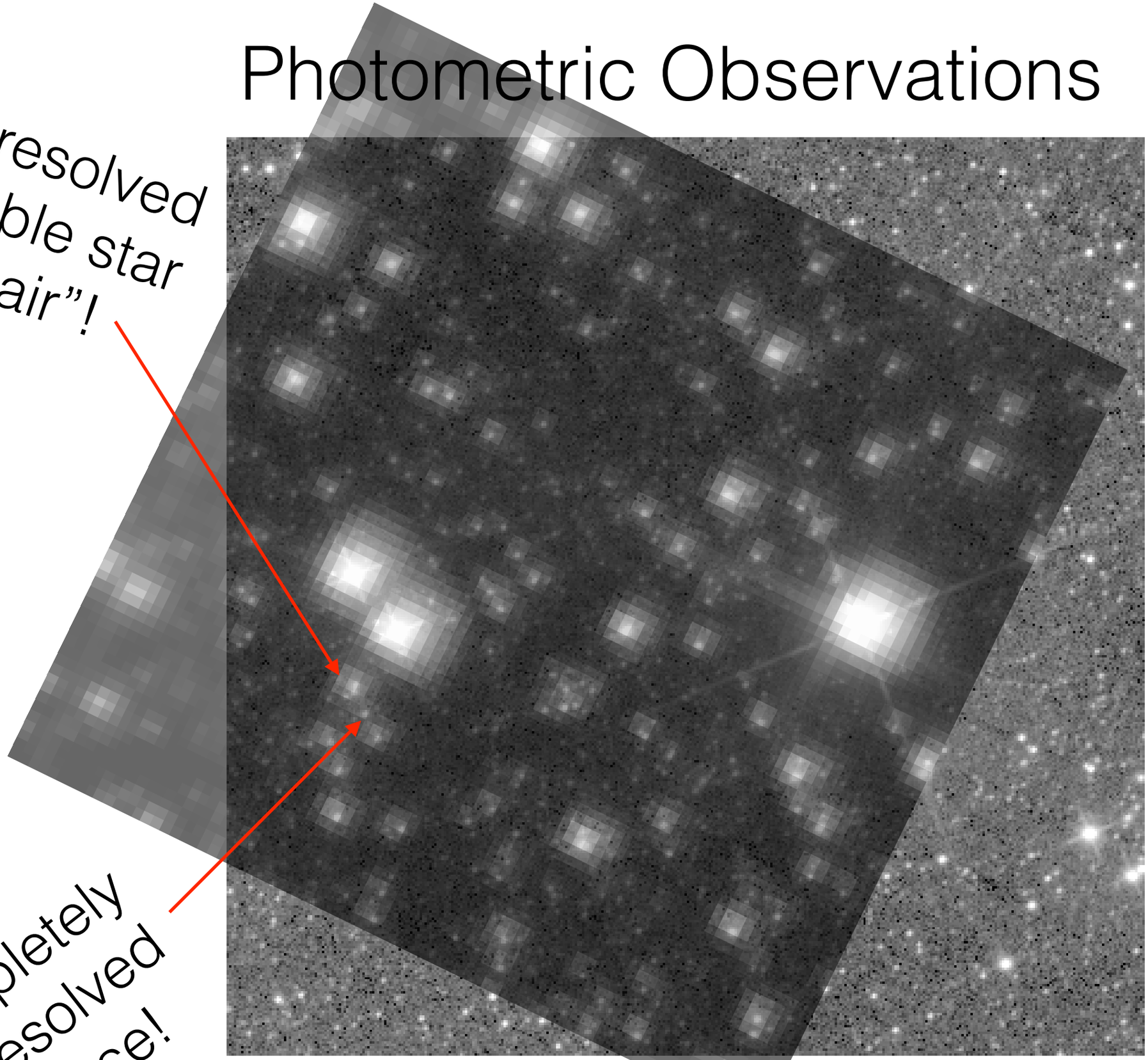
Photometric Observations



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

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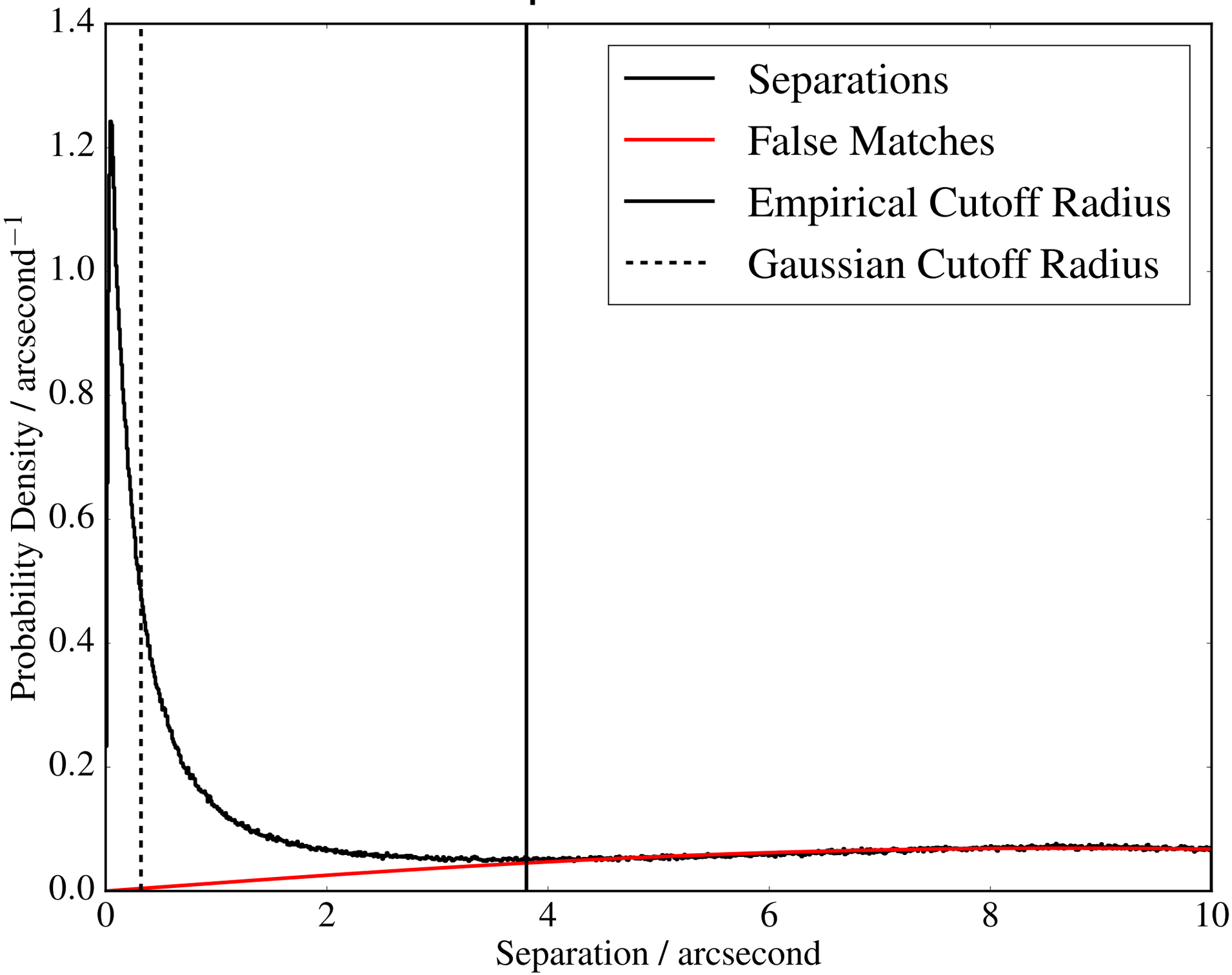
Cross-match Separation Distributions



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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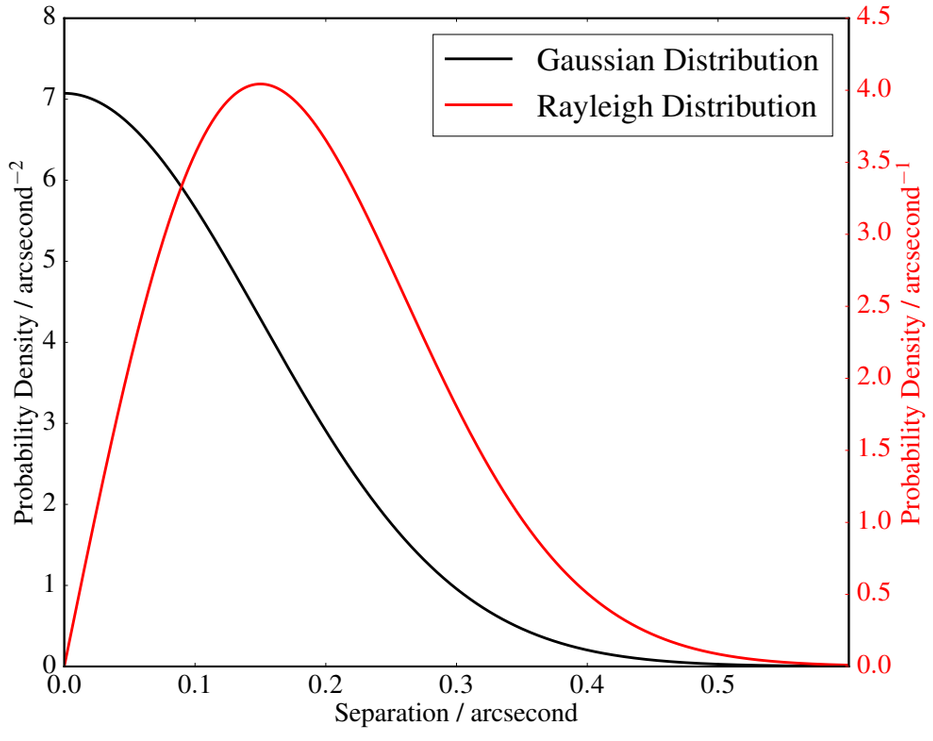
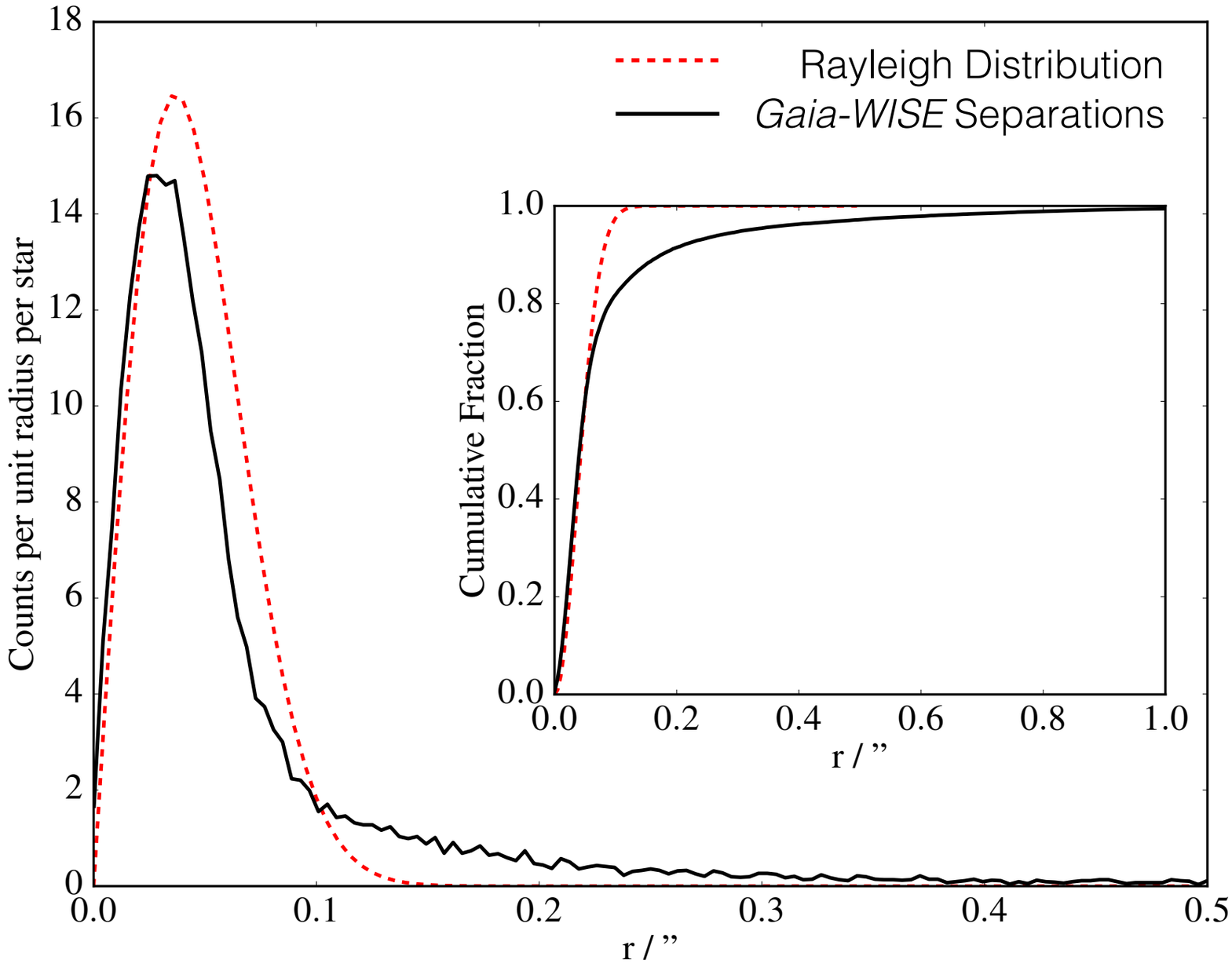
The Astrometric Uncertainty Function

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

$$\downarrow$$

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





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

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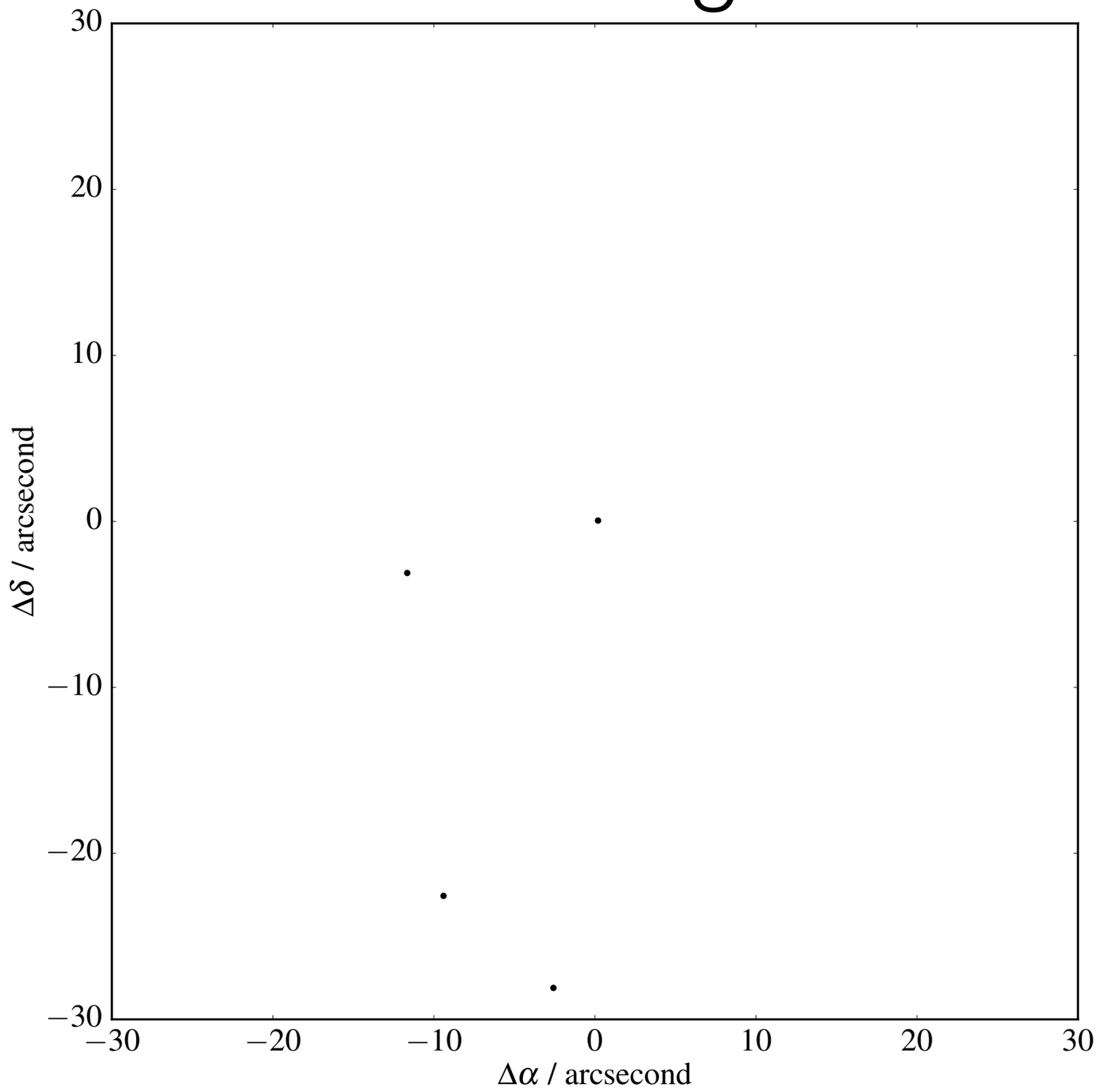
The Astrometric Uncertainty Function: Crowding



Wilson & Naylor, 2017, MNRAS, 468, 2517

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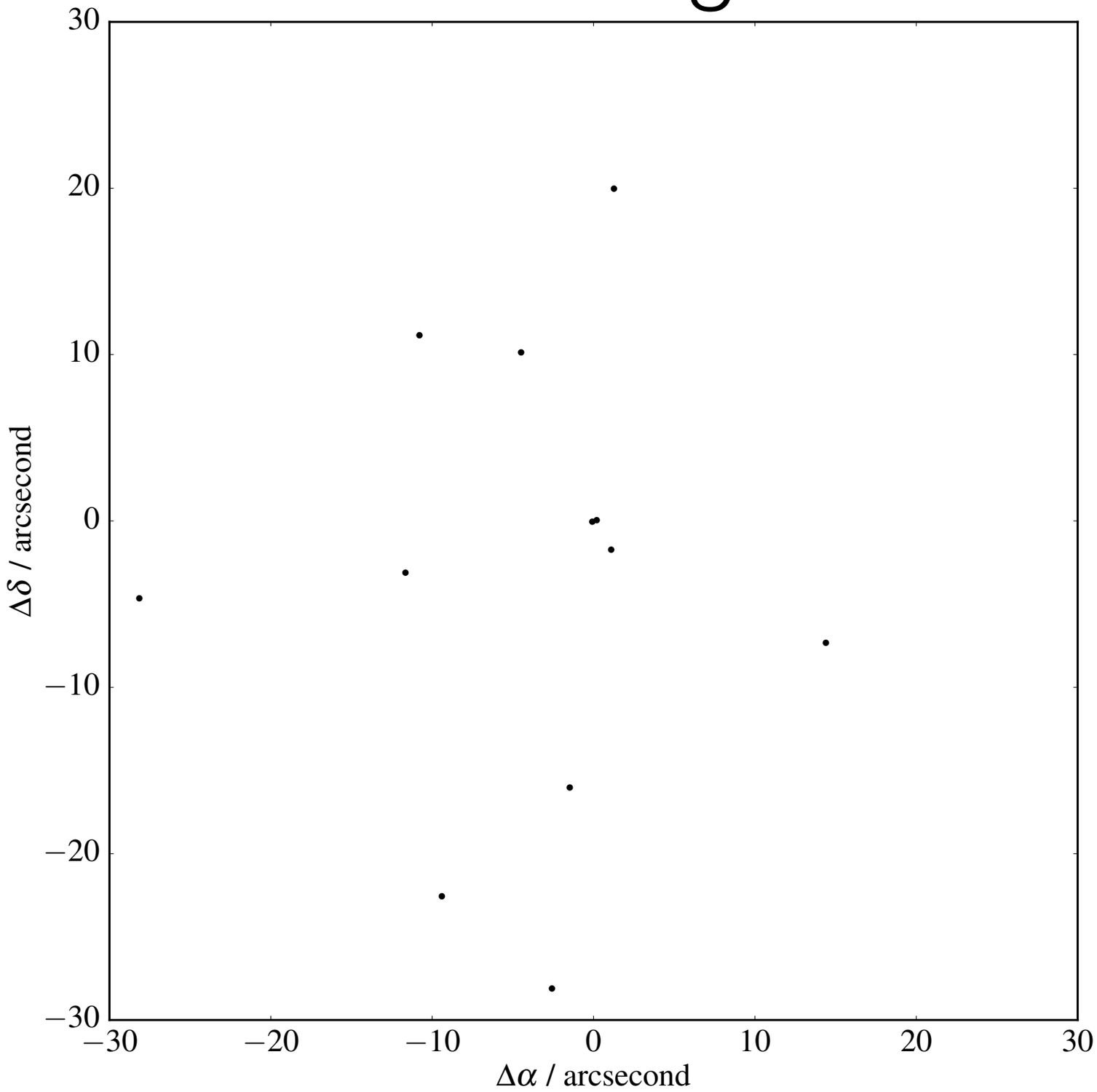
The Astrometric Uncertainty Function: Crowding



Wilson & Naylor, 2017, MNRAS, 468, 2517

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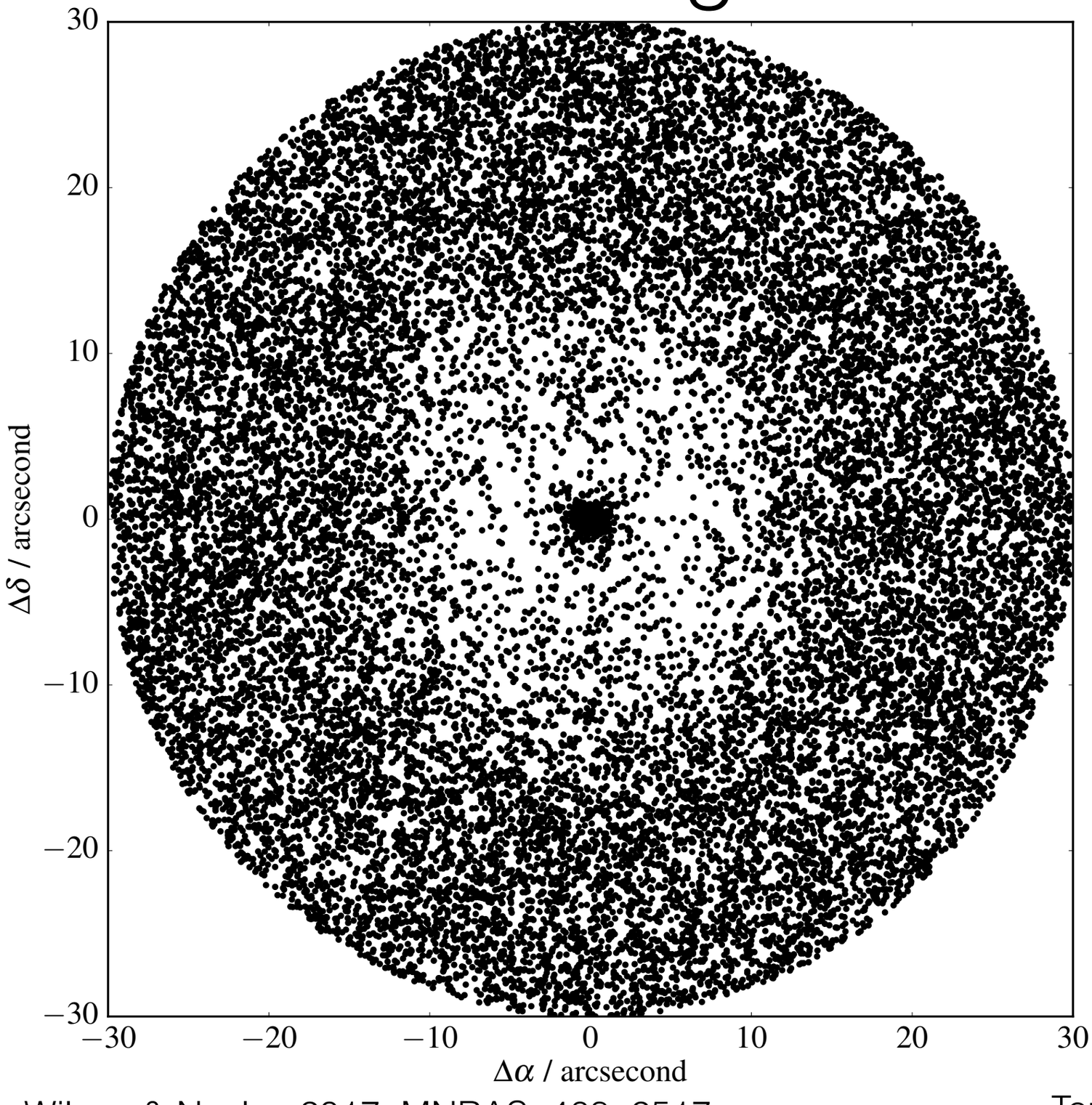
The Astrometric Uncertainty Function: Crowding



Wilson & Naylor, 2017, MNRAS, 468, 2517

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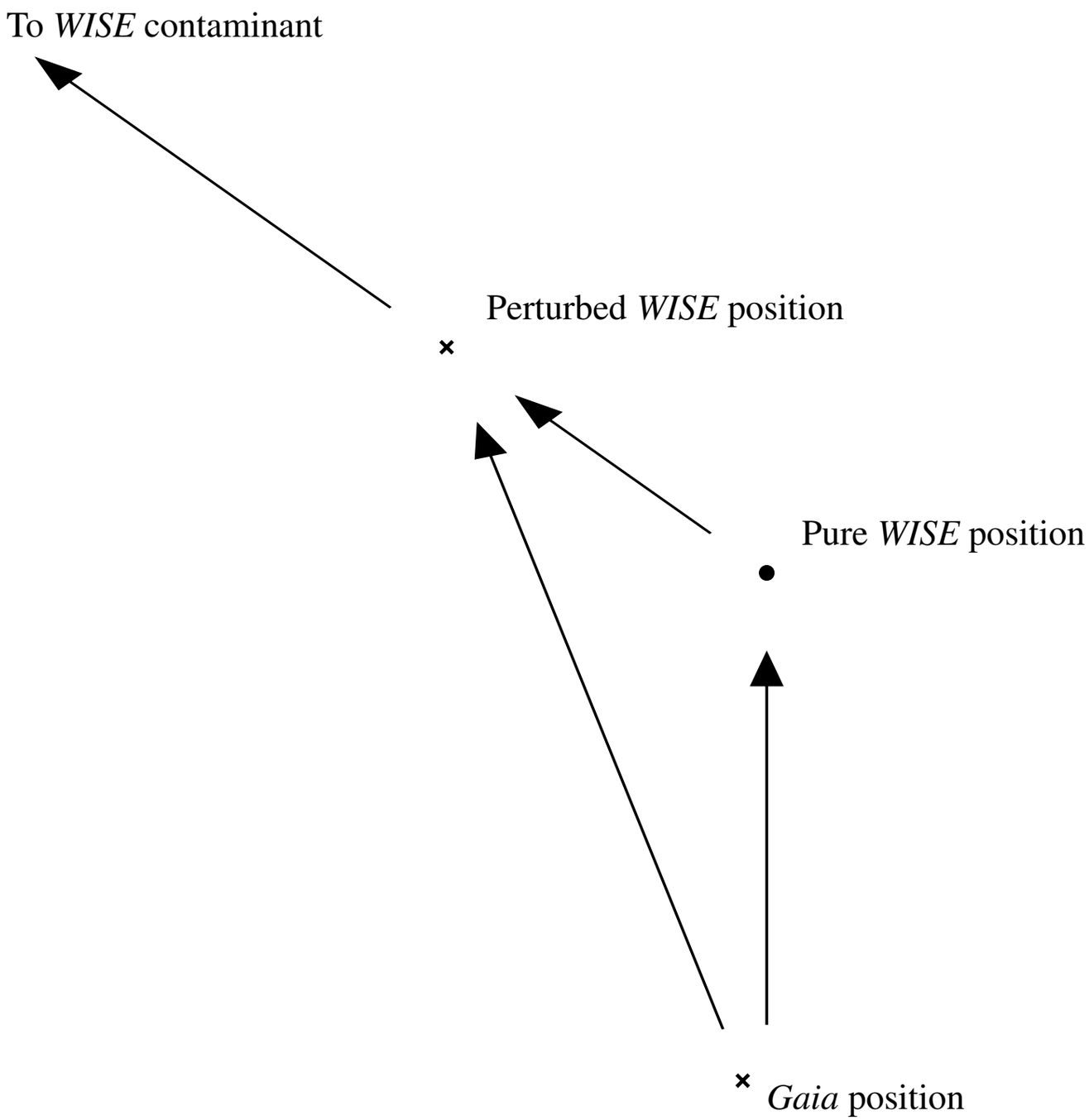
The Astrometric Uncertainty Function: Perturbation



Wilson & Naylor, 2017, MNRAS, 468, 2517

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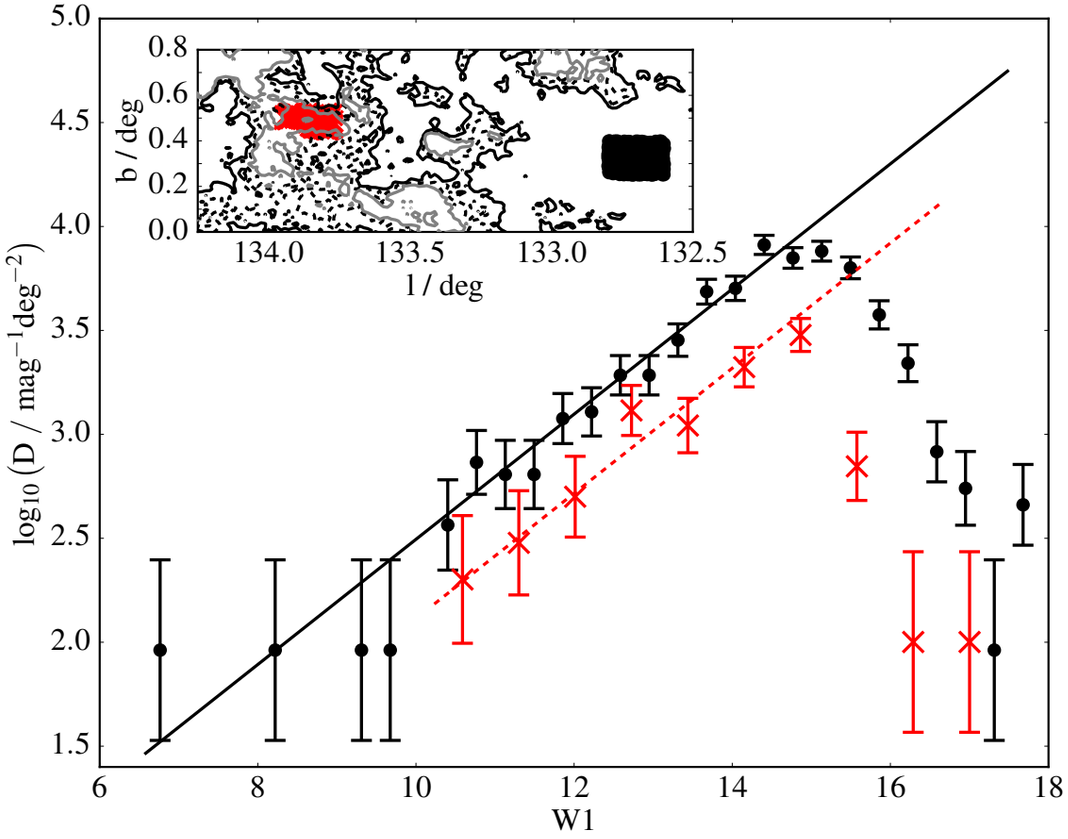
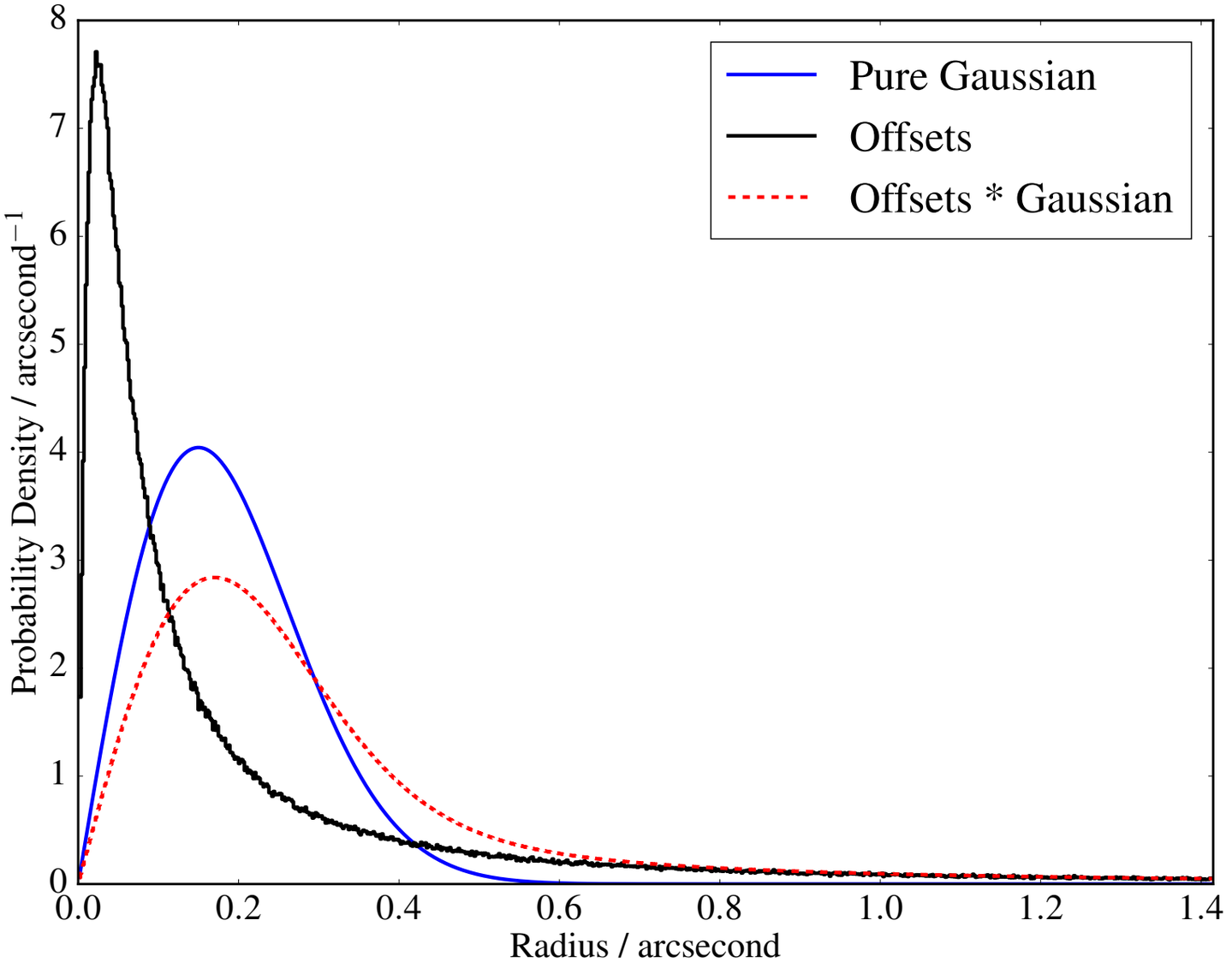
The Astrometric Uncertainty Function: Building Empirical AUFs





Wilson & Naylor, 2018, MNRAS, 481, 2148

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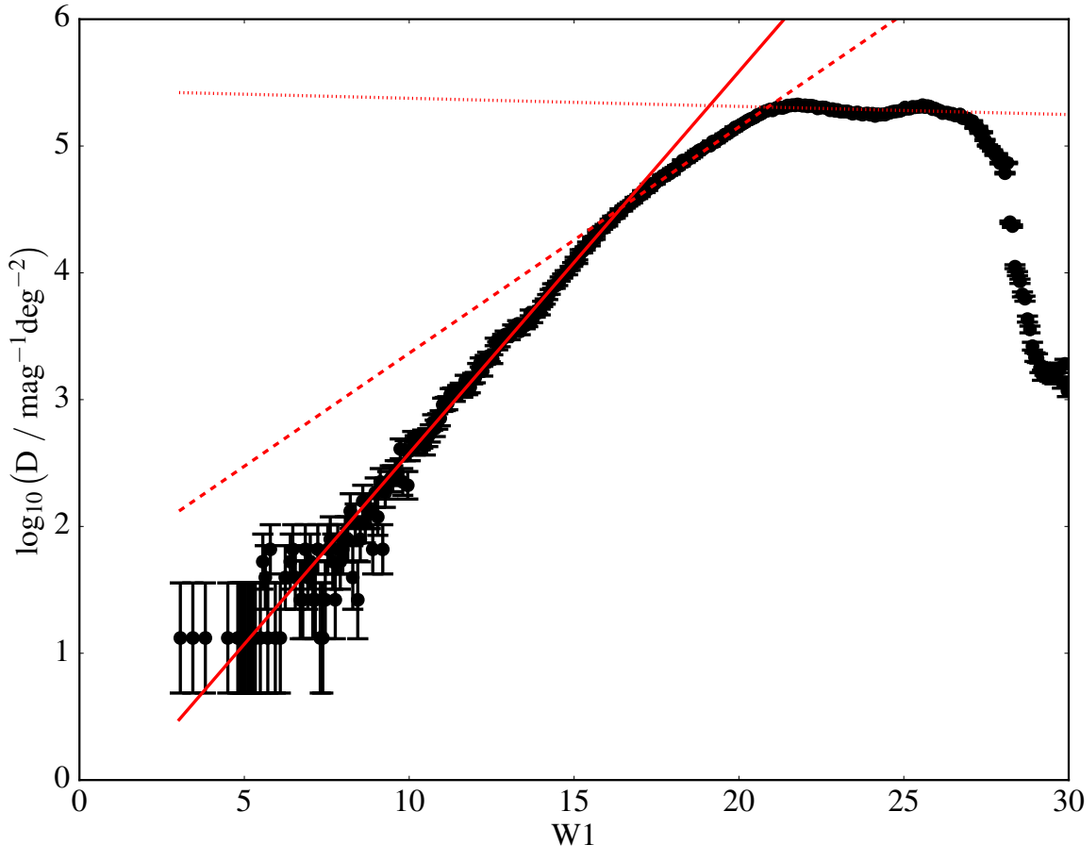
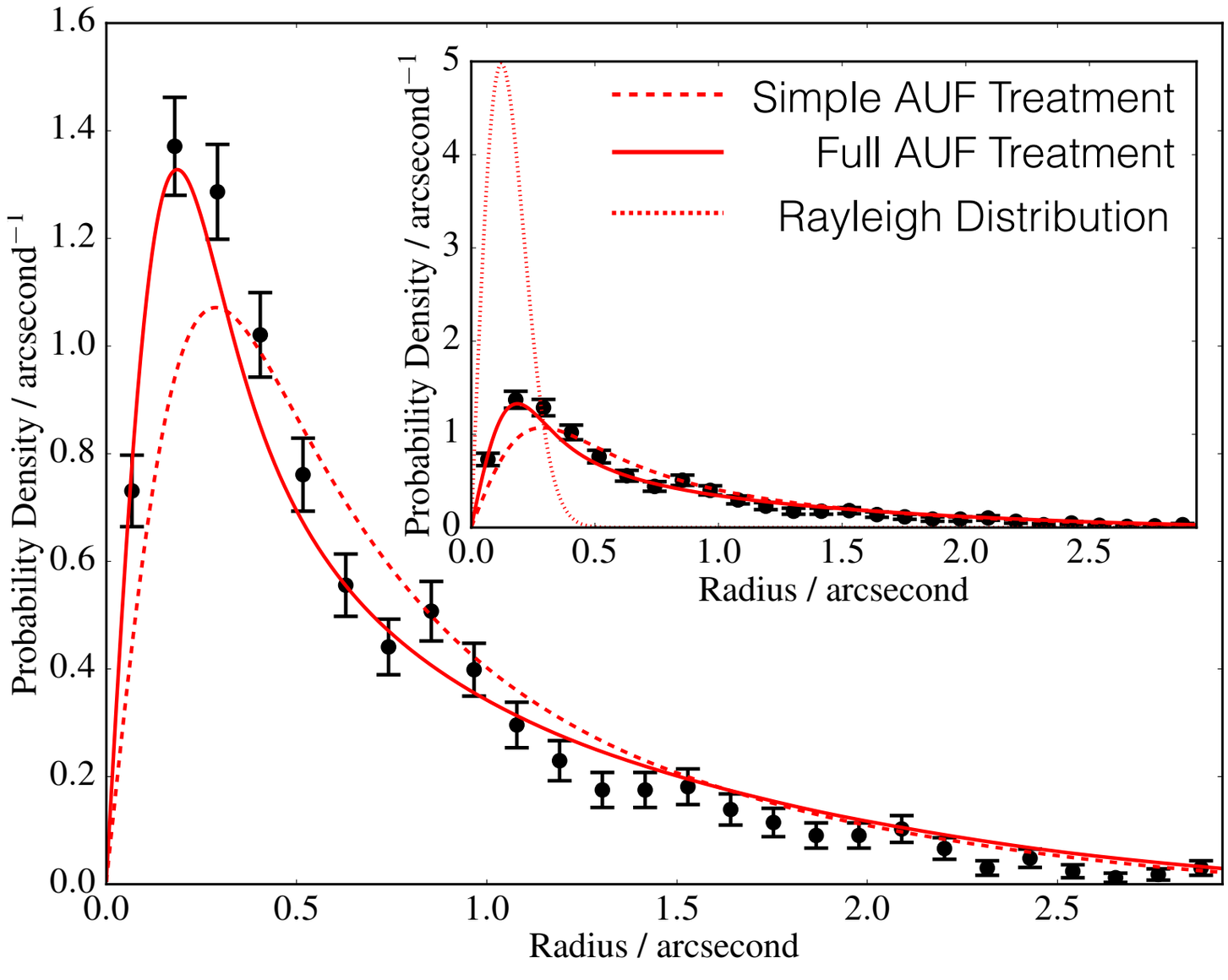
Contamination Effects: Effects Below Sensitivity Limit





Effect crucial for faint M dwarfs

TRILEGAL - Giradi et al, 2005, A&A, 436, 895
Wilson & Naylor, 2018, MNRAS, 481, 2148

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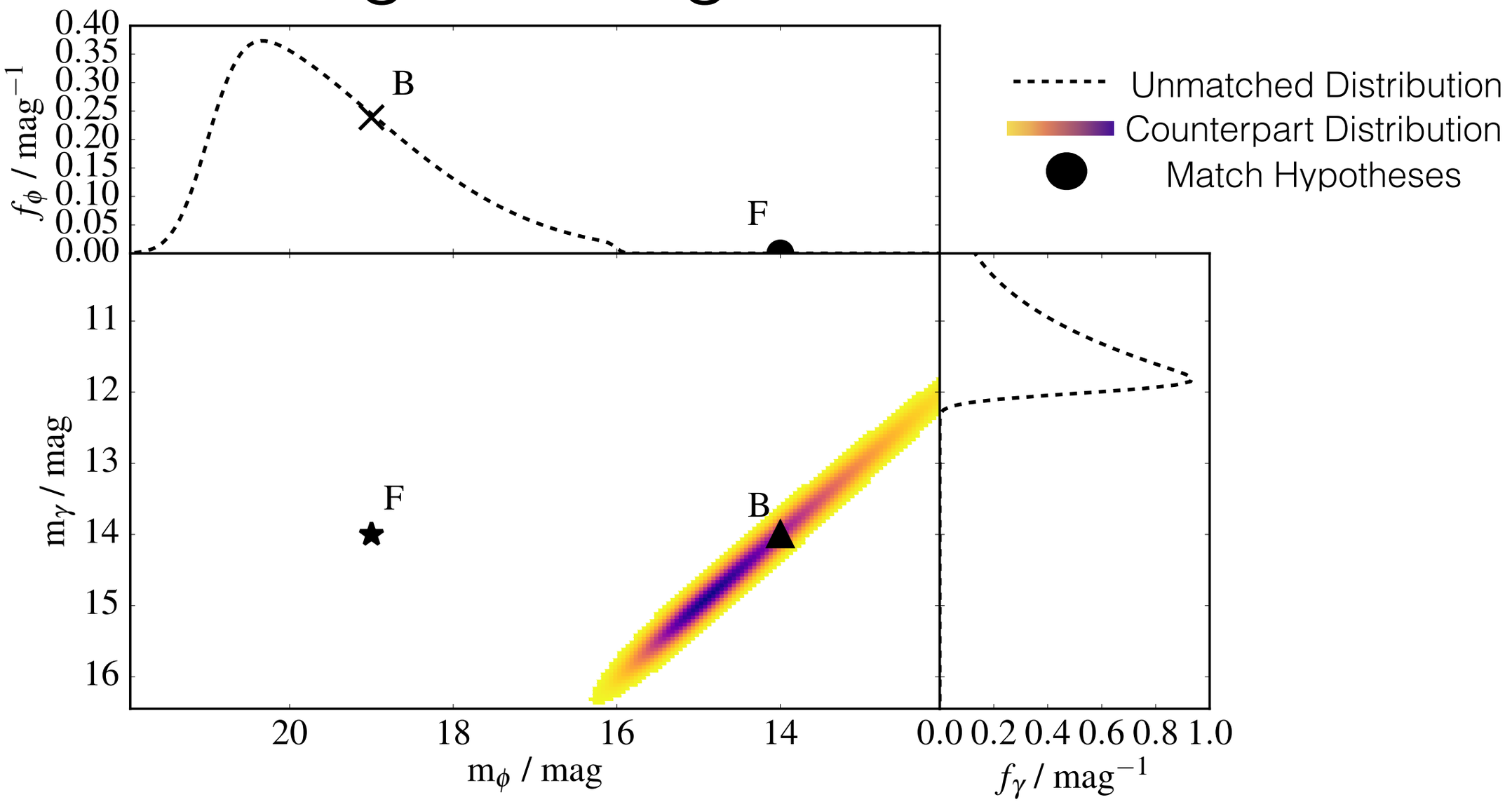
Probability-based Catalogue Matching: Including the Magnitude Information



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

$$= N_c \times (h_\gamma * h_\phi)(\Delta x_{kl}, \Delta y_{kl}).$$

Wilson & Naylor, 2018, MNRAS, 473, 5570

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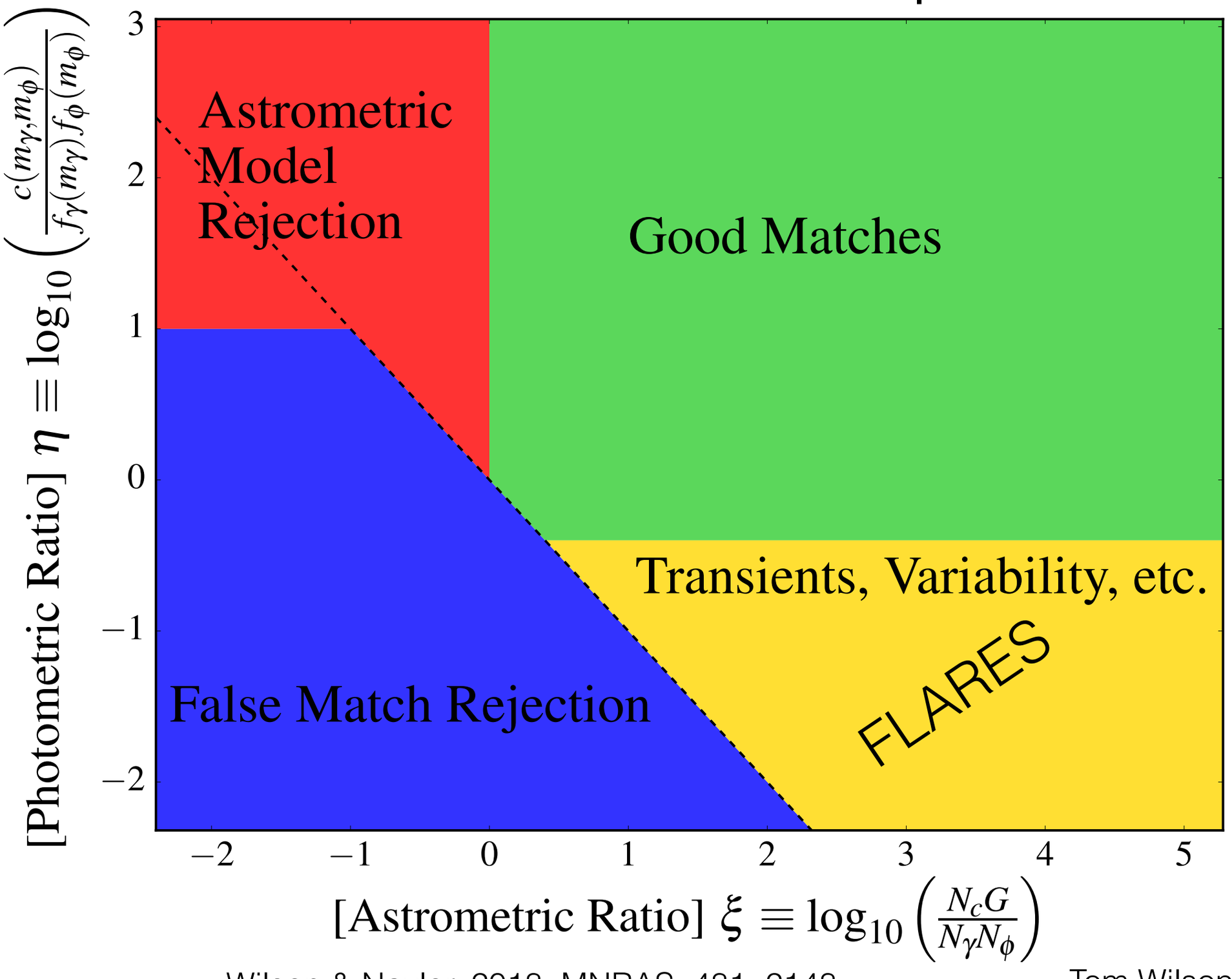
Probability-based Catalogue Matching: The Likelihood Ratio Space



Wilson & Naylor, 2018, MNRAS, 481, 2148

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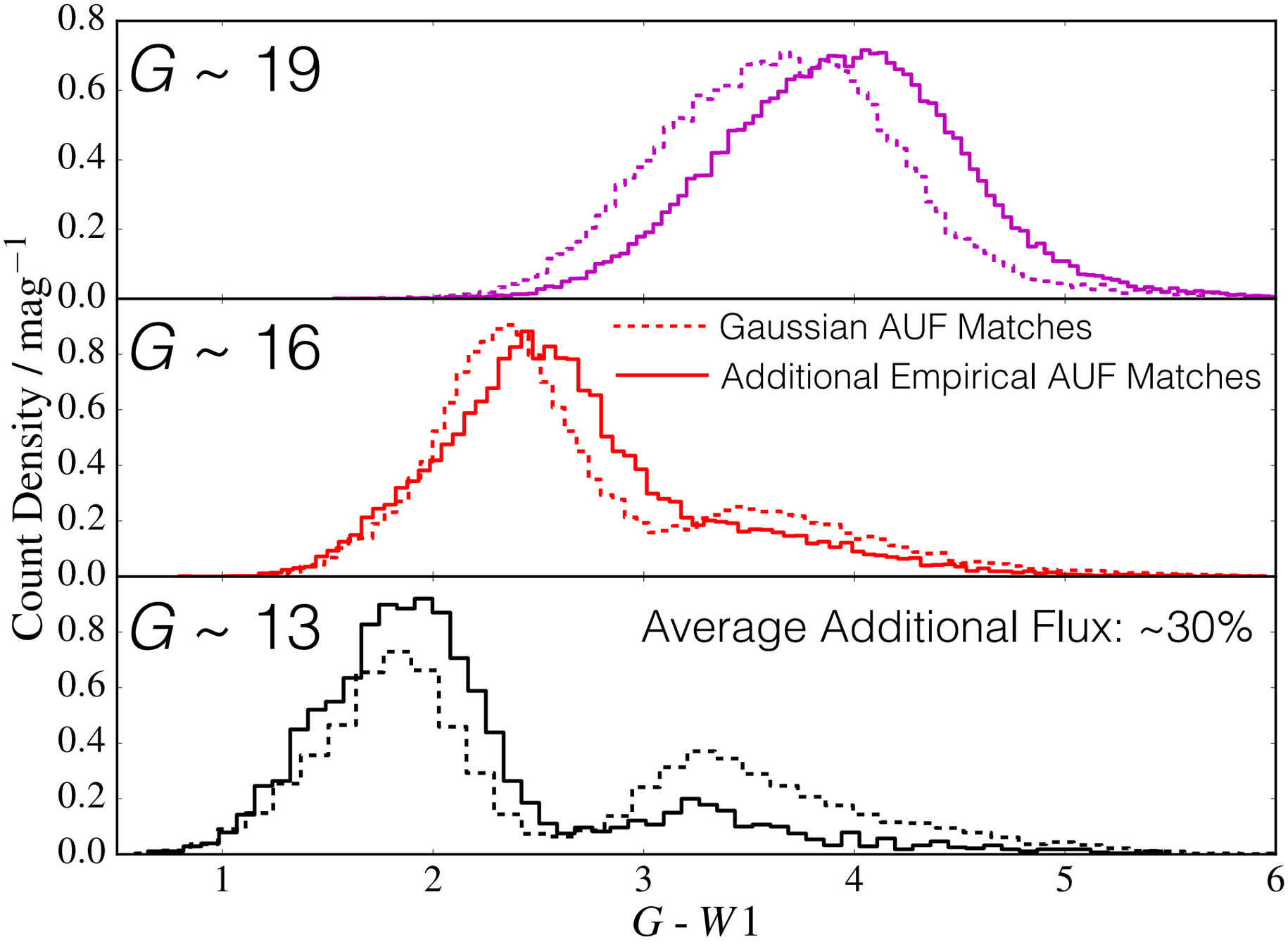
Contamination Effects: Perturbation-Colour Correlation



Wilson & Naylor, MNRAS, 2018, 481, 2148

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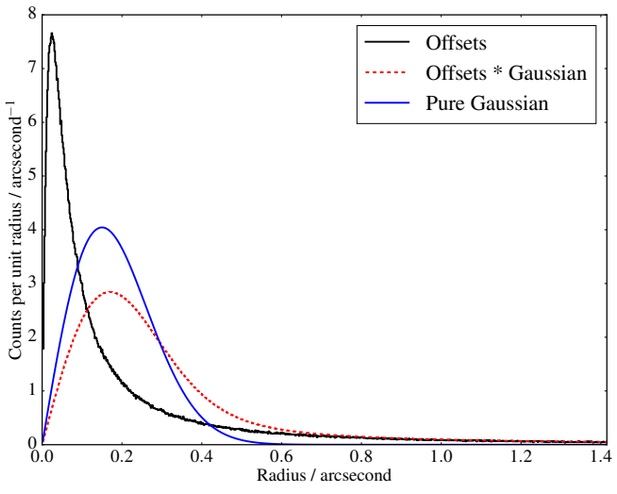
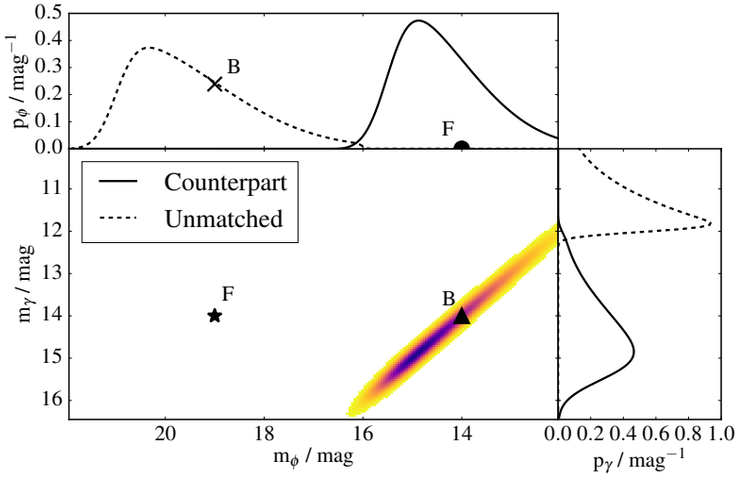
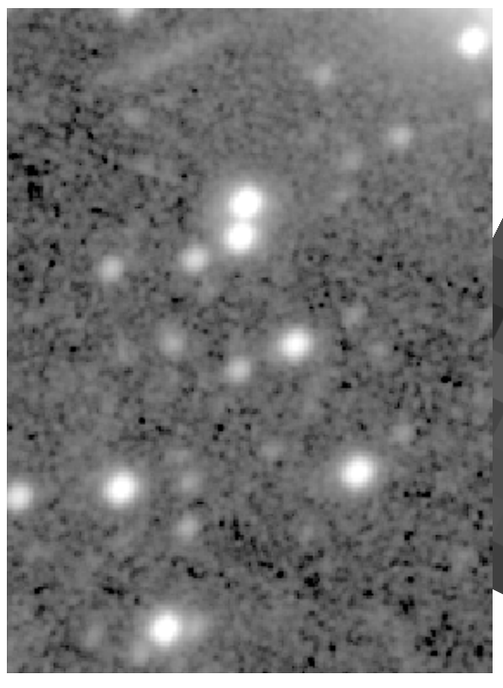
The Effects of Unresolved Contaminant Stars on the Cross-Matching of Photometric Catalogues: Conclusions

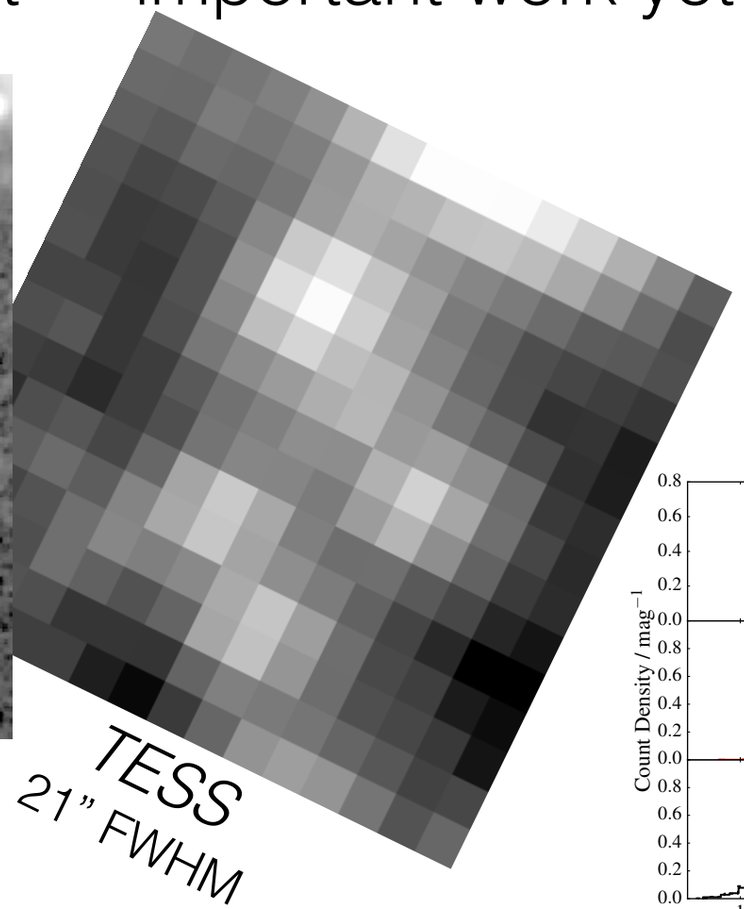
- Blended star contamination causes positional shifts
- *WISE* objects are up to 30% flux contaminated, with *TESS* suffering blending on a larger scale
- Disentangle this information with proper treatment in the cross-match to a higher angular resolution dataset — important work yet to be done!



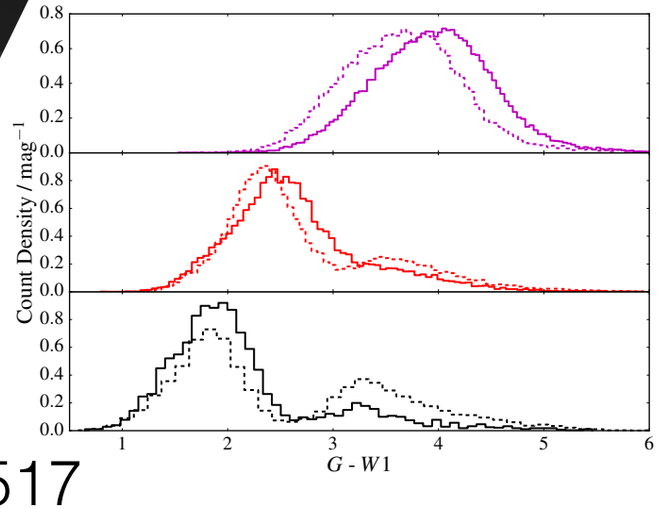




WISE
6” FWHM



TESS
21” FWHM



Wilson & Naylor, 2017, MNRAS, 468, 2517
Wilson & Naylor, 2018, MNRAS, 473, 5570
Wilson & Naylor, 2018, MNRAS, 481, 2148

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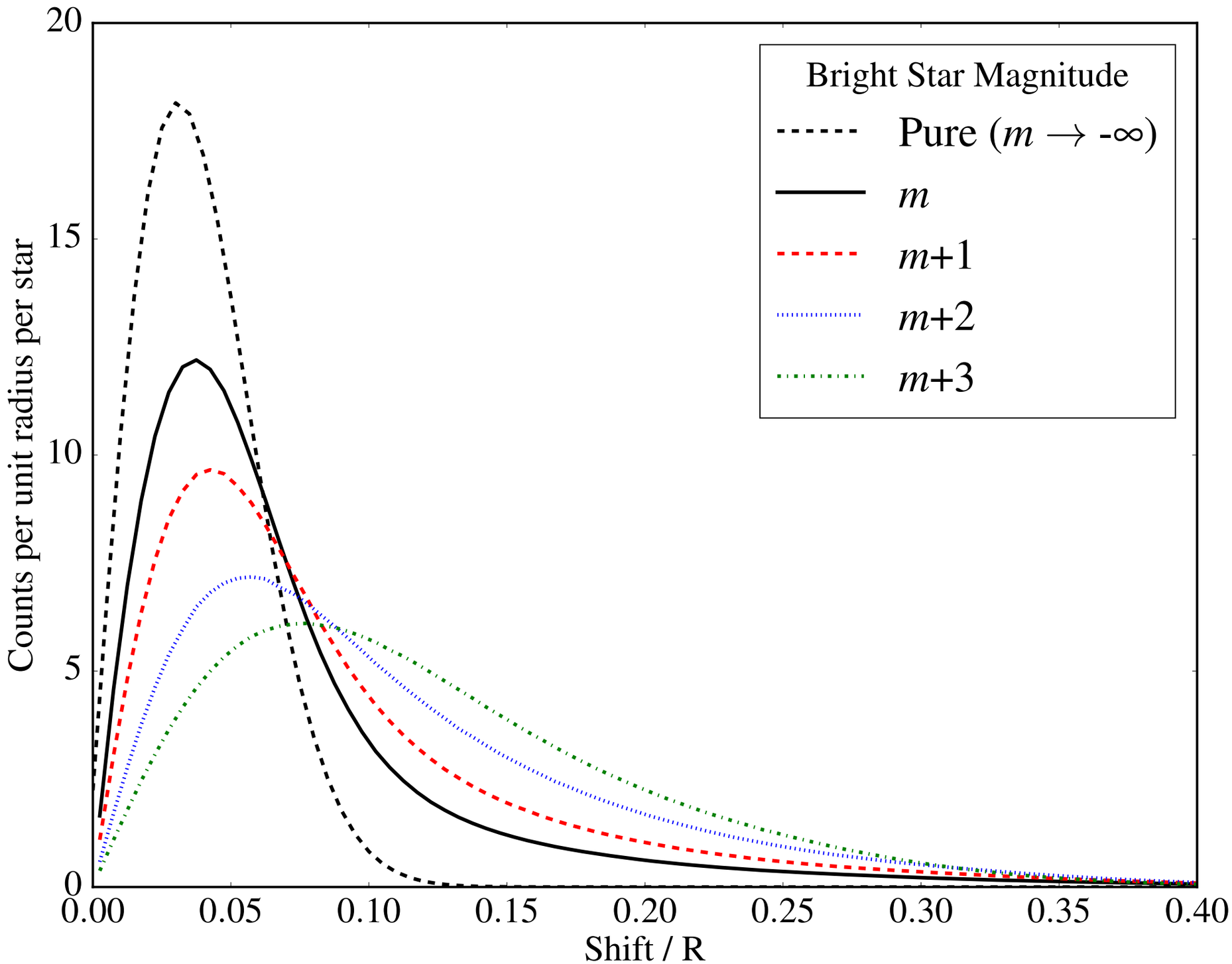
The Astrometric Uncertainty Function: Synthetic Non-Gaussian Tails



Wilson & Naylor, 2017, MNRAS, 468, 2517

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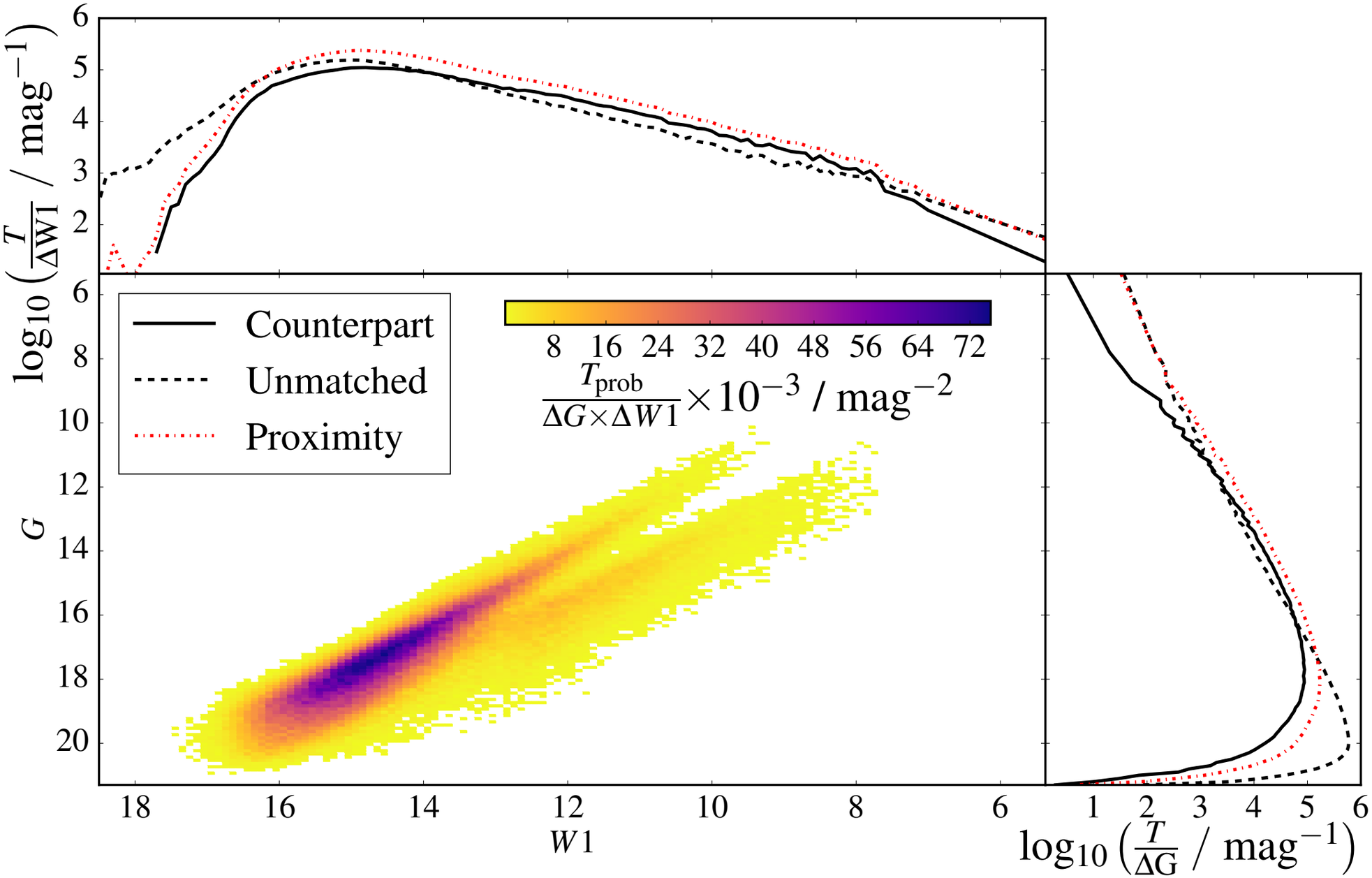
Contamination Effects: *Gaia-WISE* Gaussian Matches



Wilson & Naylor, MNRAS, 2018, 481, 2148

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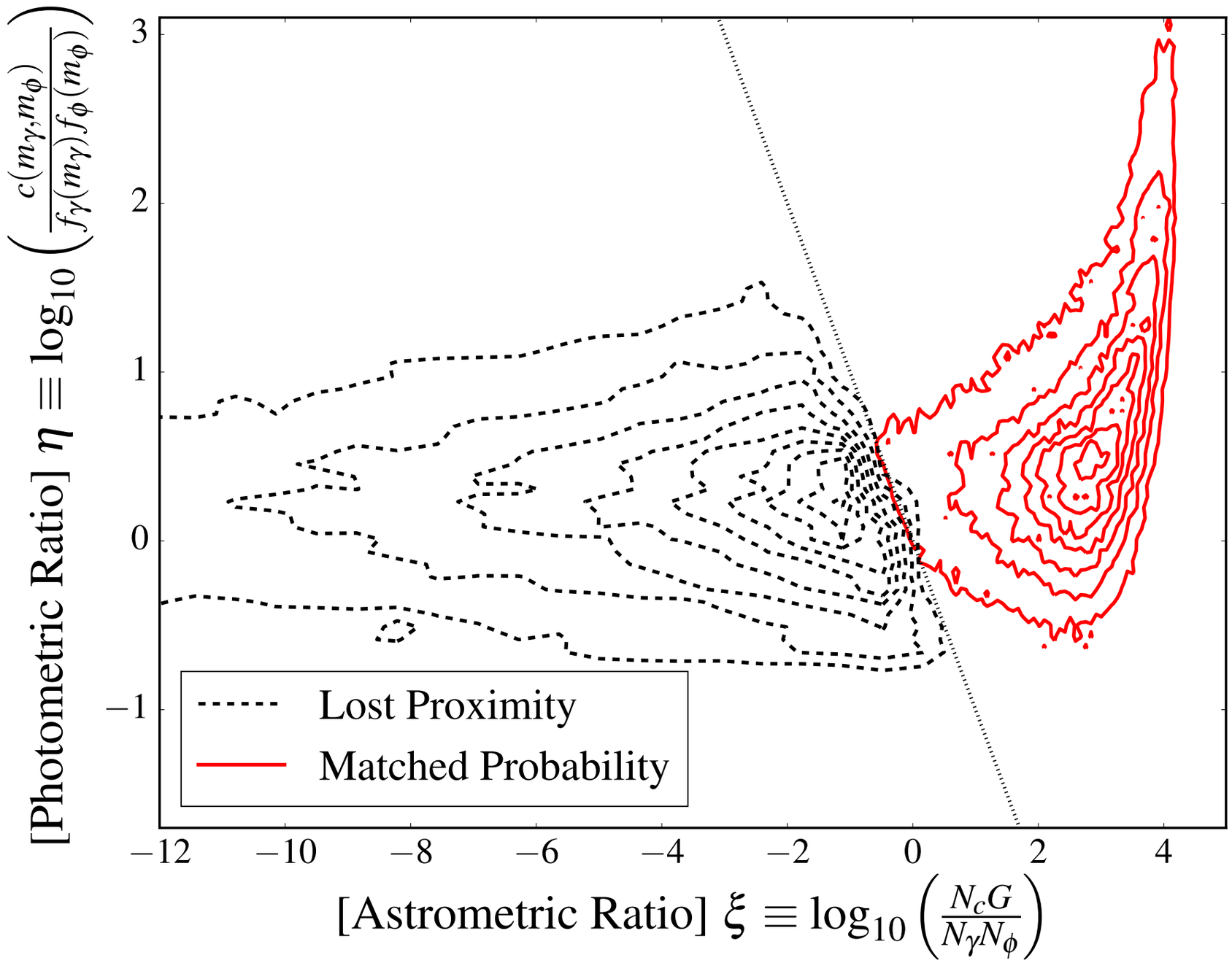
Contamination Effects: Lost Proximity Matches



Wilson & Naylor, MNRAS, 2018, 481, 2148

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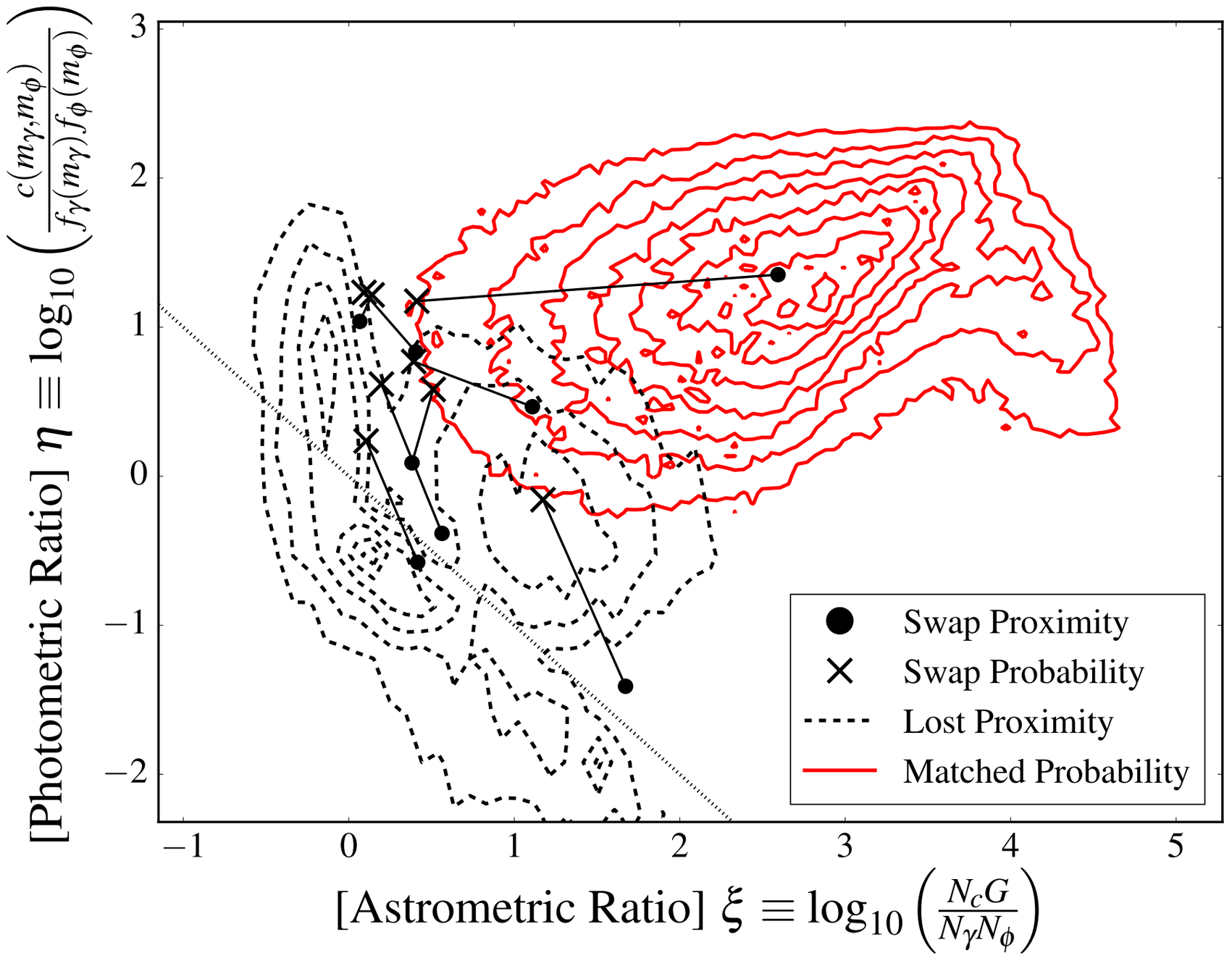
Contamination Effects: Lost Proximity Matches



Wilson & Naylor, MNRAS, 2018, 481, 2148

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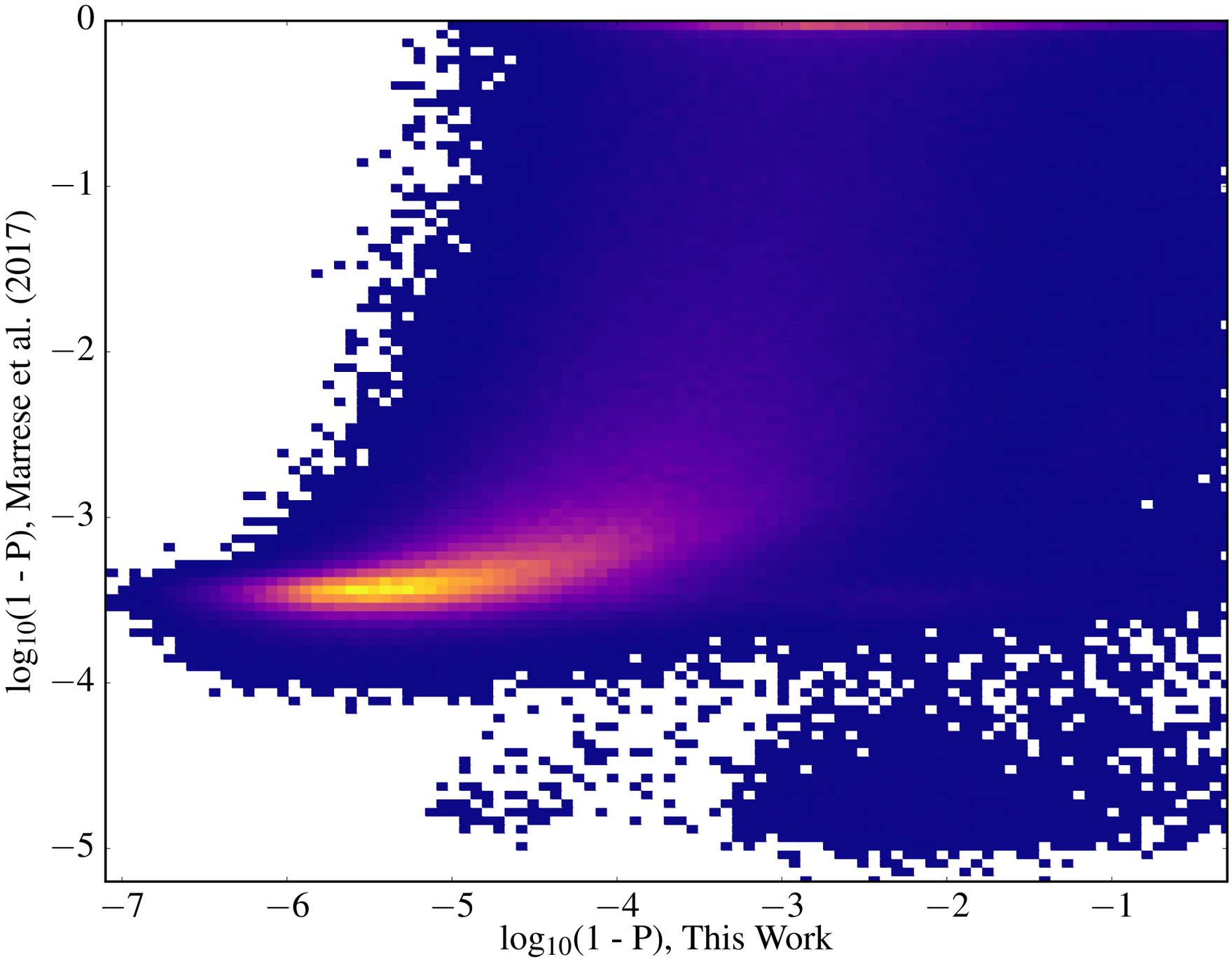
Contamination Effects: *Gaia* Lost Matches



Wilson & Naylor, MNRAS, 2018, 481, 2148

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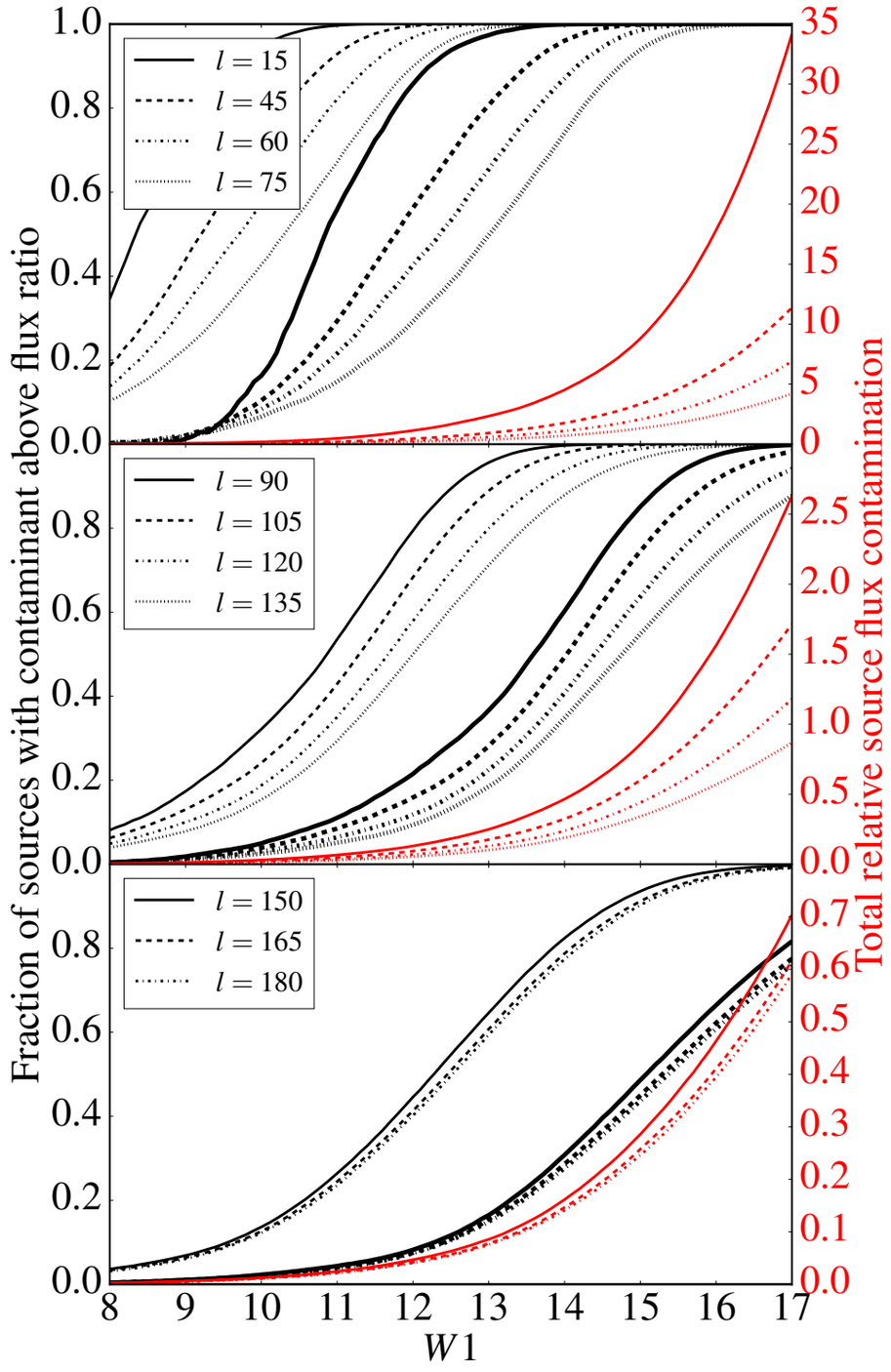
Contamination Effects: Contamination Rates & Amounts



Wilson & Naylor, MNRAS, 2018, 481, 2148

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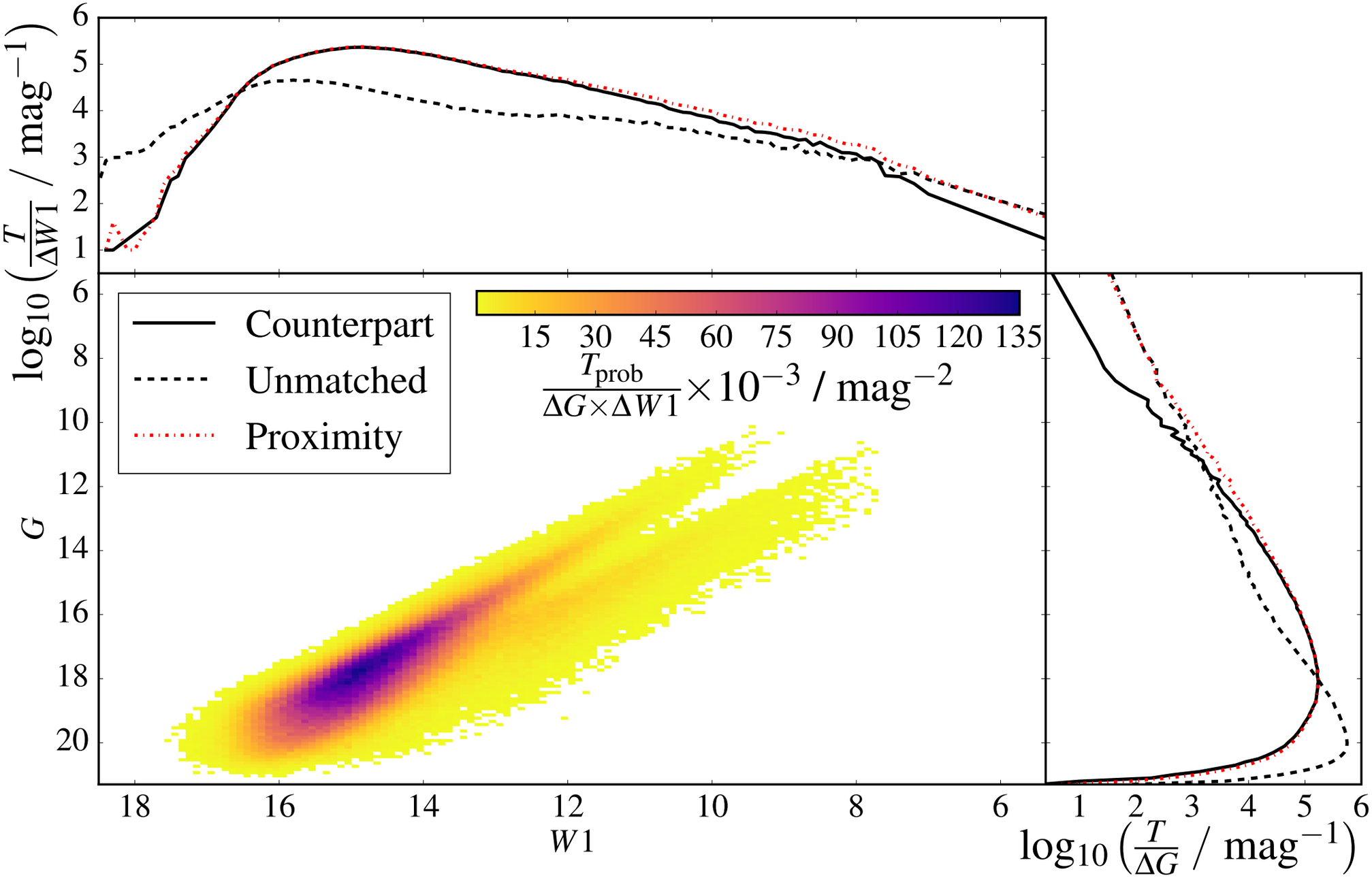
Contamination Effects: *Gaia-WISE* Empirical Matches



Wilson & Naylor, MNRAS, 2018, 481, 2148

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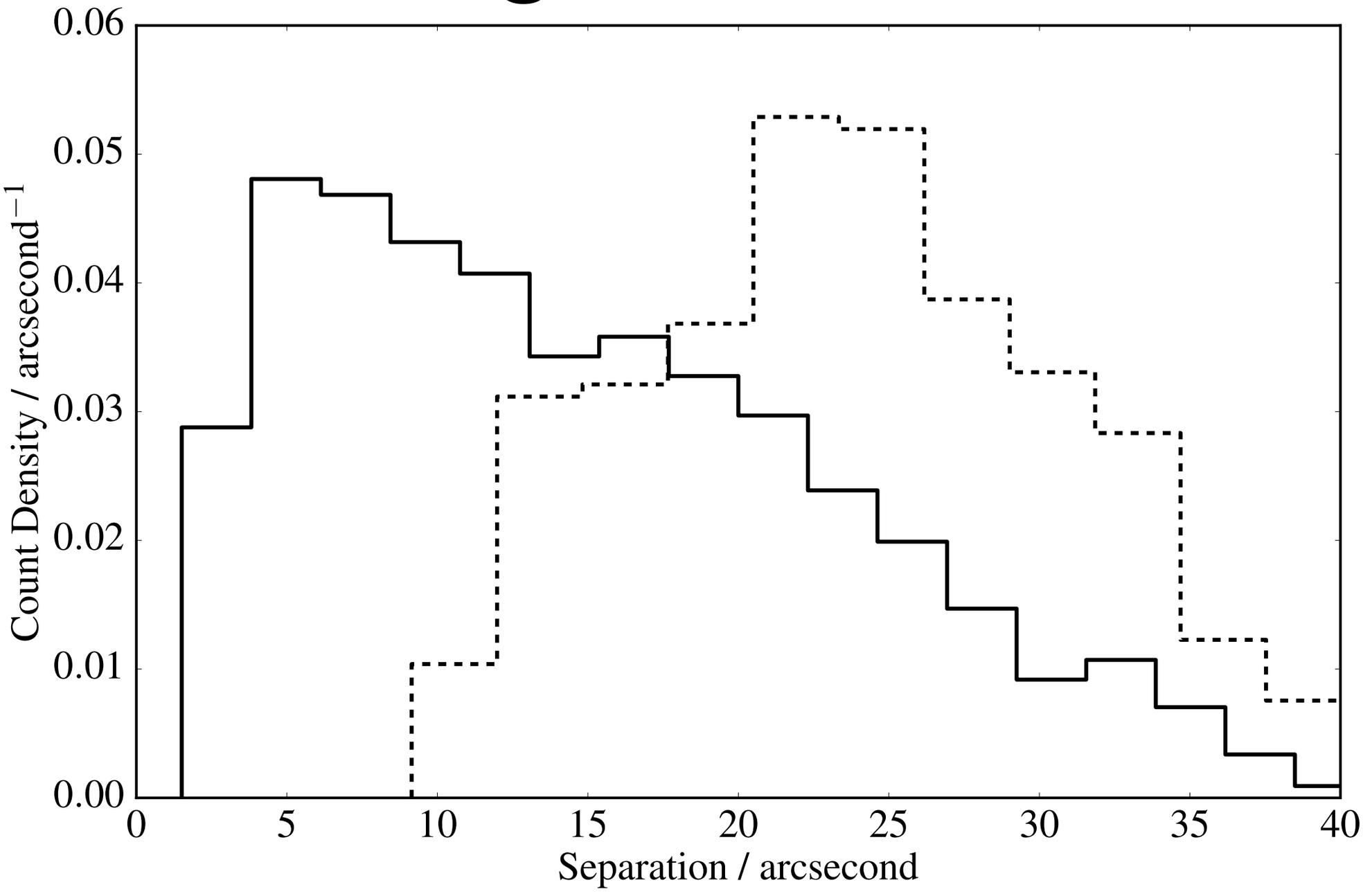
Contamination Effects: Resolving Contaminants



Spitzer - Werner et al., 2004 ,ApJS, 154, 1
IRAC - Fazio et al., 2004, ApJS, 154, 10
Wilson & Naylor, MNRAS, 2018, 481, 2148

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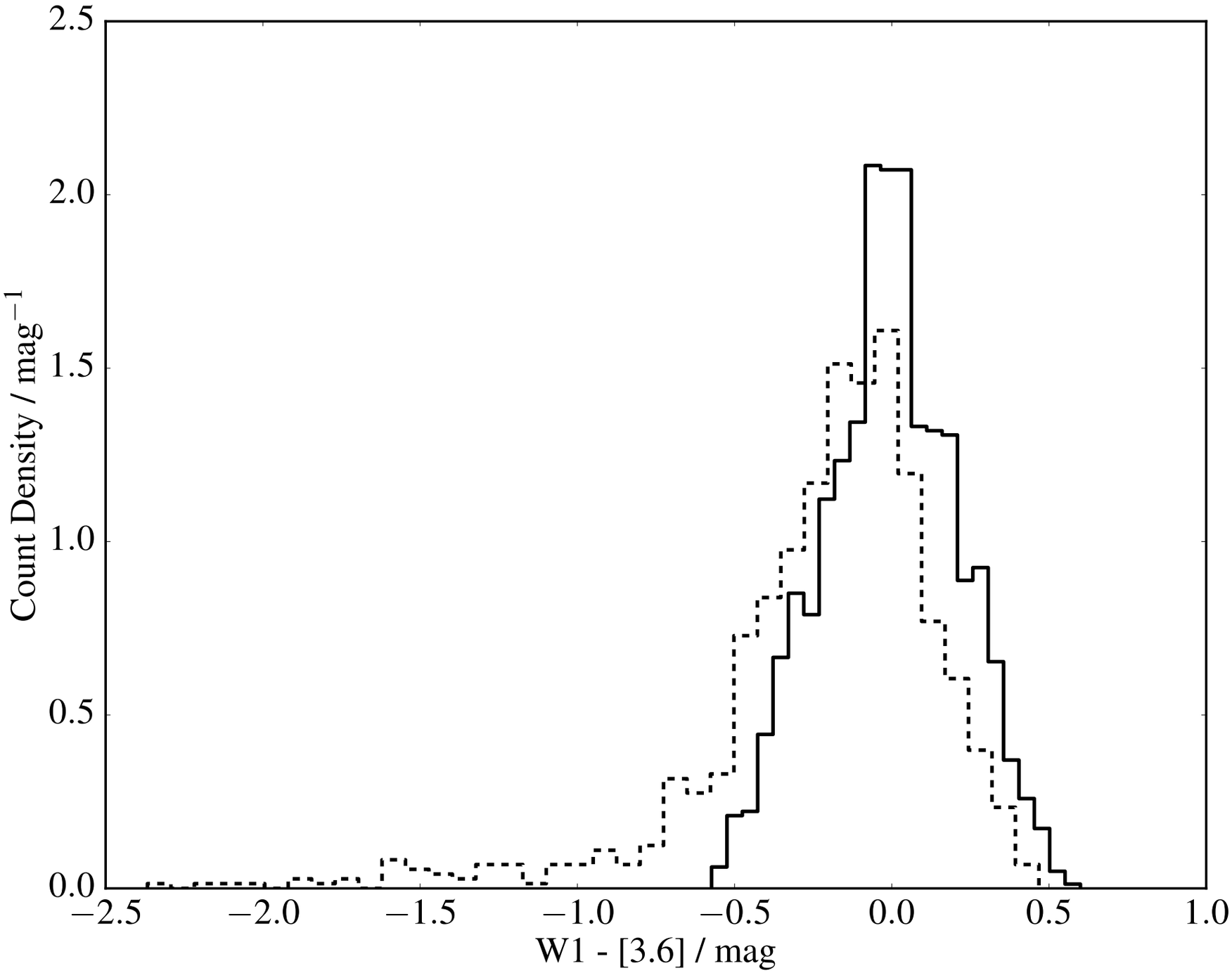
Contamination Effects: Resolving Contaminant Flux



Wilson & Naylor, MNRAS, 2018, 481, 2148

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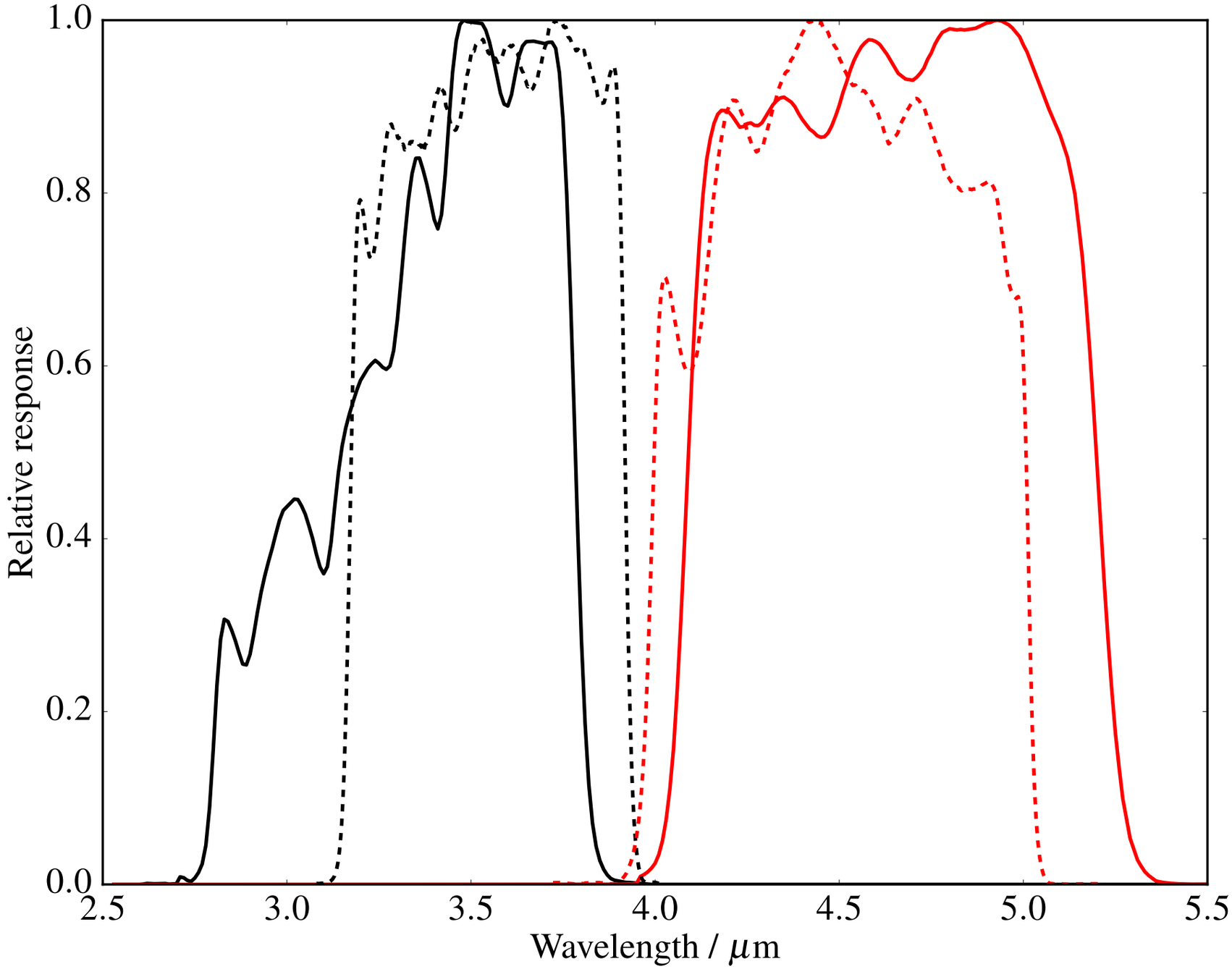
Contamination Effects: Wavelength Coverage



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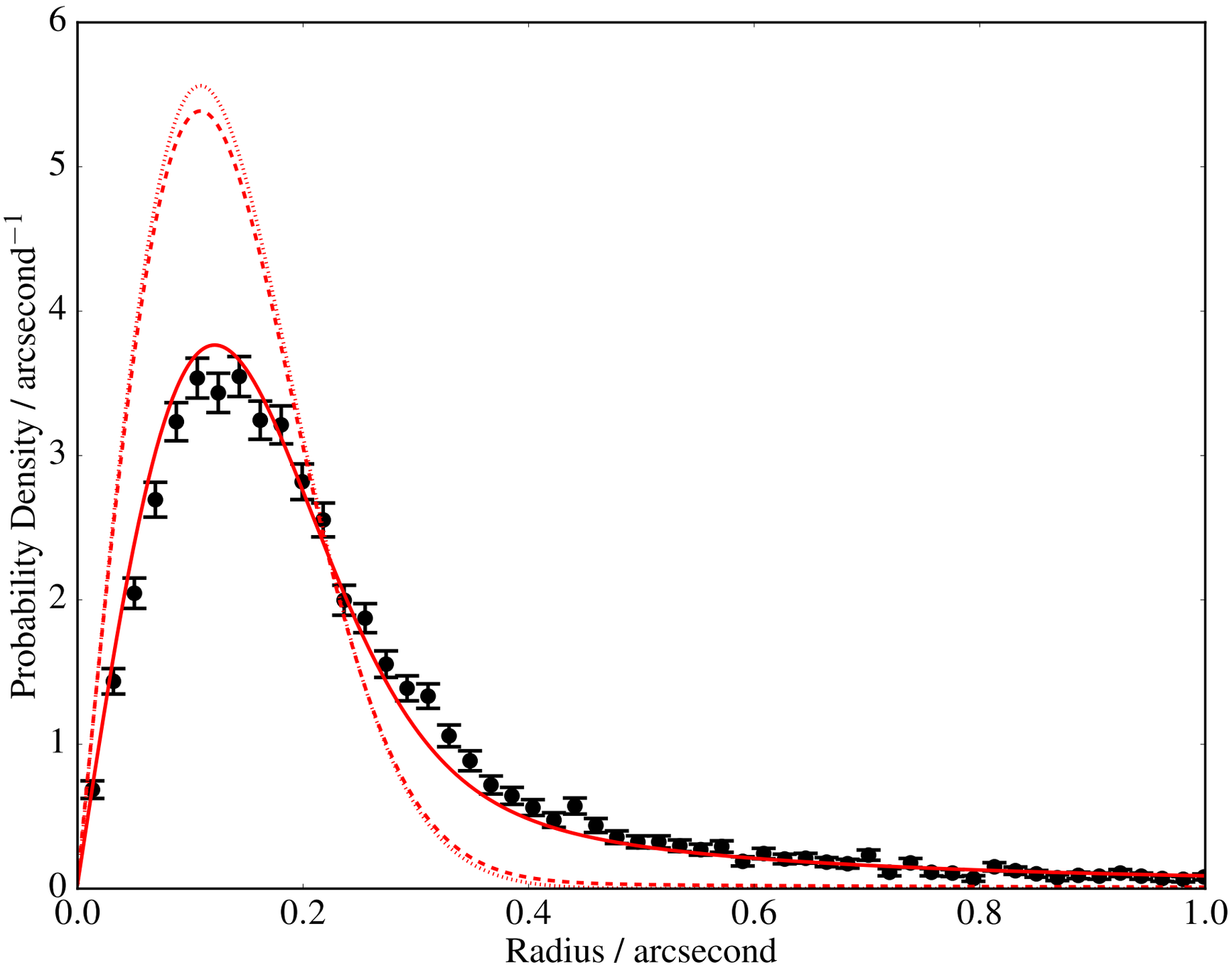
Contamination Effects: Galaxy Contamination



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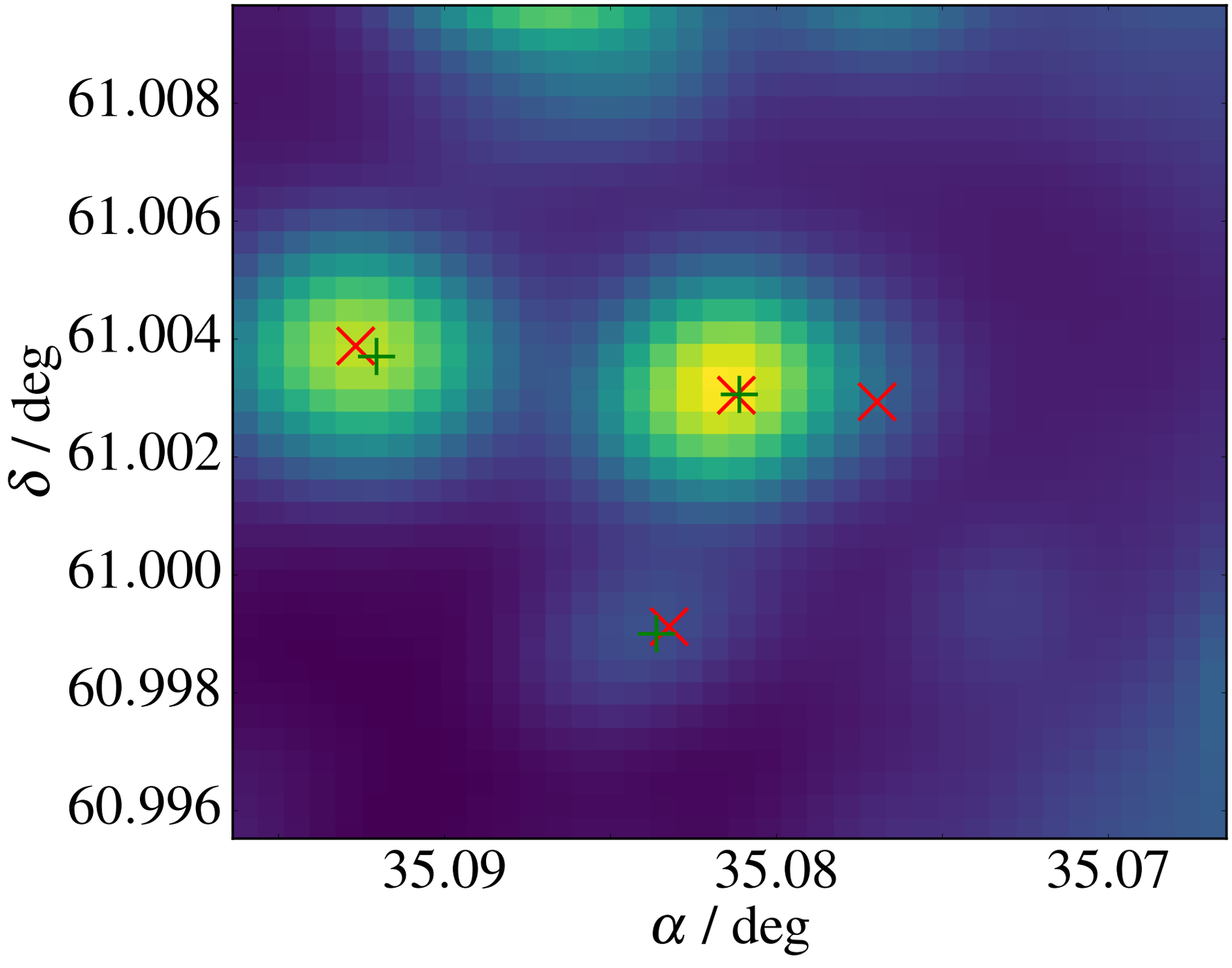
Contamination Effects: *Gaia-Wise* Resolved Blend



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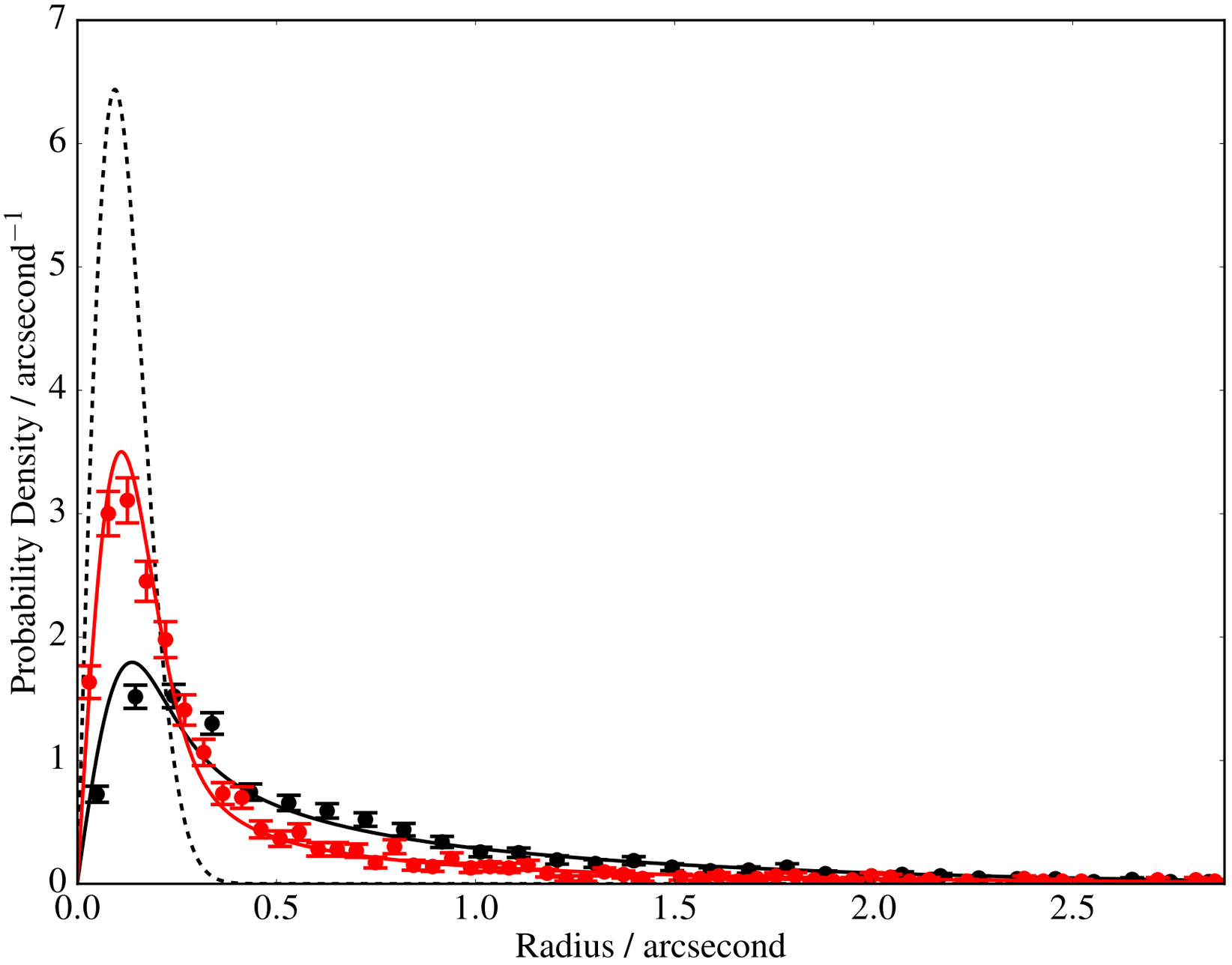
Contamination Effects: Crowding Normalisation



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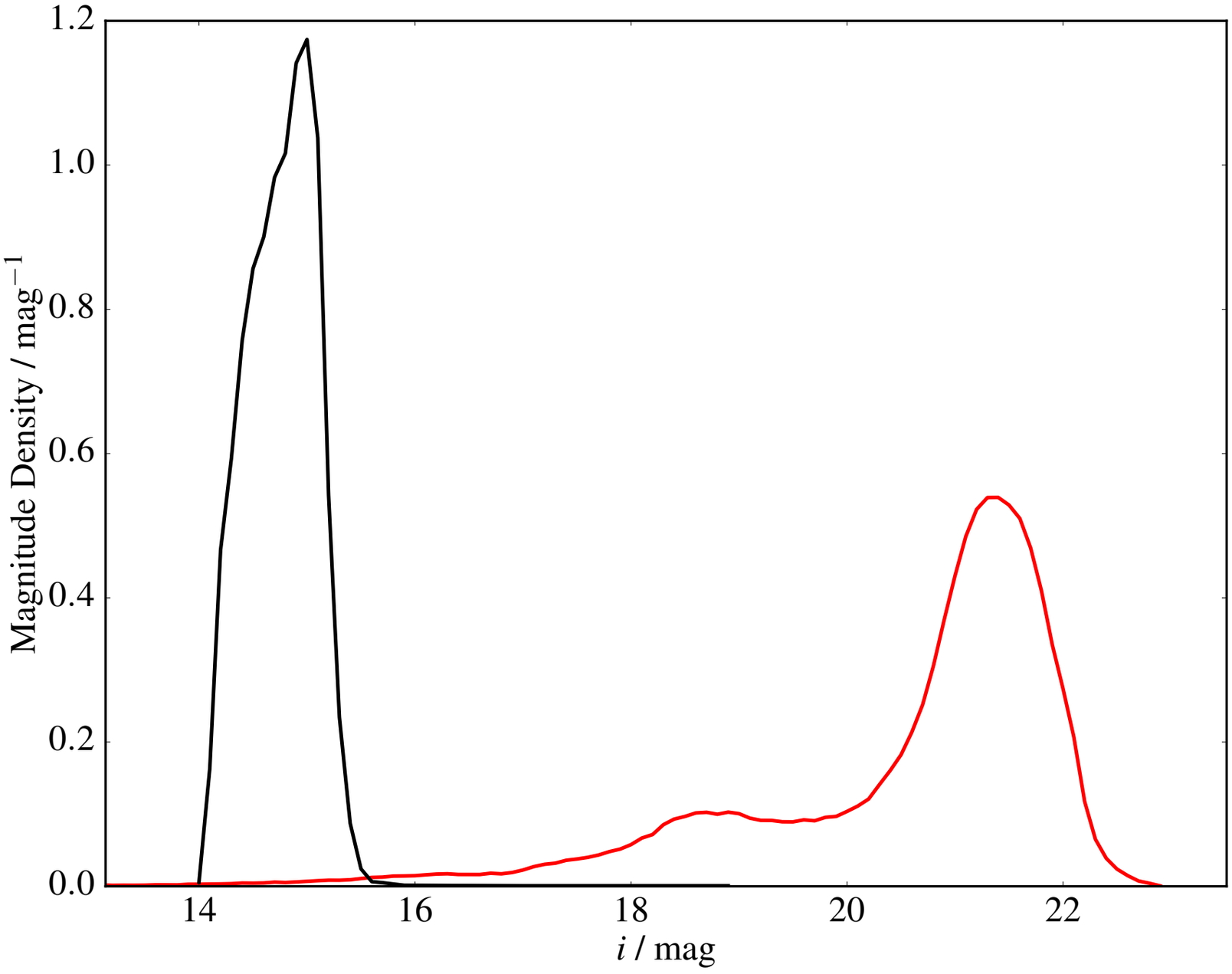
Probability-Based Catalogue Matching: Colour-based False Match Rejection



Wilson & Naylor, 2018, MNRAS, 473, 5570

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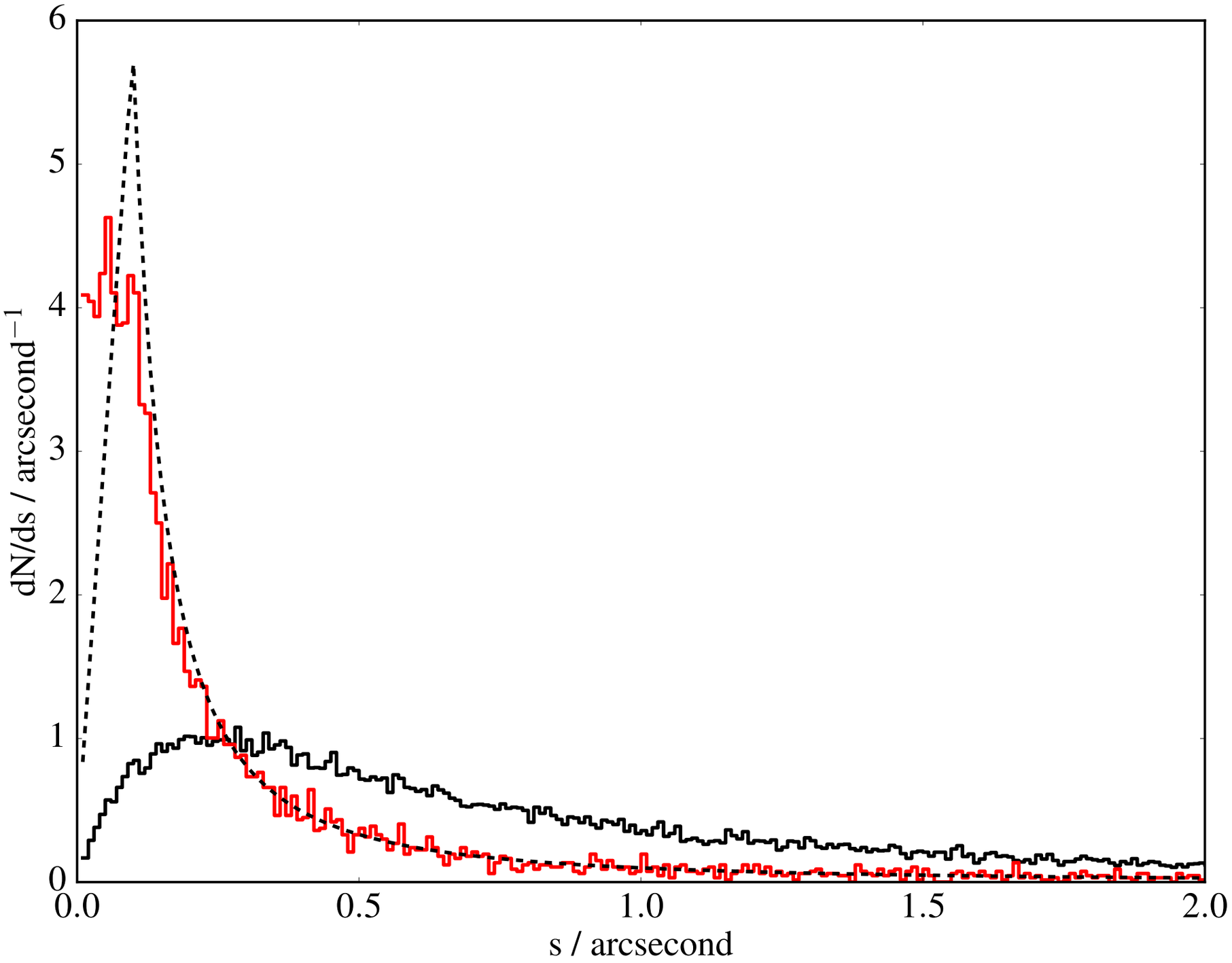
The Astrometric Uncertainty Function: Analytical perturbations



Wilson & Naylor, 2017, MNRAS, 468, 2517

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