



NEW LENSES FROM SPACE WARPS-CFHTLS

ANUPREETA MORE

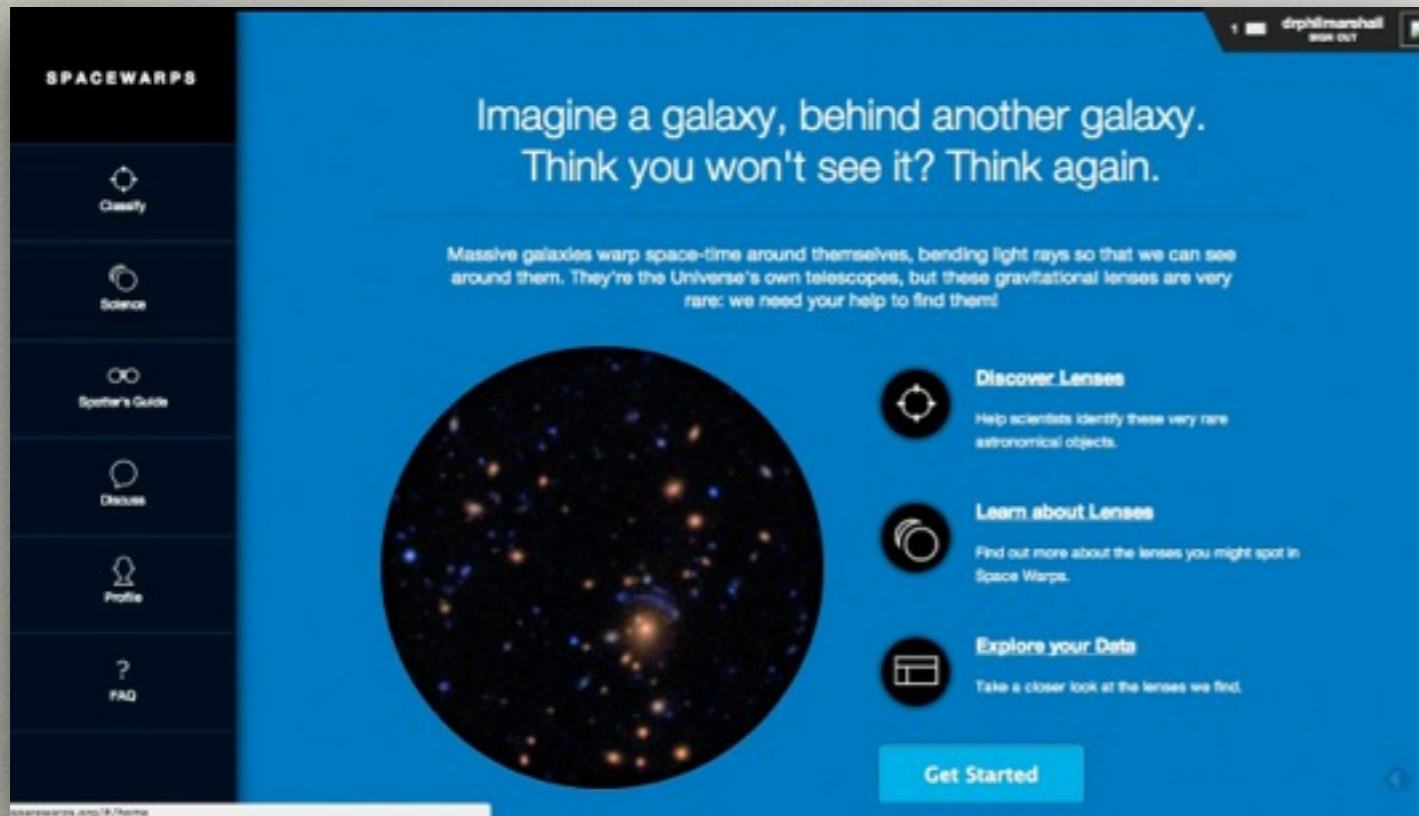
KAVLI IPMU, U. OF TOKYO

NOVEMBER 21, 2014



SPACE WARPS

- TEAM



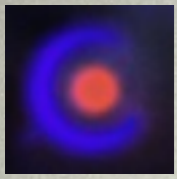
PIs:

Phil Marshall (US),
Aprajita Verma (UK),
AM (Japan)

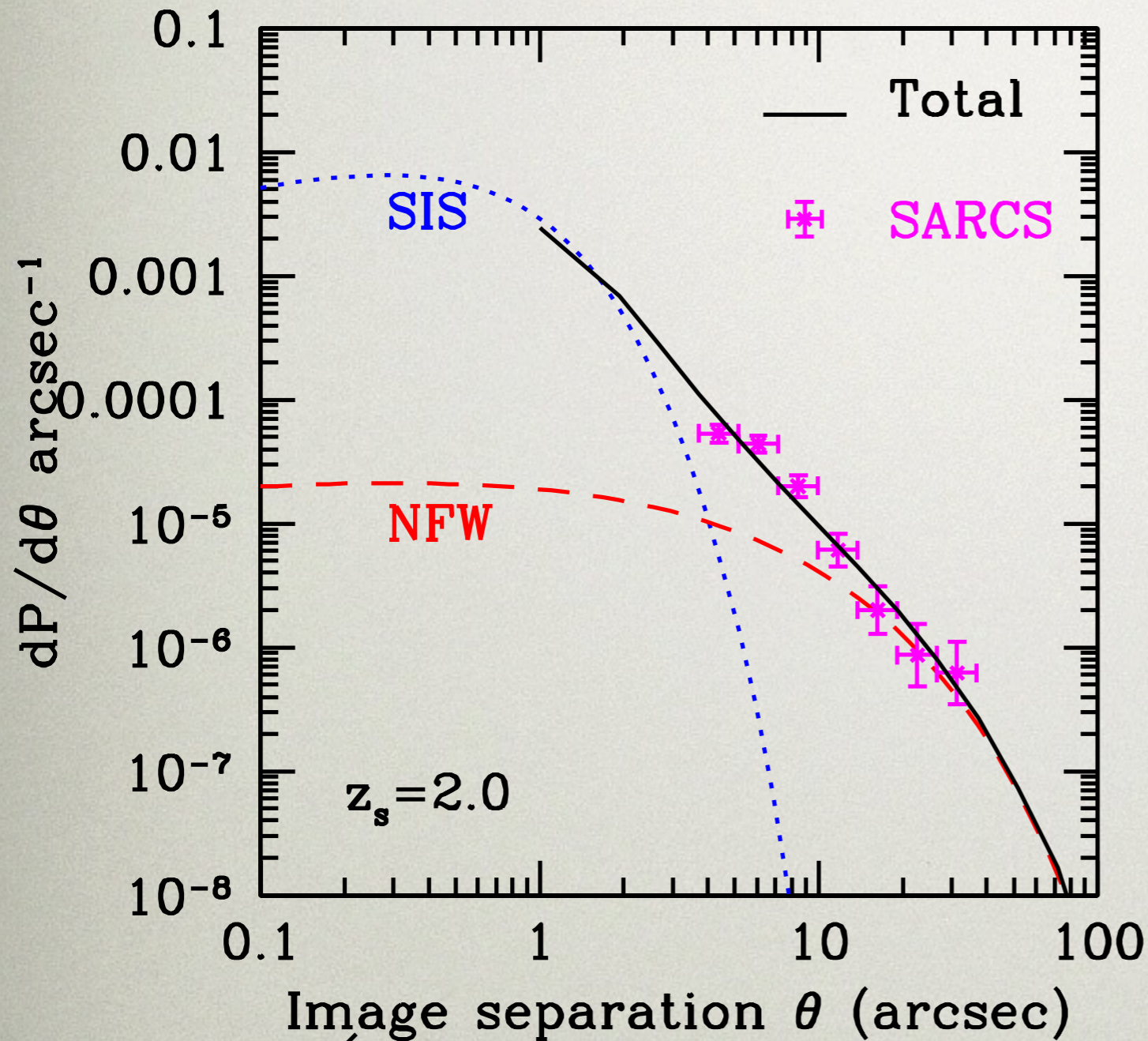
Science Team: Chris Davis, Mike Baumer (US), *Surhud More (Japan)*, Prasenjit Saha, Rafael Kueng, Tom Collett, Matthias Tecza (Europe)

Tech Team (Zooniverse): A. Kapadia, M. Parrish, C. Snyder, R. Simpson, D. Miller, A. Smith, E. Paget, K. Borden, C. Lintott (US and UK)

Citizen Scientists: J. Wilcox, E. Baeten, C. Macmillan, C. Cornen, L. Wright, T. Jennings and 50,000+ volunteers (World)



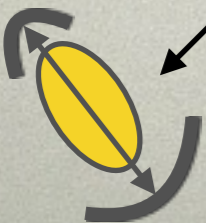
SEARCH IN THE CFHTLS: MOTIVATION



- Understand the selection function of the new lens sample
- Account for incompleteness in the ISD
- Improve constraints on lens properties e.g. mass density profile and concentration-mass relation

Predictions from Oguri 2006

More et al. 2012





SPACE WARPS

<http://spacewarps.org/>

CFHTLS

- **Blind lens search in CFHTLS (170 sq. deg) - First project with SW**
 - assess the completeness and improve the arcfinding algorithm (SARCS sample, More et al. 2012)
 - find quasar lenses, red arcs, exotic lenses ?
- **Stage 1:**
 - Fast inspection; 10^5 images \rightarrow 10^3 images
- **Stage 2:**
 - Careful inspection; 10^3 images \rightarrow 10^2 images/candidates



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TRAINING

<https://github.com/anupreeta27/SIMCT>

Types of training images:

1a. Duds (Images containing no lenses - visually confirmed) : # 450

1b. False positives: # 500

2. Simulated lenses: # 4500

- Galaxy-galaxy
- Galaxy-quasar
- Group-galaxy



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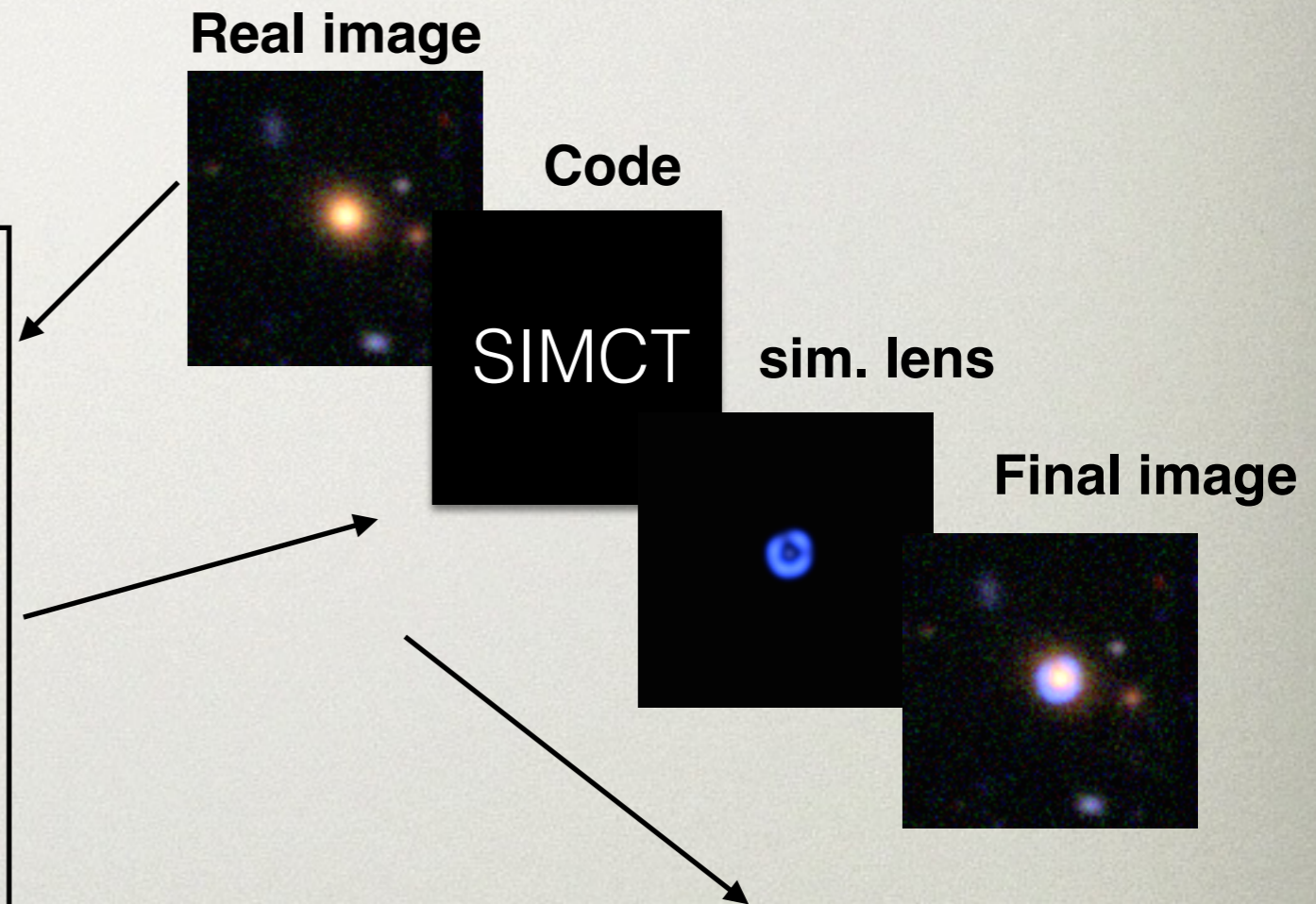
SIMULATIONS

<https://github.com/anupreeta27/SIMCT>

Galaxy-galaxy lens

Use:

- Lens (**foreground**) properties:
 - magnitudes, redshift and ellipticities
- Source (**background**) properties:
 - colors and redshift
- Keep lensed images satisfying certain detection thresholds



More, et al., (in prep)



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SIMULATIONS

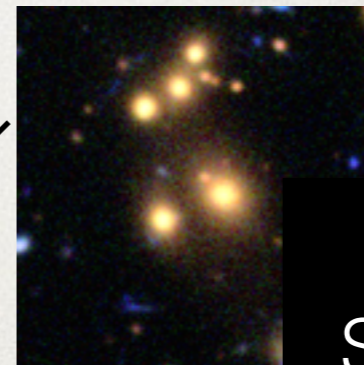
<https://github.com/anupreeta27/SIMCT>

Group-galaxy lens

Use:

- Lens (**foreground**) properties:
 - group members, magnitudes, redshift and ellipticities
- Source (**background**) properties:
 - colors and redshift
- Keep lensed images satisfying certain detection thresholds

Real image



Code

SIMCT

sim. lens

Final image



More, et al., (in prep)



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<https://github.com/anupreeta27/SIMCT>

SIMULATIONS



Galaxy-Quasar lenses



Galaxy-Galaxy lenses



Group-Galaxy lenses

- First citizen science project in Zooniverse that
 - includes thorough and convincing simulated training material
 - uses the training sample to calibrate volunteer performance
- Essential for training users and keeping them alert !!!
- Important for characterizing the selection function of the resulting lens sample



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ANALYZING CLASSIFICATIONS

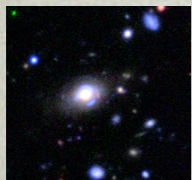
1. Subject **has prior probability**



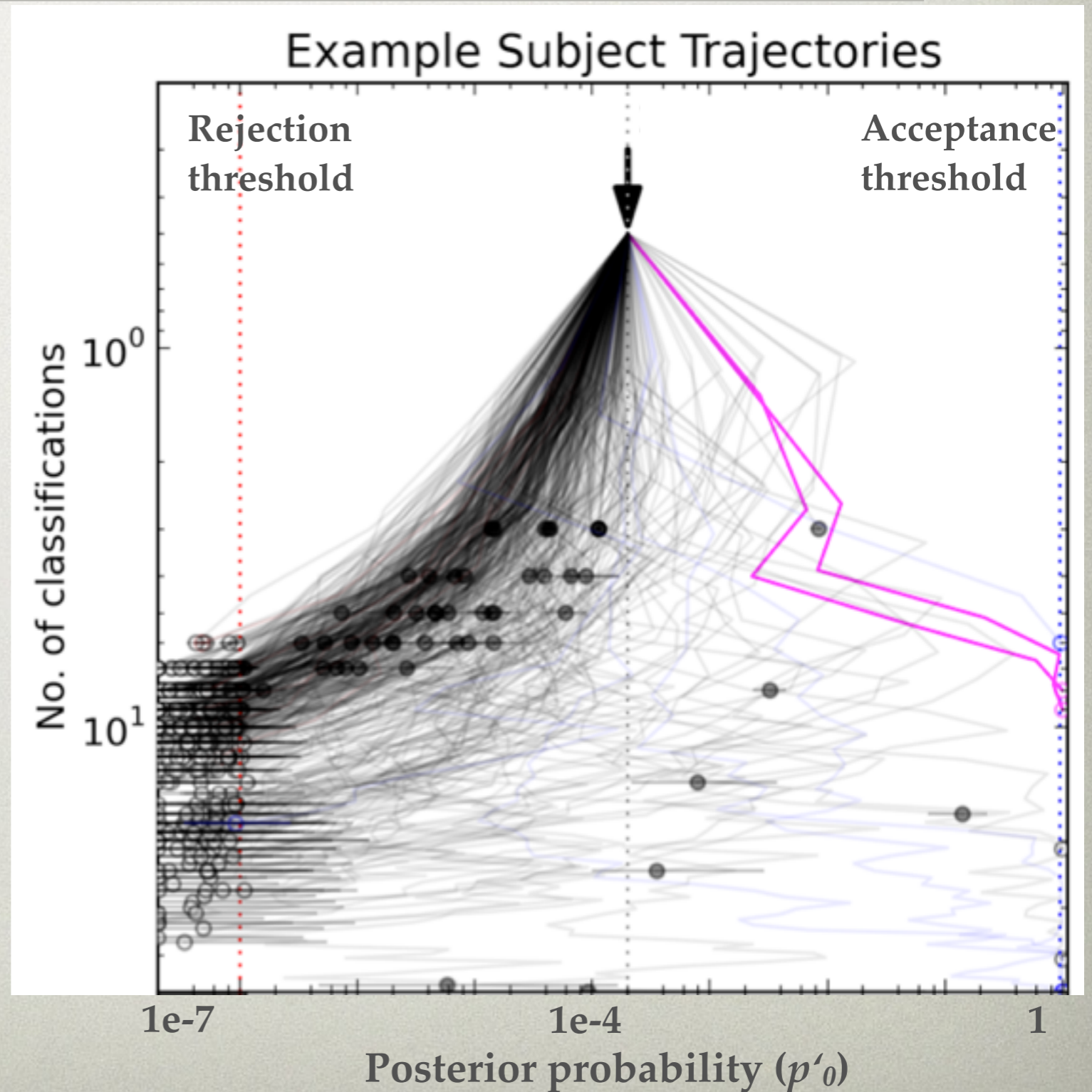
2. Volunteer **classifies subject**



3. Training set **calibrates volunteer**



4. Subject **update probability**

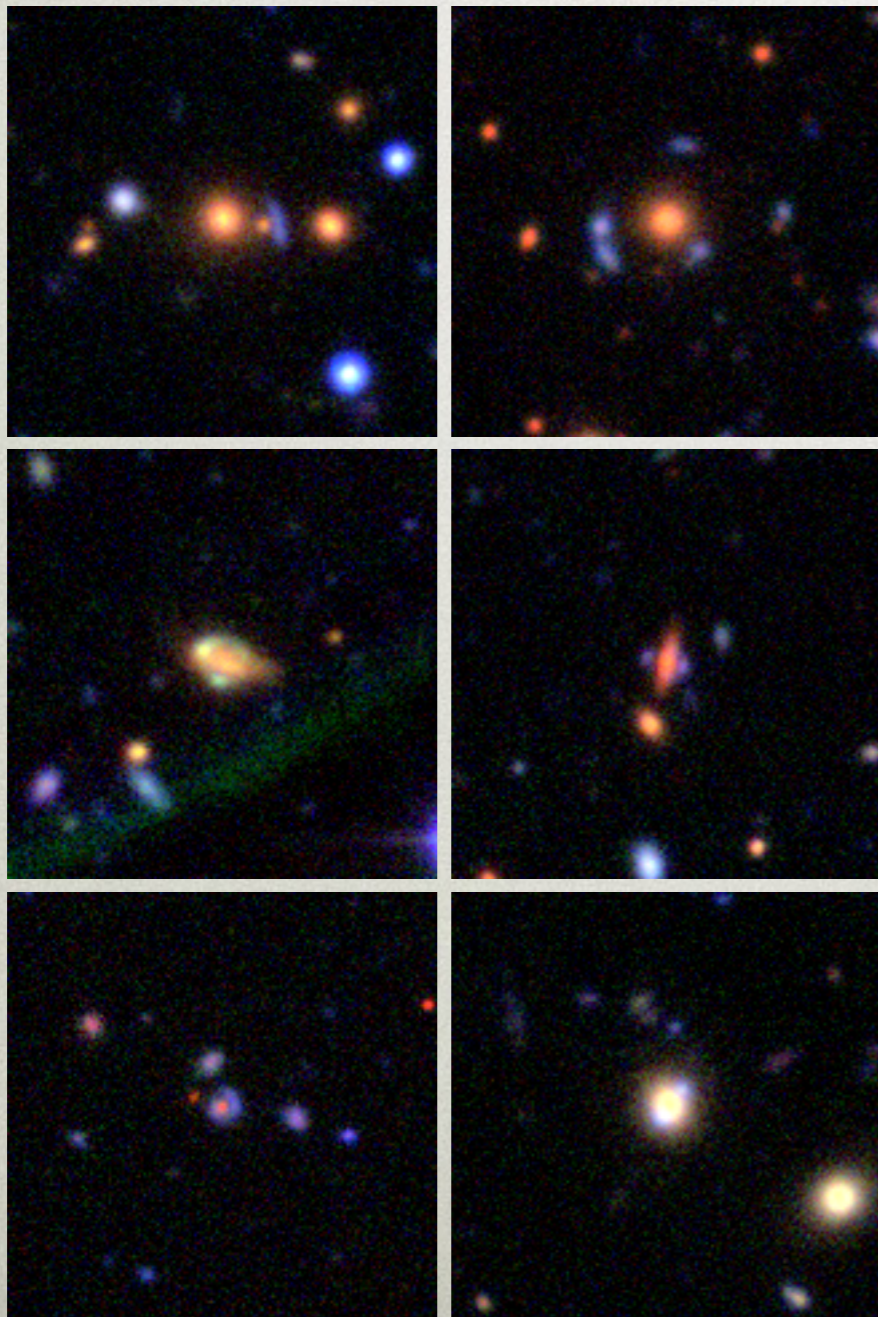




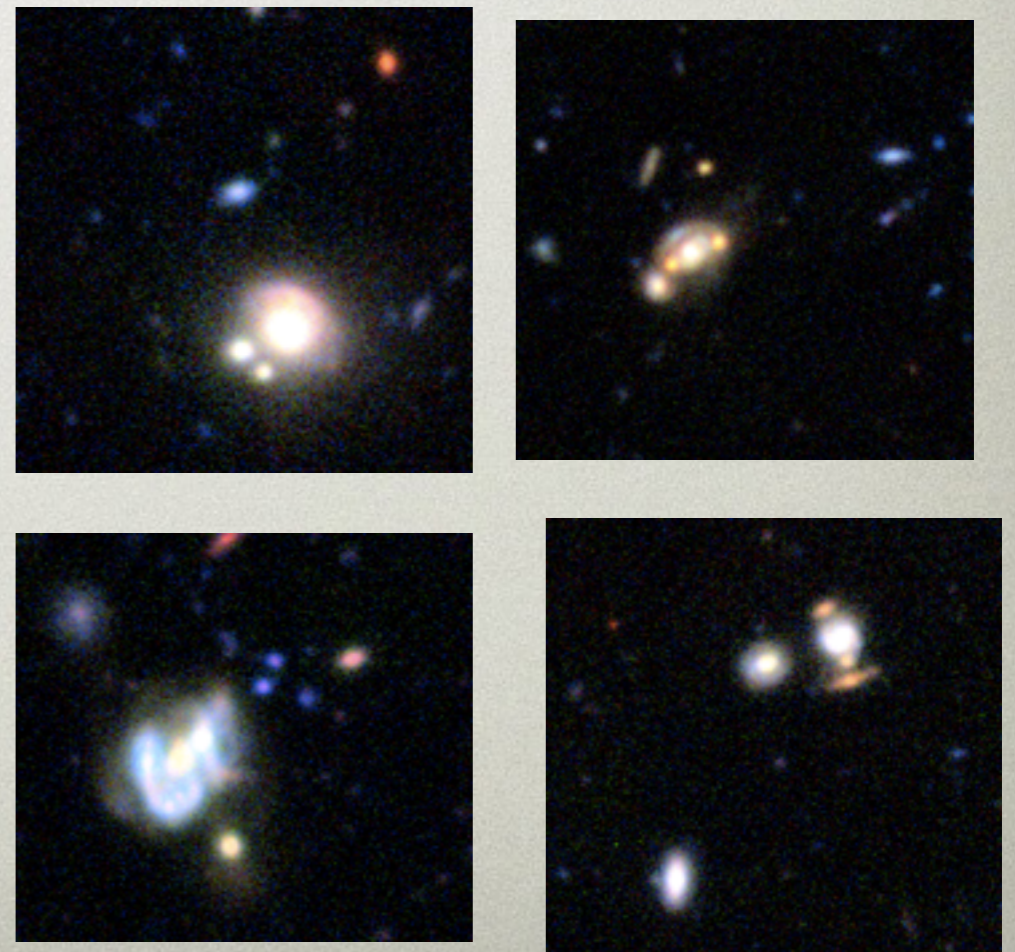
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DISCOVERIES

About 60 new lens candidates



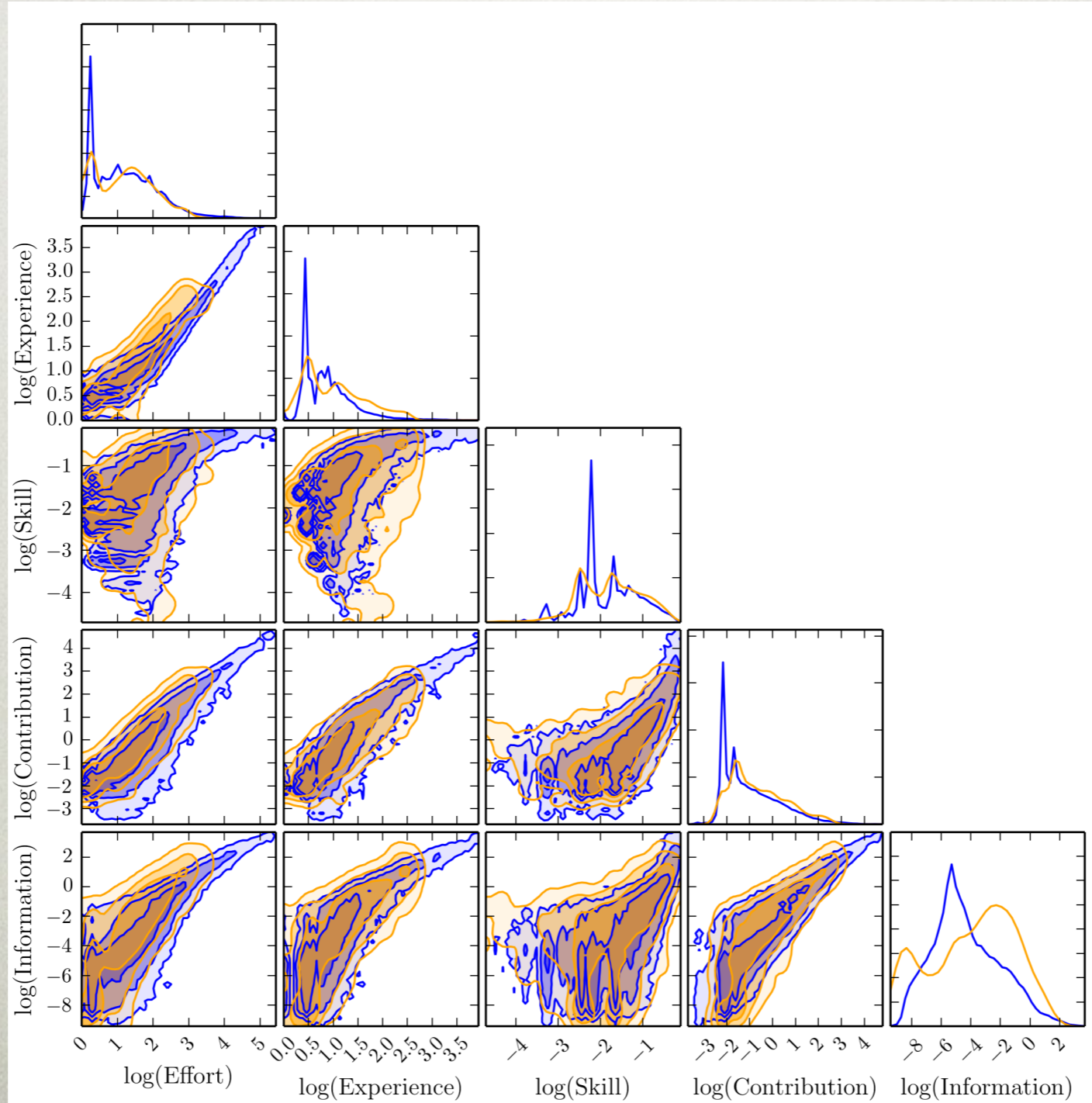
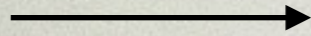
Some strange/interesting candidates (?)





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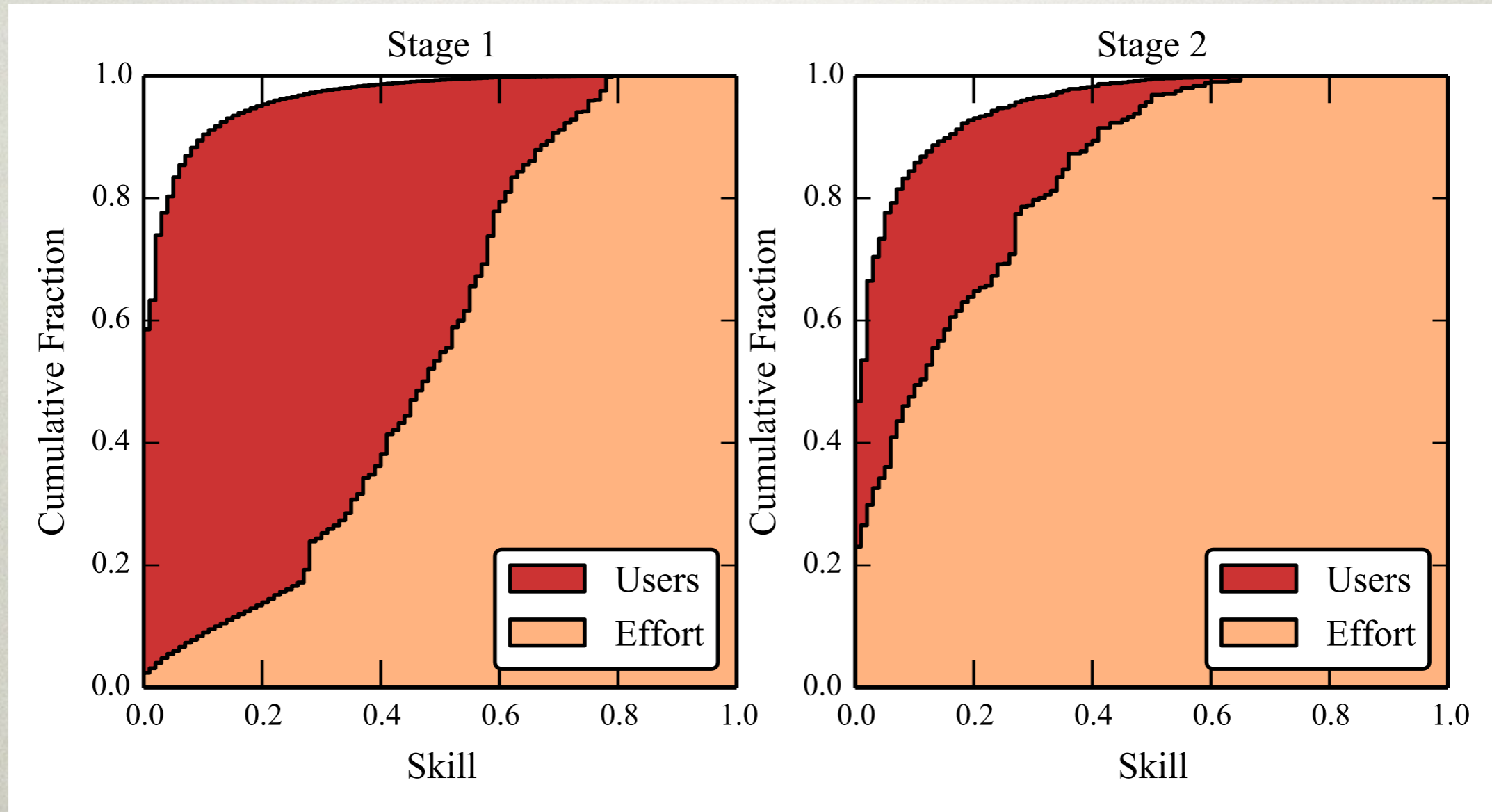
IN PROGRESS





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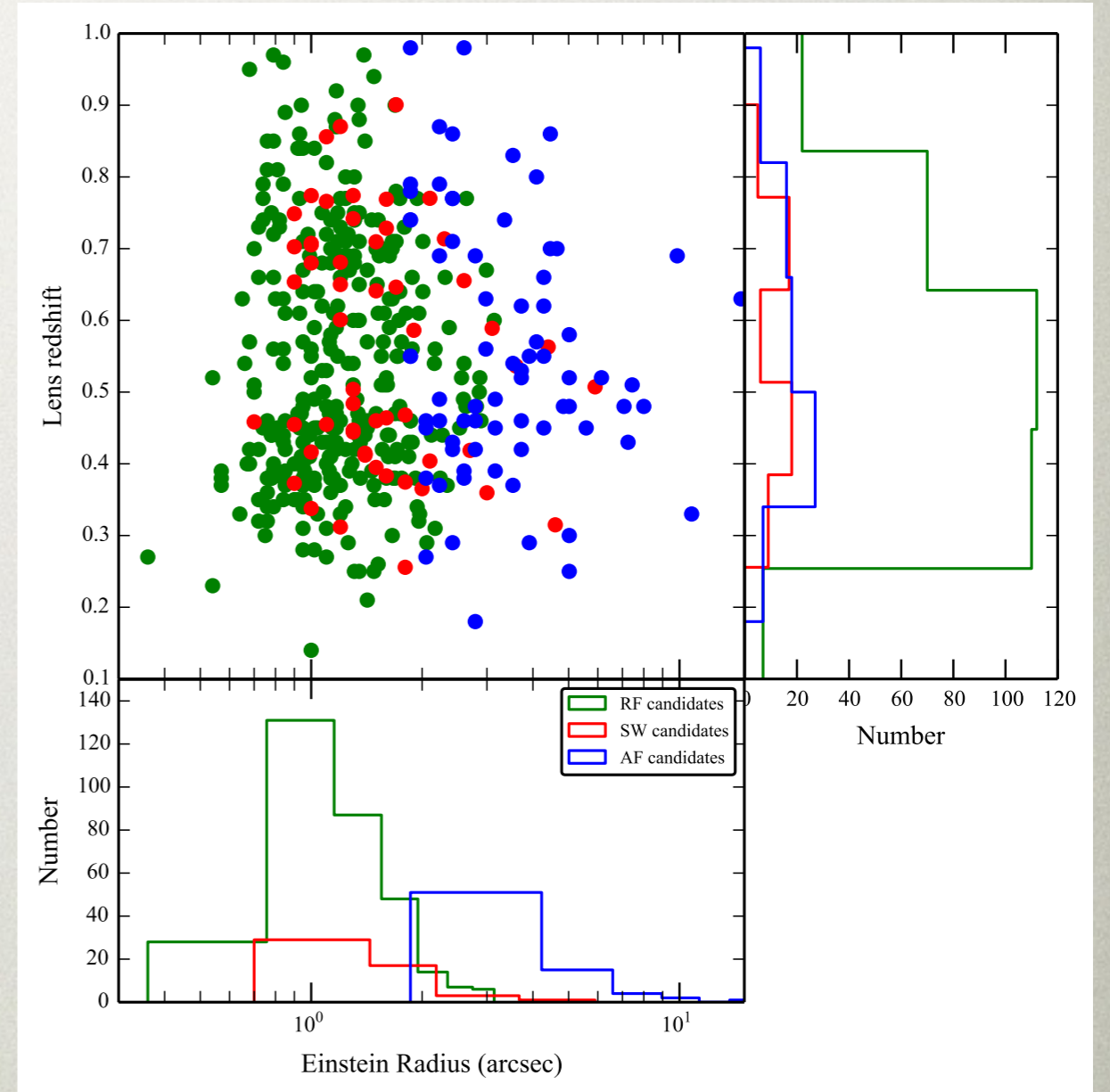
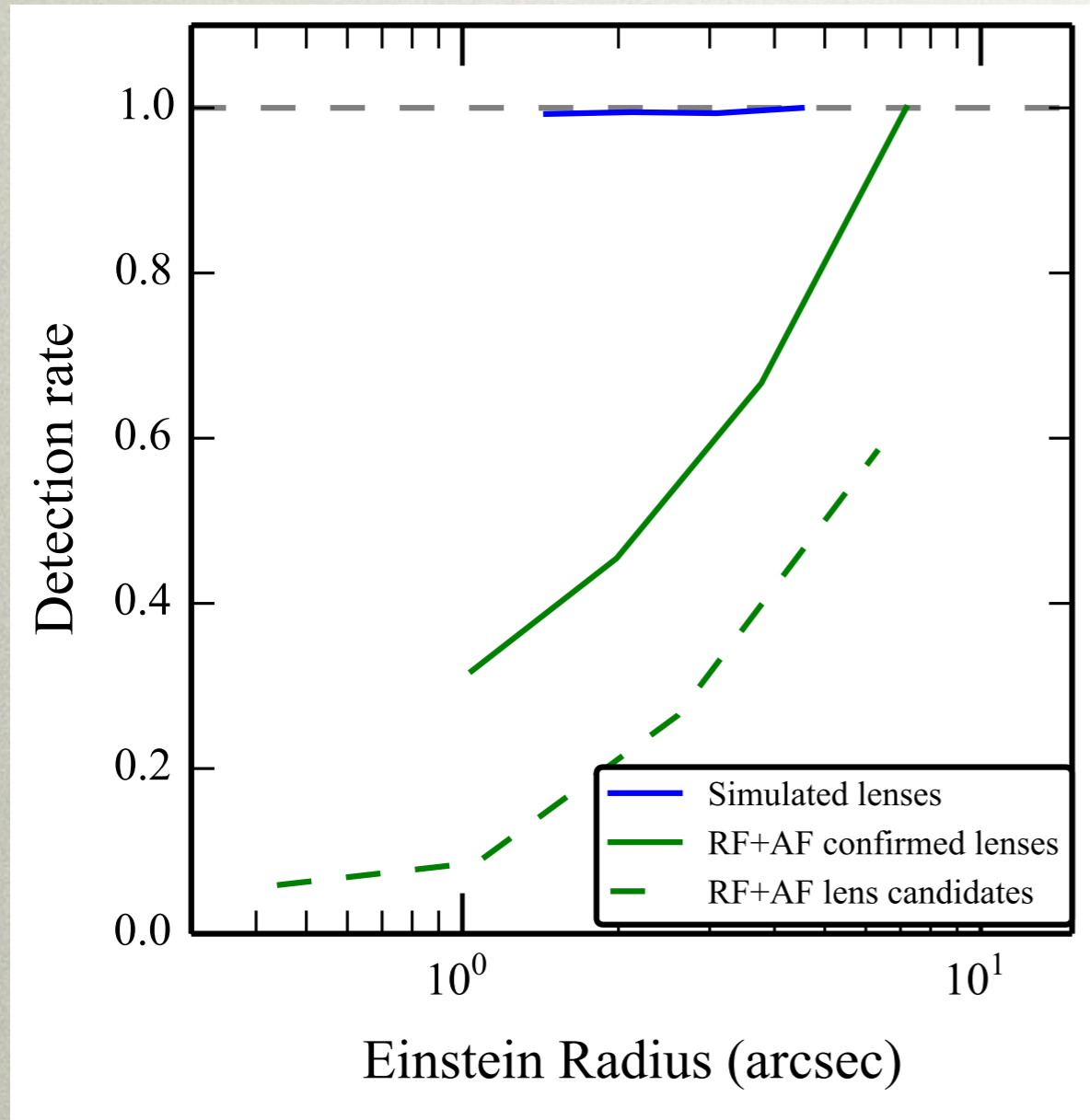
IN PROGRESS





SPACE WARPS

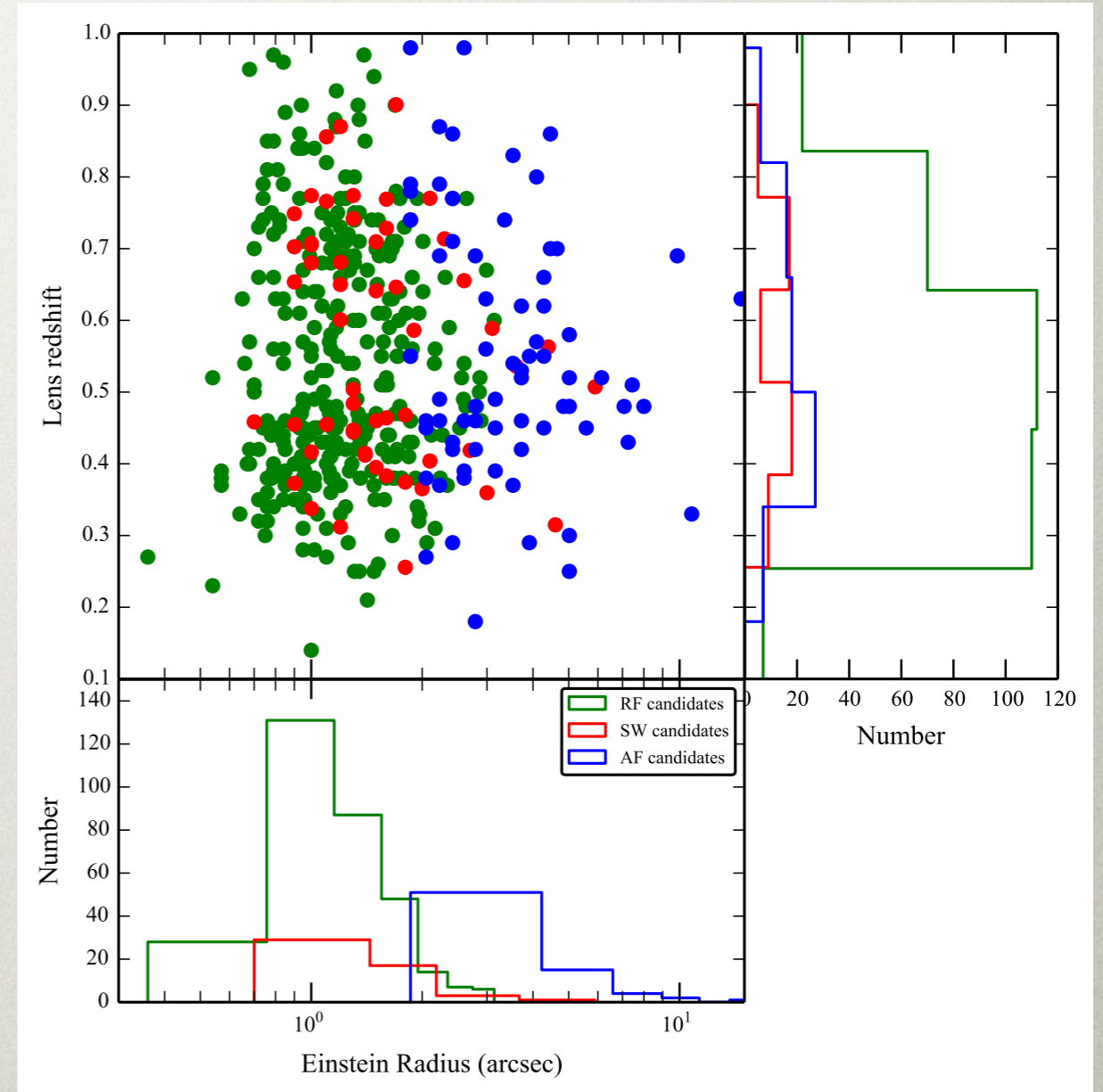
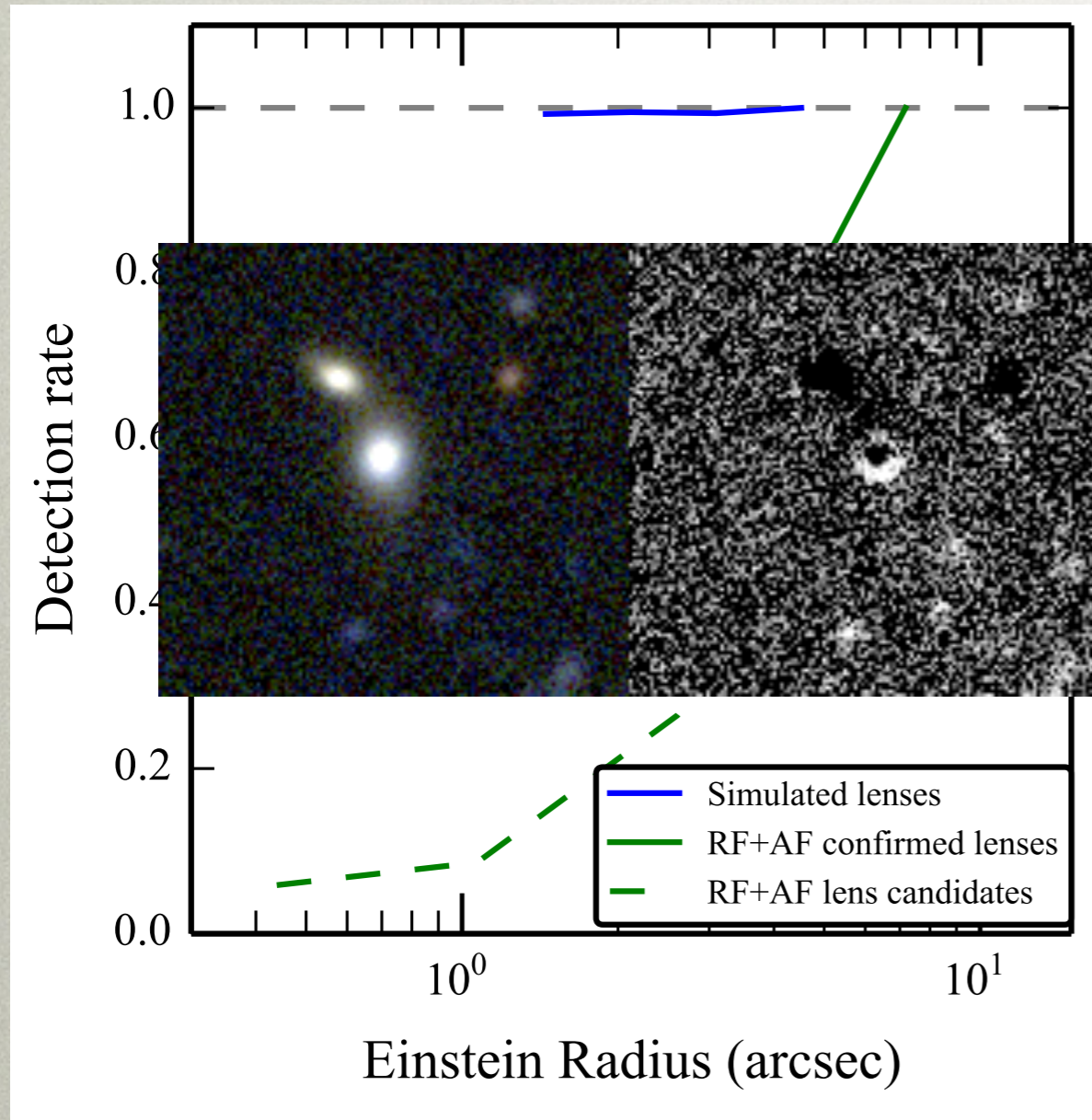
IN PROGRESS





SPACE WARPS

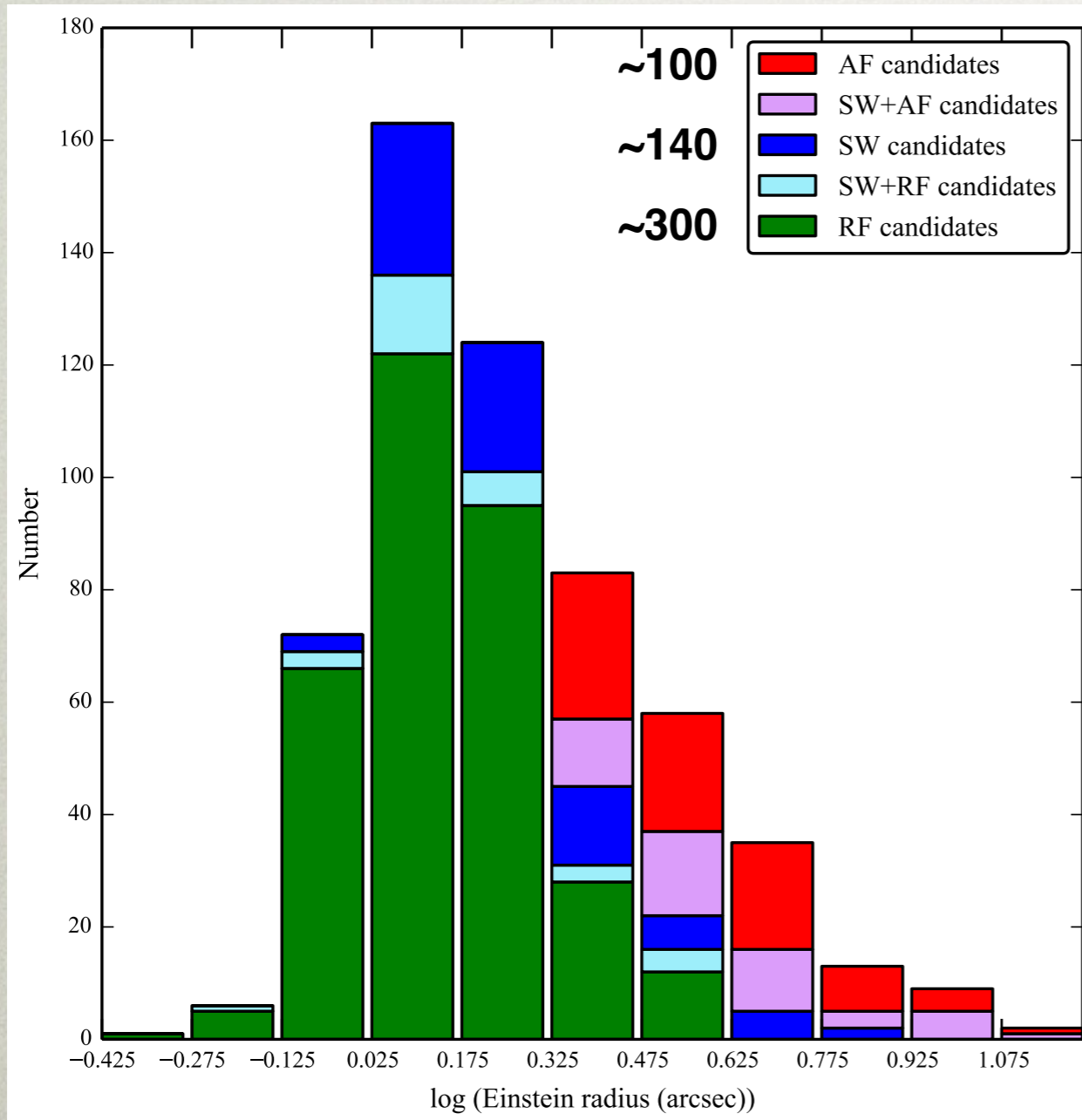
IN PROGRESS





SPACE WARPS

IN PROGRESS

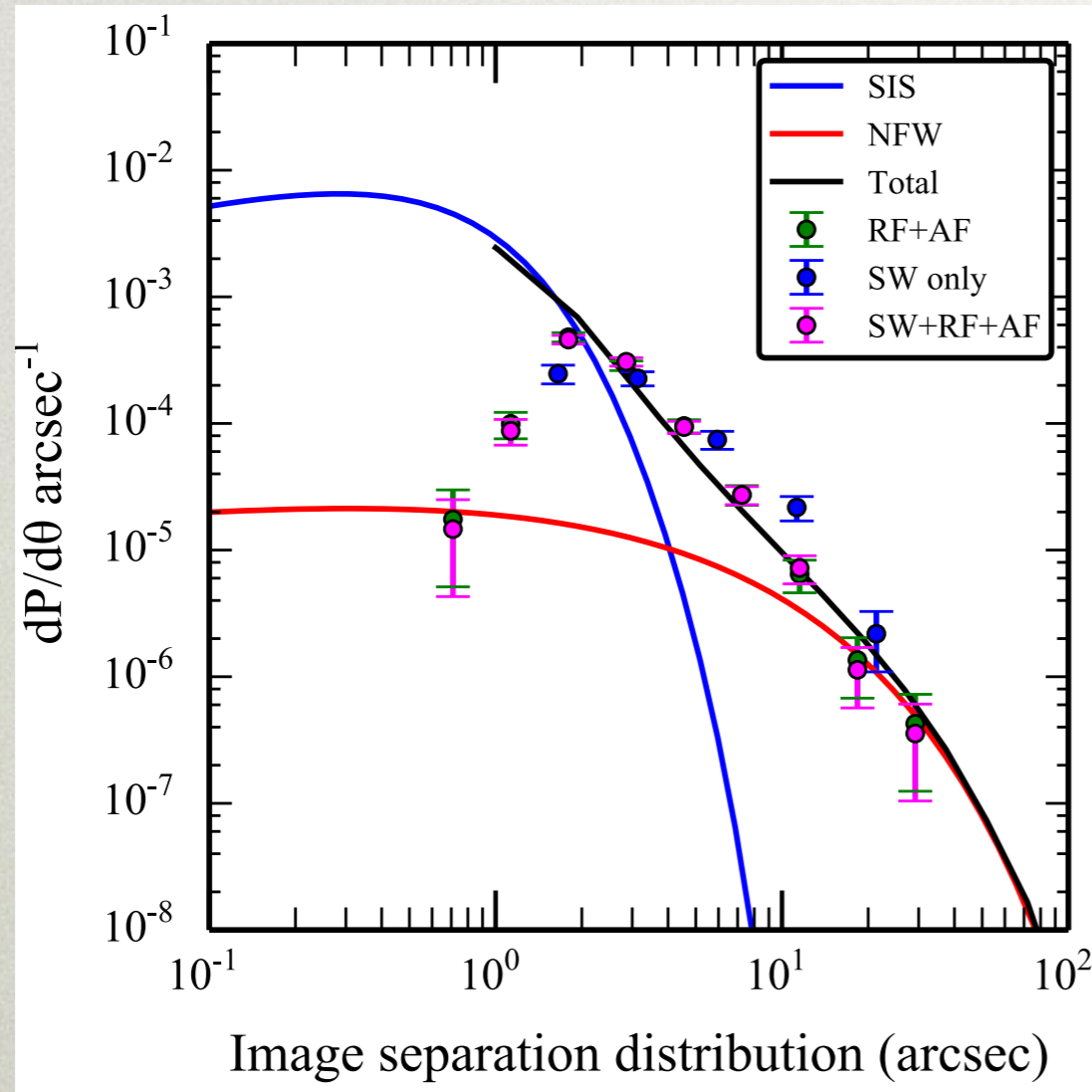


- Number of detections from each of the three methods (Ringfinder, Space Warps and Arcfinder)
- Space Warps sample finds most lenses in an intermediate range in the Einstein radius compared to RF and AF



SPACE WARPS

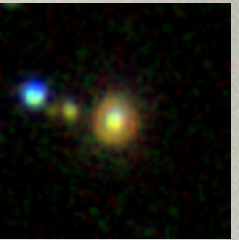
IN PROGRESS



- Any incompleteness in the SARCS (AF sample) does not have significant dependence on the Einstein radius
- At small image separations, RF / SW samples indicate high incompleteness which is most likely due to the deteriorating image quality rather than the limitations of any one lens finding method



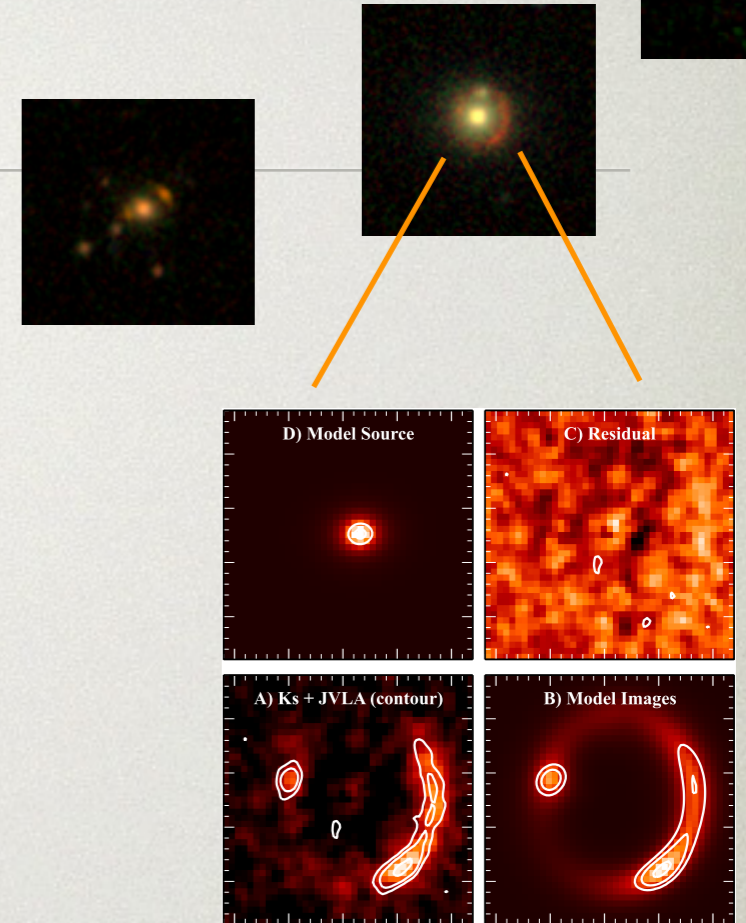
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OTHER SEARCHES

- Targeted search with VISTA-CFHT-Stripe82
 - 3-day public event (BBC stargazing live show)
 - Optical+IR data
 - 40,000 candidates (preselected clusters, quasars, LRG from catalogs)

- SW - DES
 - Targeted search being planned with Y1 data
 - Improved simulations and strategy



Geach, AM et al., (in prep)