A SEARCH FOR OPTICAL EMISSION FROM BINARY-BLACK-HOLE MERGER GW170814

Zoheyr Doctor
on behalf of the DECam-GW team
Midwest Workshop on Supernovae and Transients
February 26th
arXiv 1812.01579, accepted by ApJL

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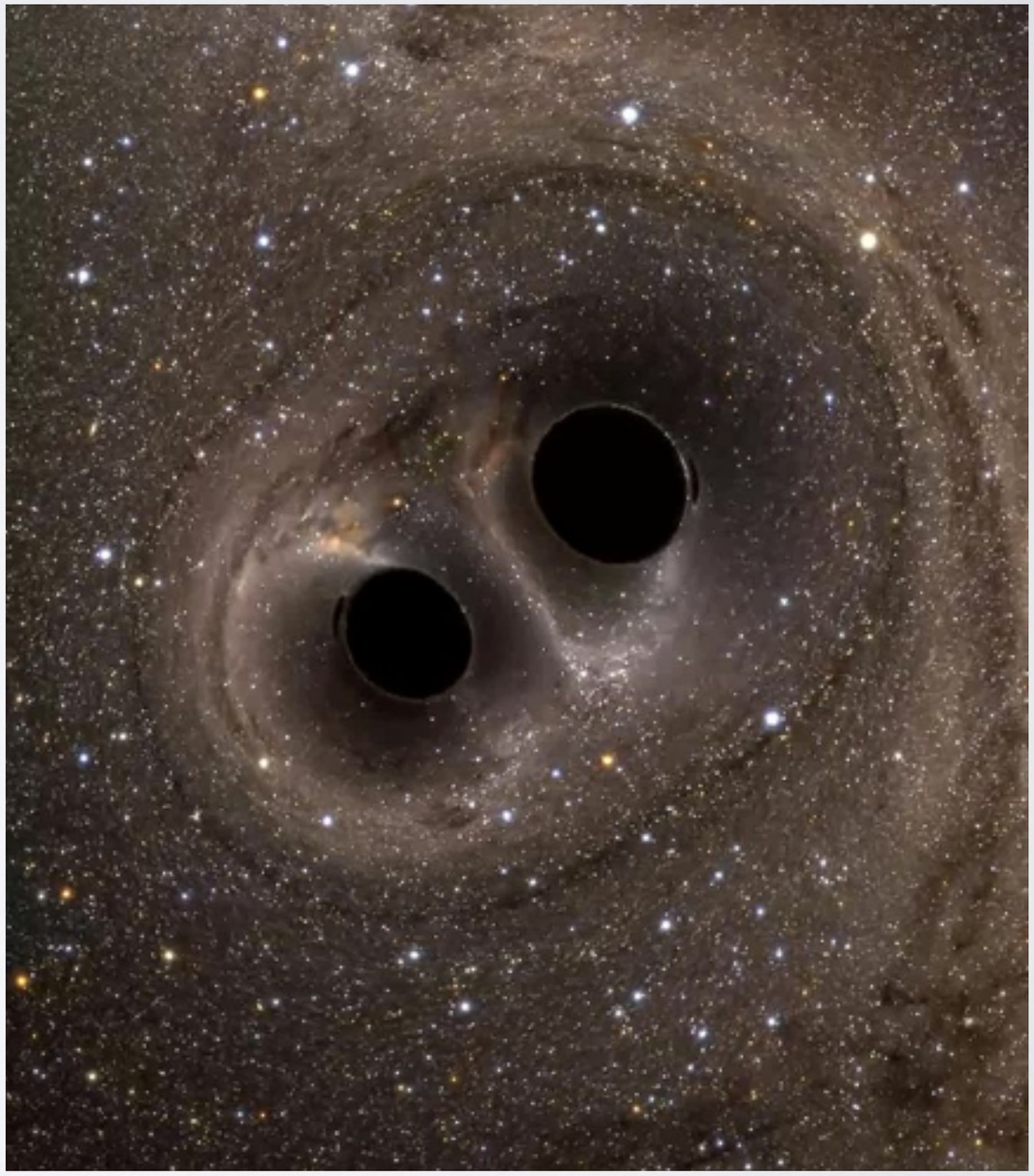
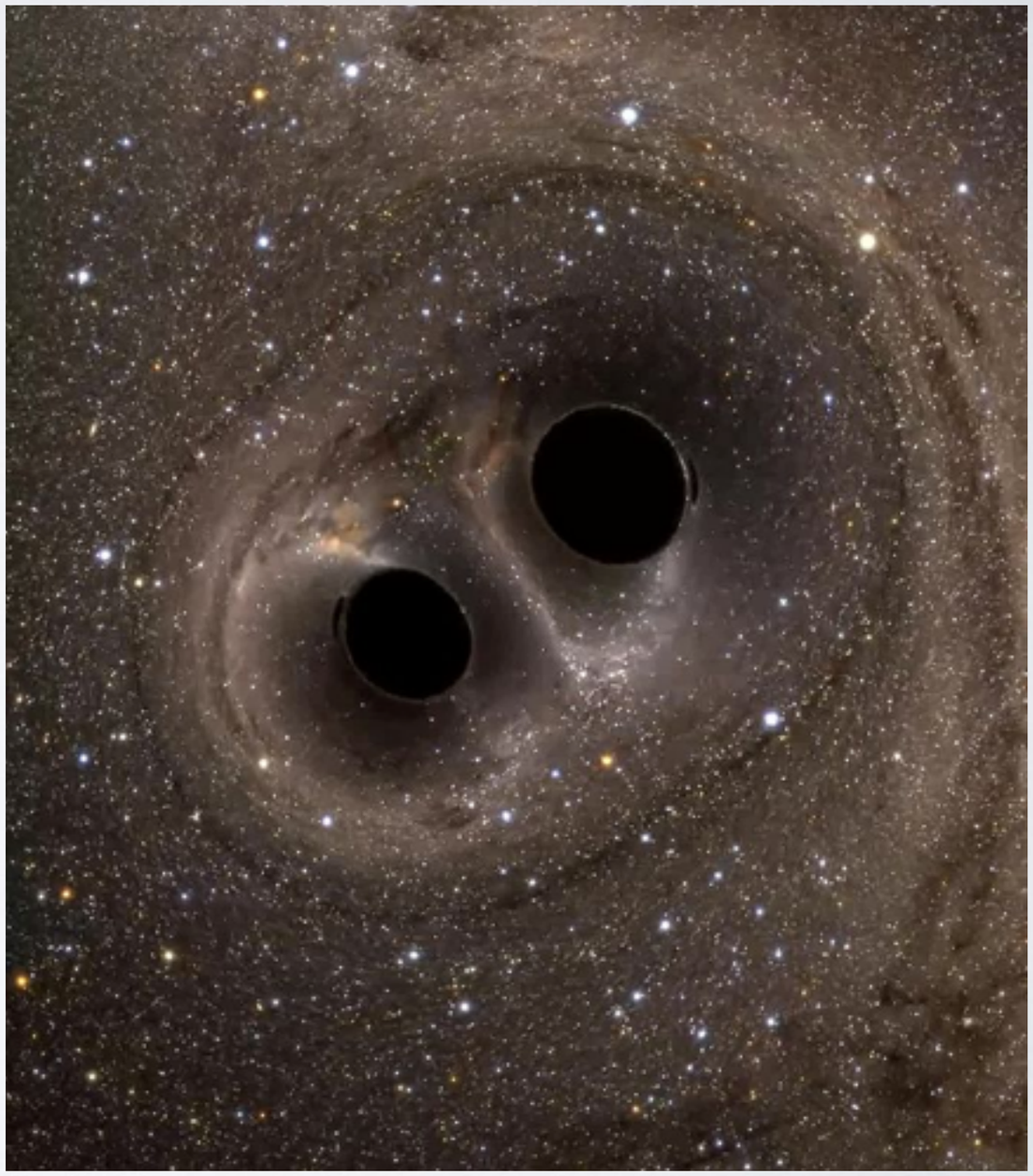
WHY SEARCH FOR BBH OPTICAL EMISSION?



WHY SEARCH FOR BBH OPTICAL EMISSION?

- BHs are just empty space-time, so nominally don't expect any EM signatures



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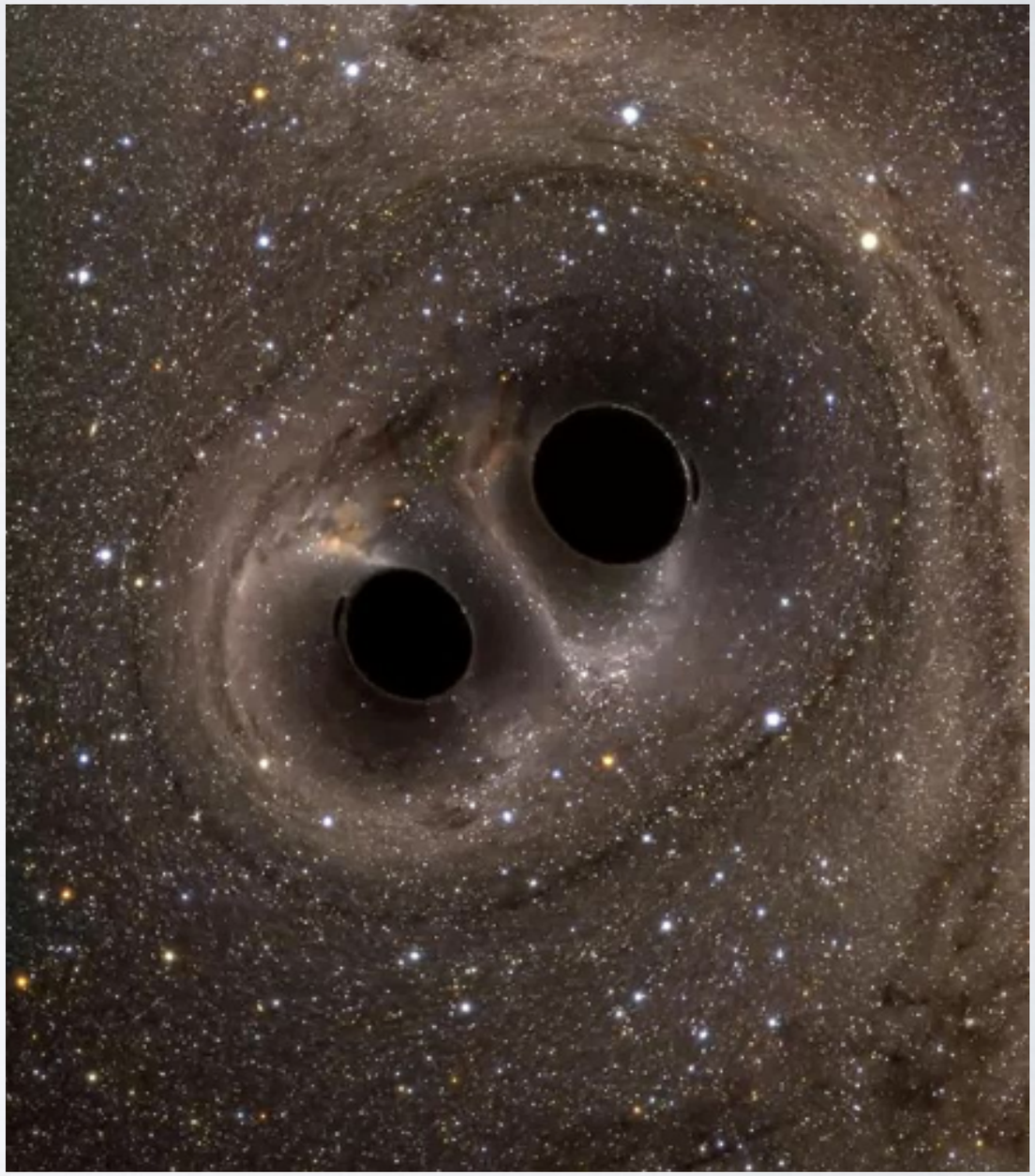
  - Disks around merging BHs

  - Massive star collapsing to two BHs



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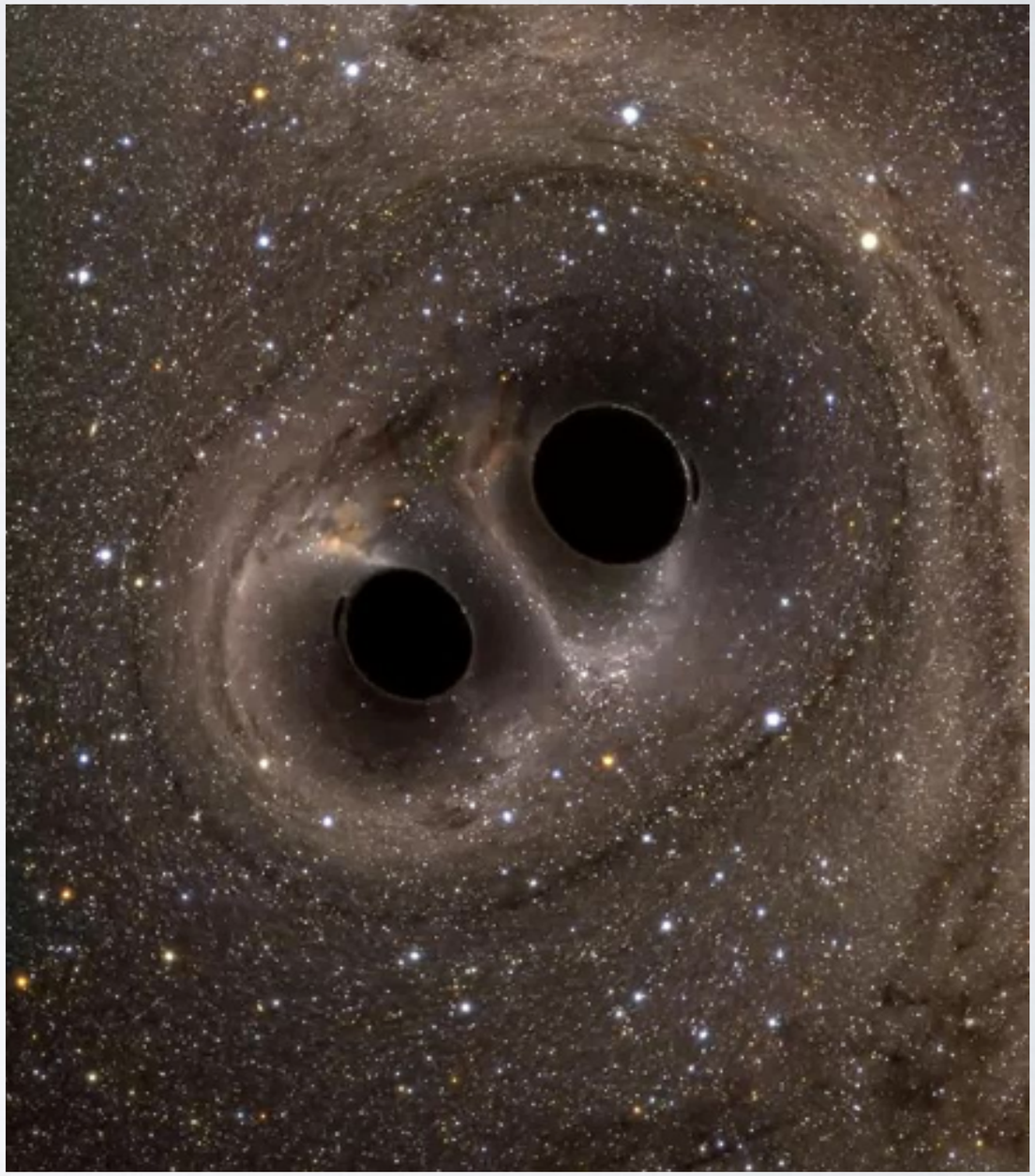
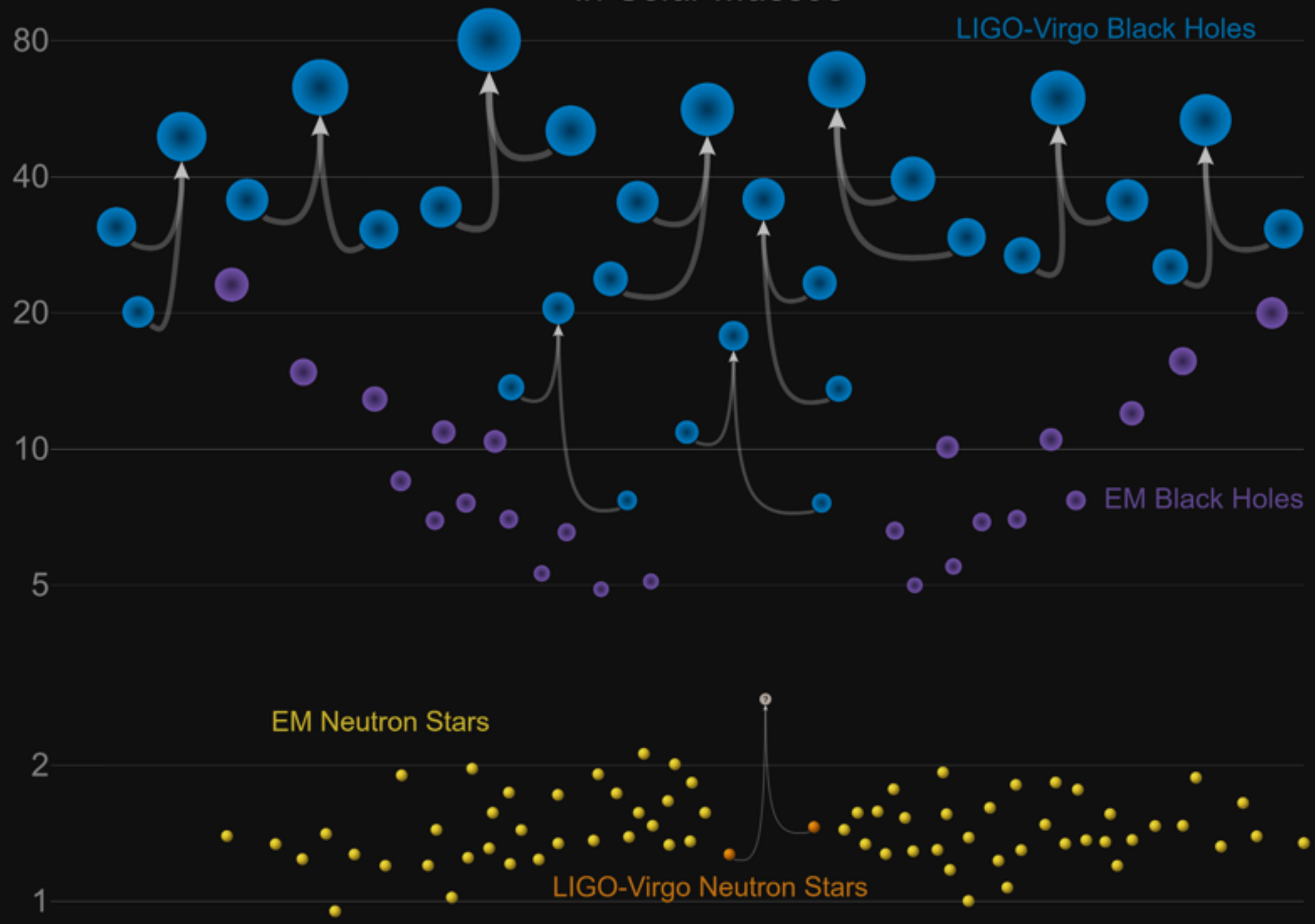
- Finding a BBH EM counterpart would be a very high-impact discovery



Masses in the Stellar Graveyard

in Solar Masses



LIGO-Virgo | Frank Elavsky | Northwestern

GW170814

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- $30M_\odot$ + $25M_\odot$ merger

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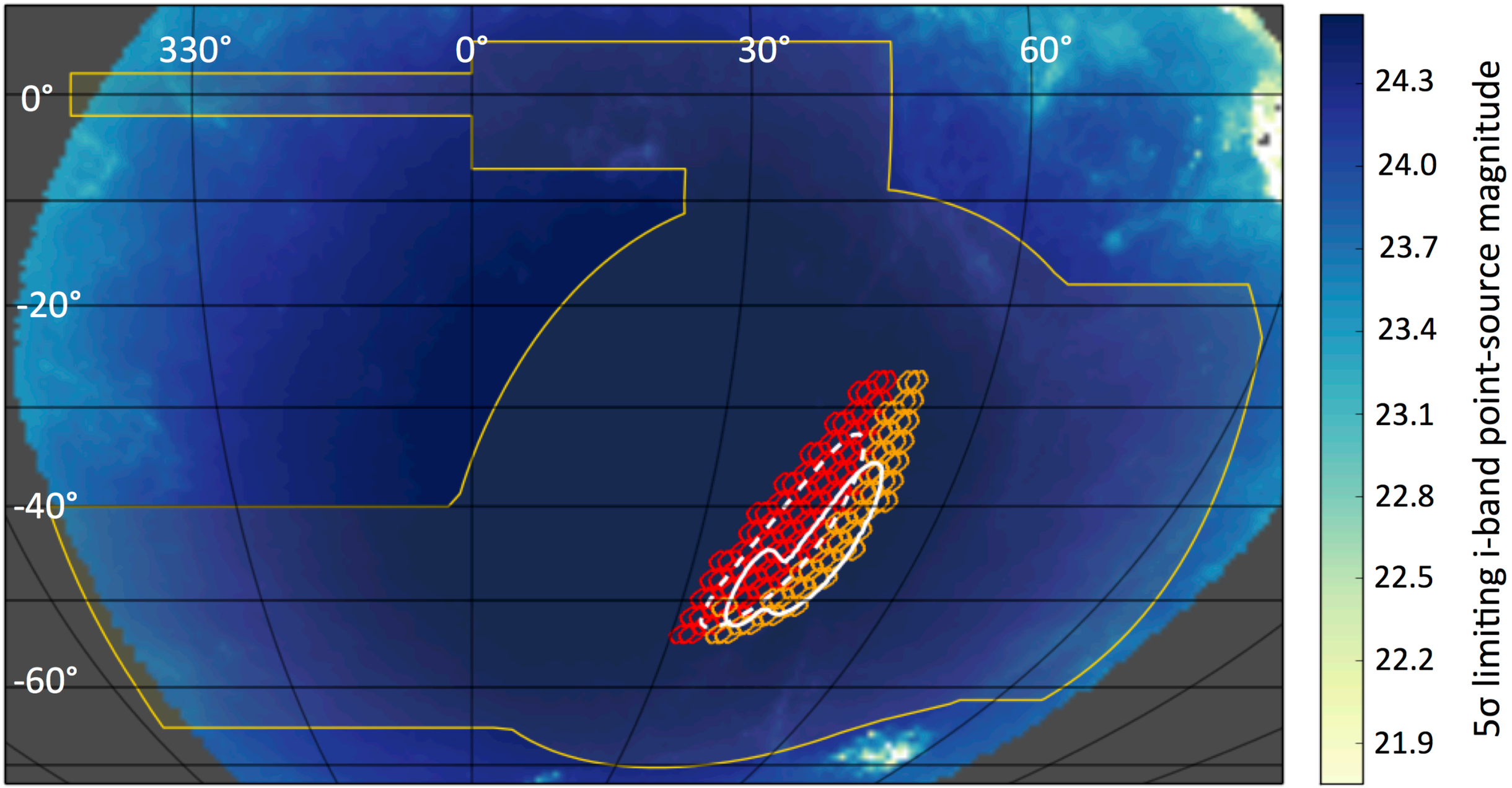
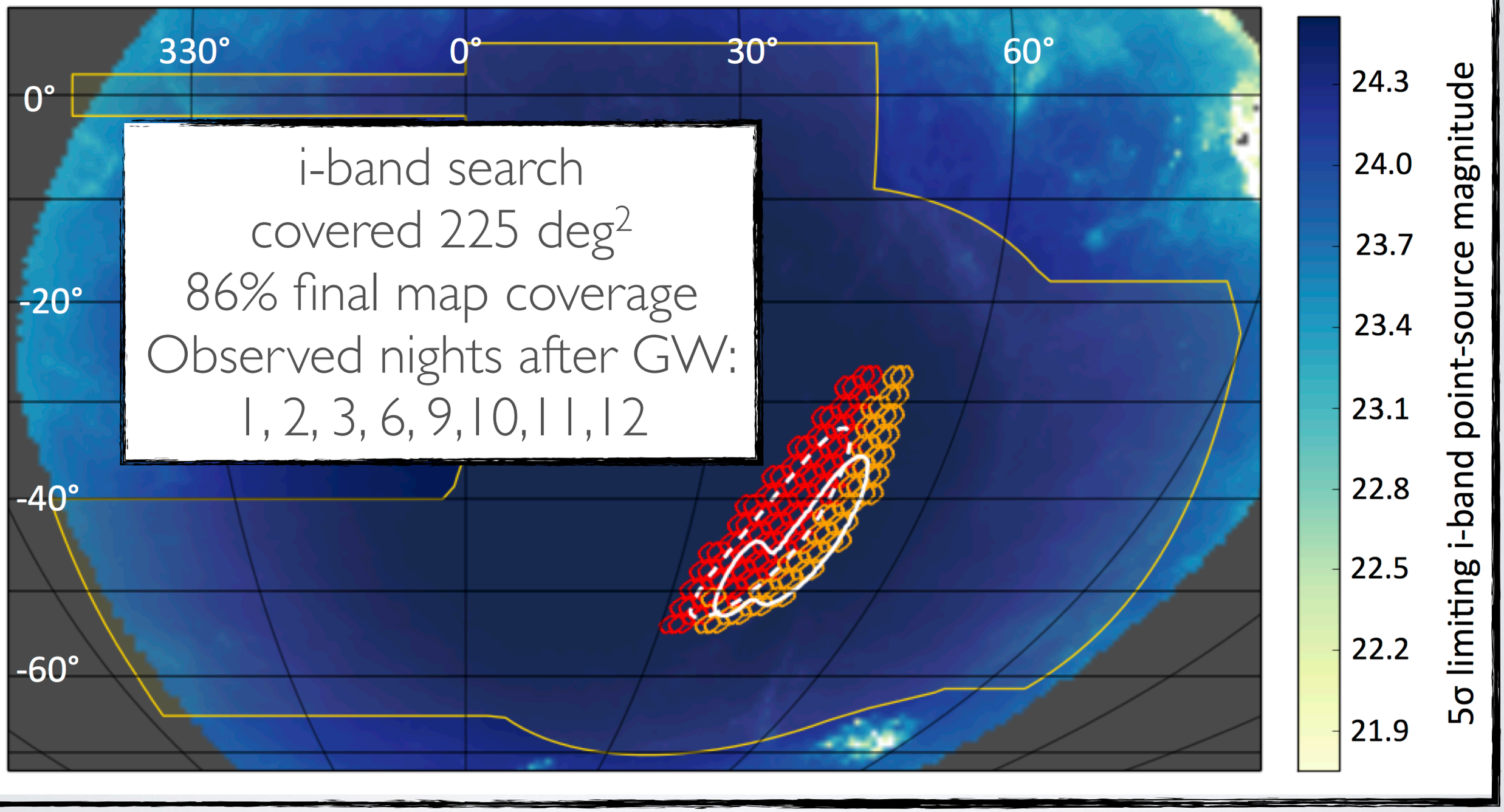
- 87-deg^2 sky localization (90% confidence region)


330°
0°
30°
60°
0°
-20°
-40°
-60°
24.3
24.0
23.7
23.4
23.1
22.8
22.5
22.2
21.9
5σ limiting i-band point-source magnitude


330°
0°
30°
60°
0°
-20°
-40°
-60°
i-band search
covered 225 deg²
86% final map coverage
Observed nights after GW:
1, 2, 3, 6, 9,10,11,12
24.3
24.0
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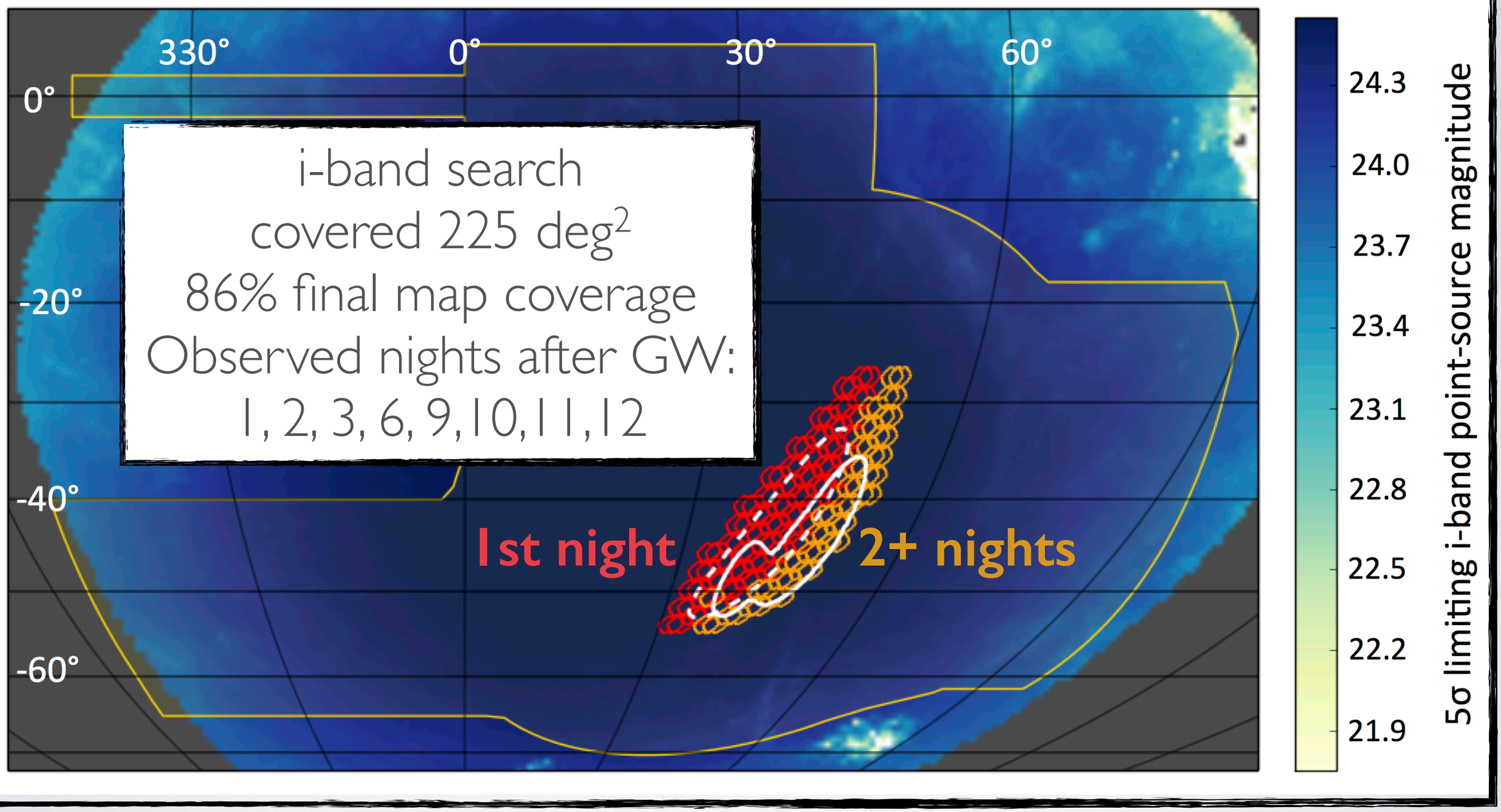
330°
0°
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covered 225 deg²
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Observed nights after GW:
1, 2, 3, 6, 9,10,11,12
1st night
2+ nights
24.3
24.0
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22.8
22.5
22.2
21.9
5σ limiting i-band point-source magnitude

ANALYSIS

- Candidate light curves identified through difference imaging
- 60k raw candidates
- Use a control sample of candidates to predict number of false-positives passing cuts
- Treat candidates first observed 1st night separately from those first observed 2nd+ nights

Cuts	$N_{\rm seq}$ [a]	$N_{\rm only}$ [b]	$N_{\rm LO}$ [c]
1. Raw Sample	59560	–	–
2. 1st Epoch ML > 0.7	1206	1206	258
3. Unmatched or Host $z < 0.30$	730	31119	8
4. 2nd Obs S/N ≥ 2.0	663	44181	4
5. > 2.0 sigma decline	45	5570	65
6. $N_{\rm obs} \geq 4$	31	50029	2
7. Late-time S/N < 6	4	27571	21
8. No Late-time Brightening	2	36499	4
9. Visual Inspection	2	–	2

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1. Raw Sample	59560	–	–
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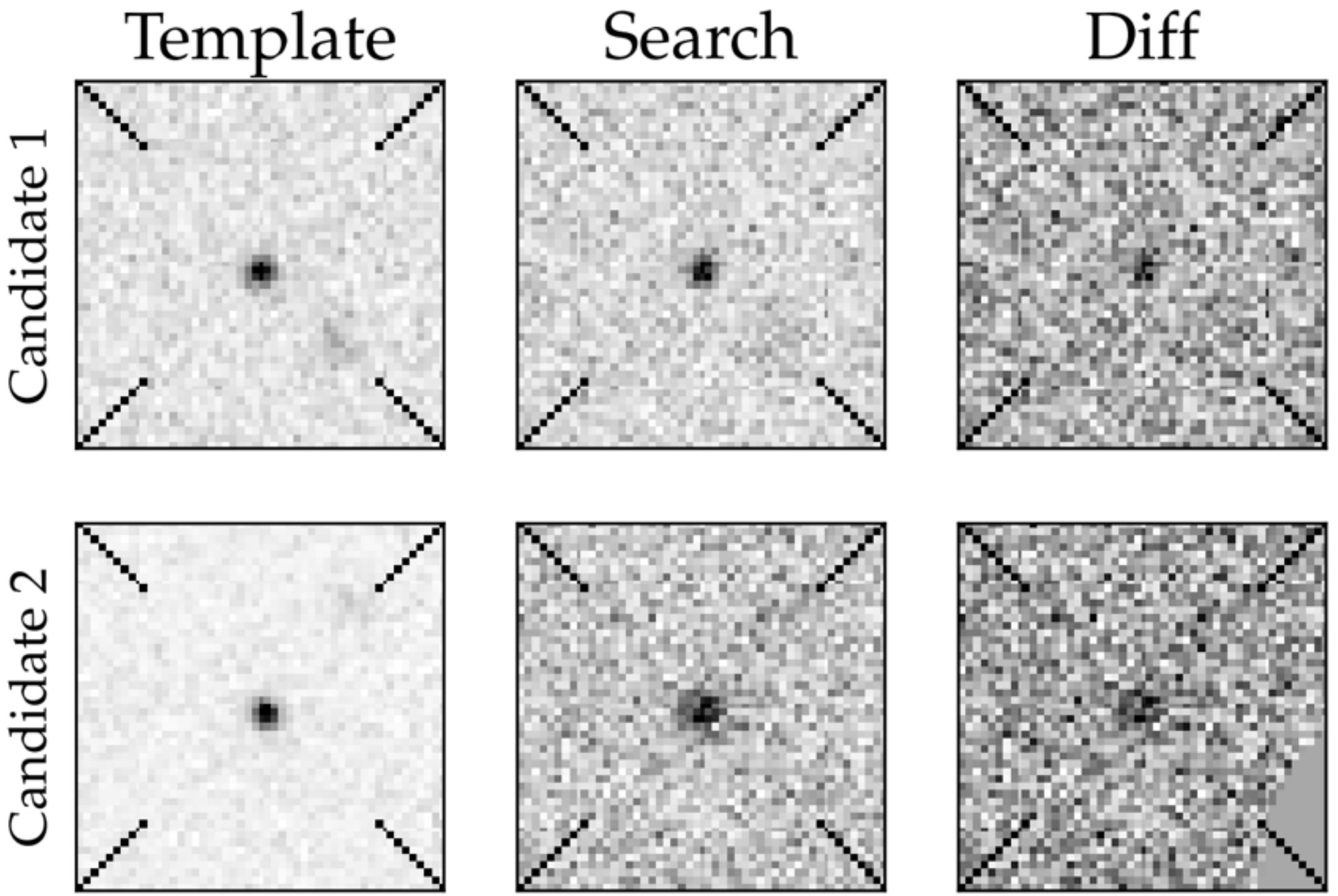
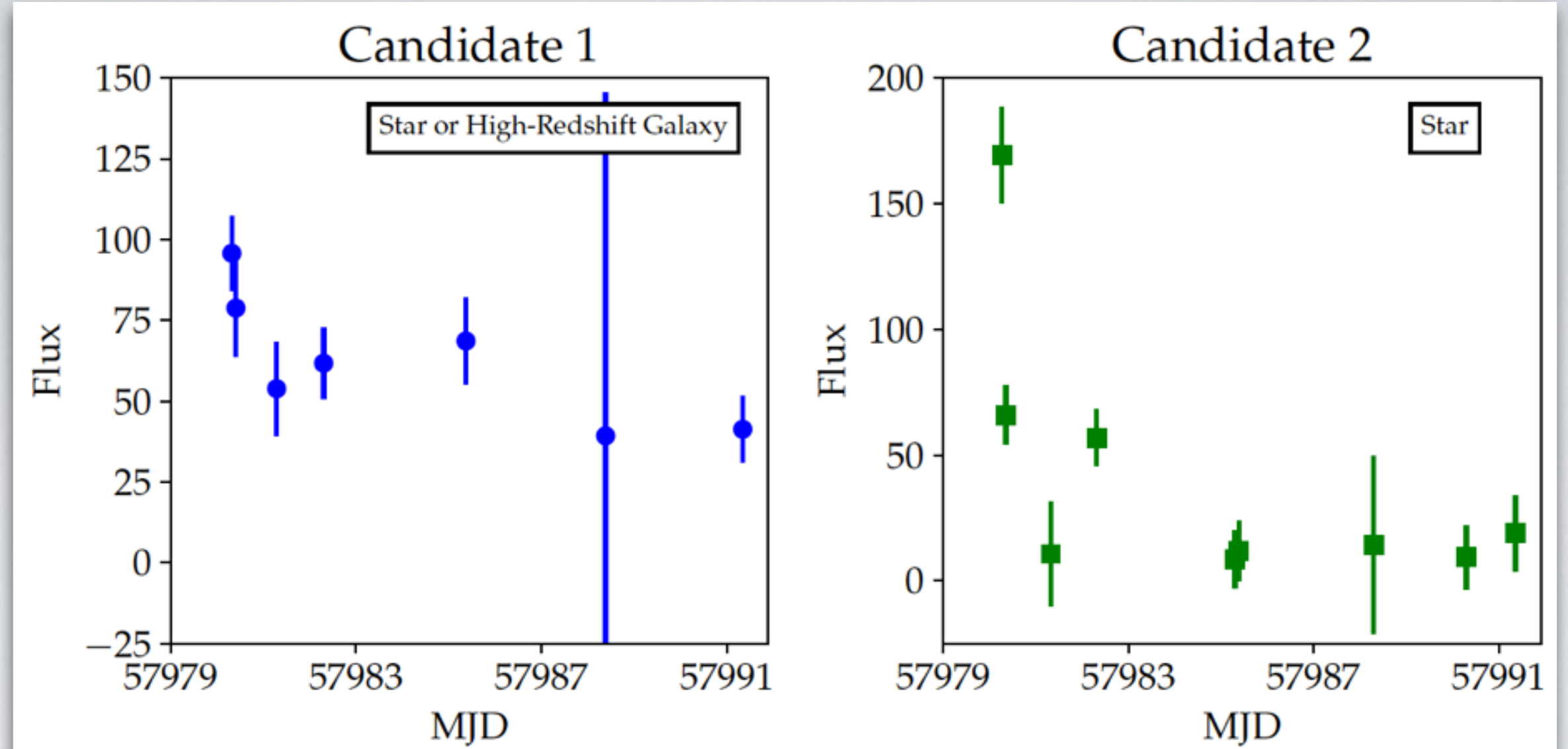
Expectation from control sample: 2.4 events


Template
Search
Diff
Candidate 1
Candidate 2


Candidate 1
Star or High-Redshift Galaxy
Flux
150
125
100
75
50
25
0
−25
57979
57983
57987
57991
MJD
Candidate 2
Star
Flux
200
150
100
50
0
57979
57983
57987
57991
MJD

Candidate 1

Star or High-Redshift Galaxy

Flux

150
125
100
75
50
25
0
−25

57979
5798

Candidate 2

Star

200
150
100

57987
57991

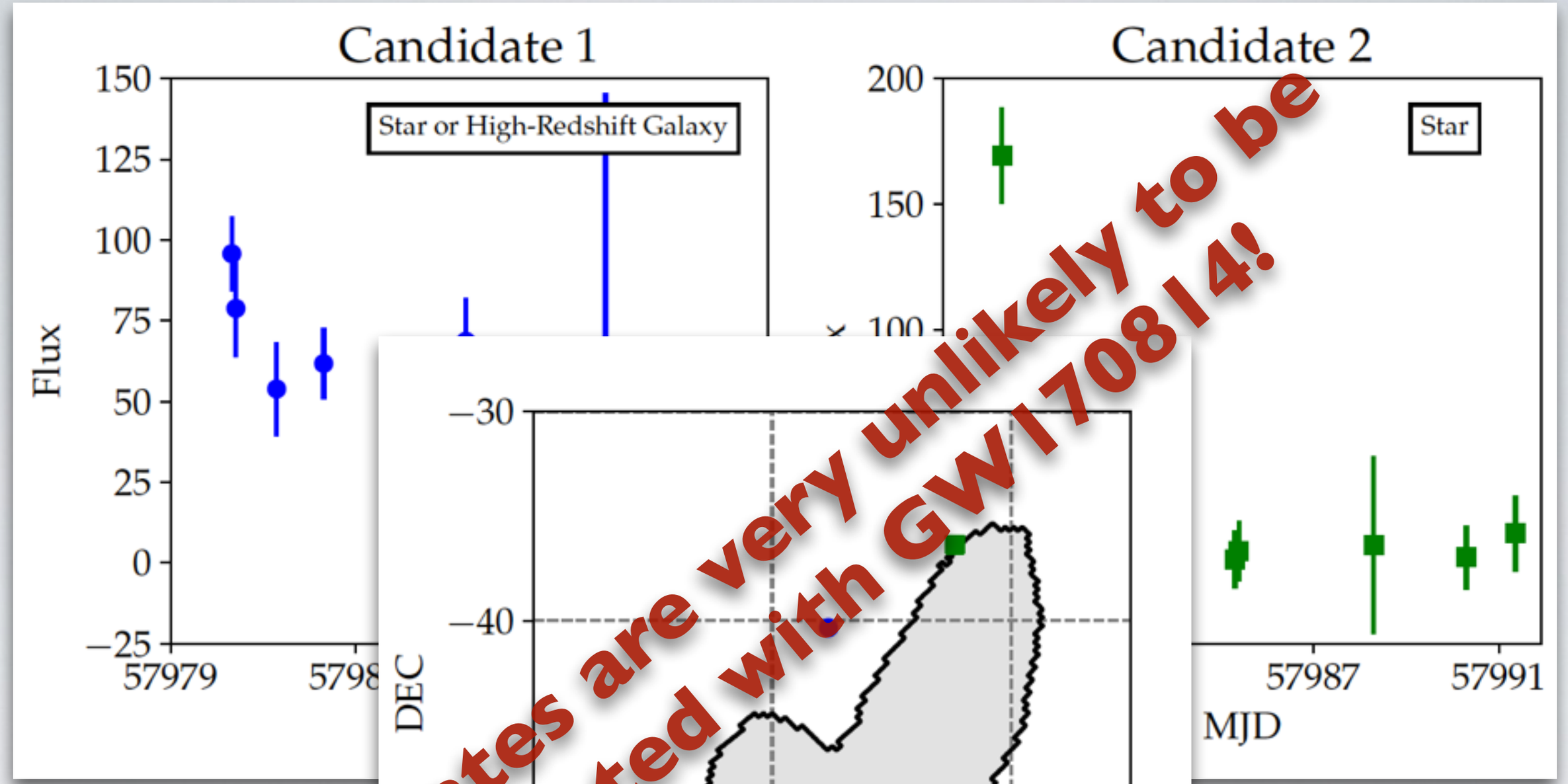
MJD

−30
−40
−50

DEC

30
40
50

RA



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- Analysis disfavors BBH light curves that dim quickly after merger with i mag < 23