

Deep H α Imaging Survey of IC 348 with the Hubble Space Telescope:

Demographics of *Accreting Protoplanets* on *Wide* Orbits

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Jiang et al. (in prep)

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What is the origin of planets on wide orbits?

Core accretion

Andrews et al. (2018)

Disk instability

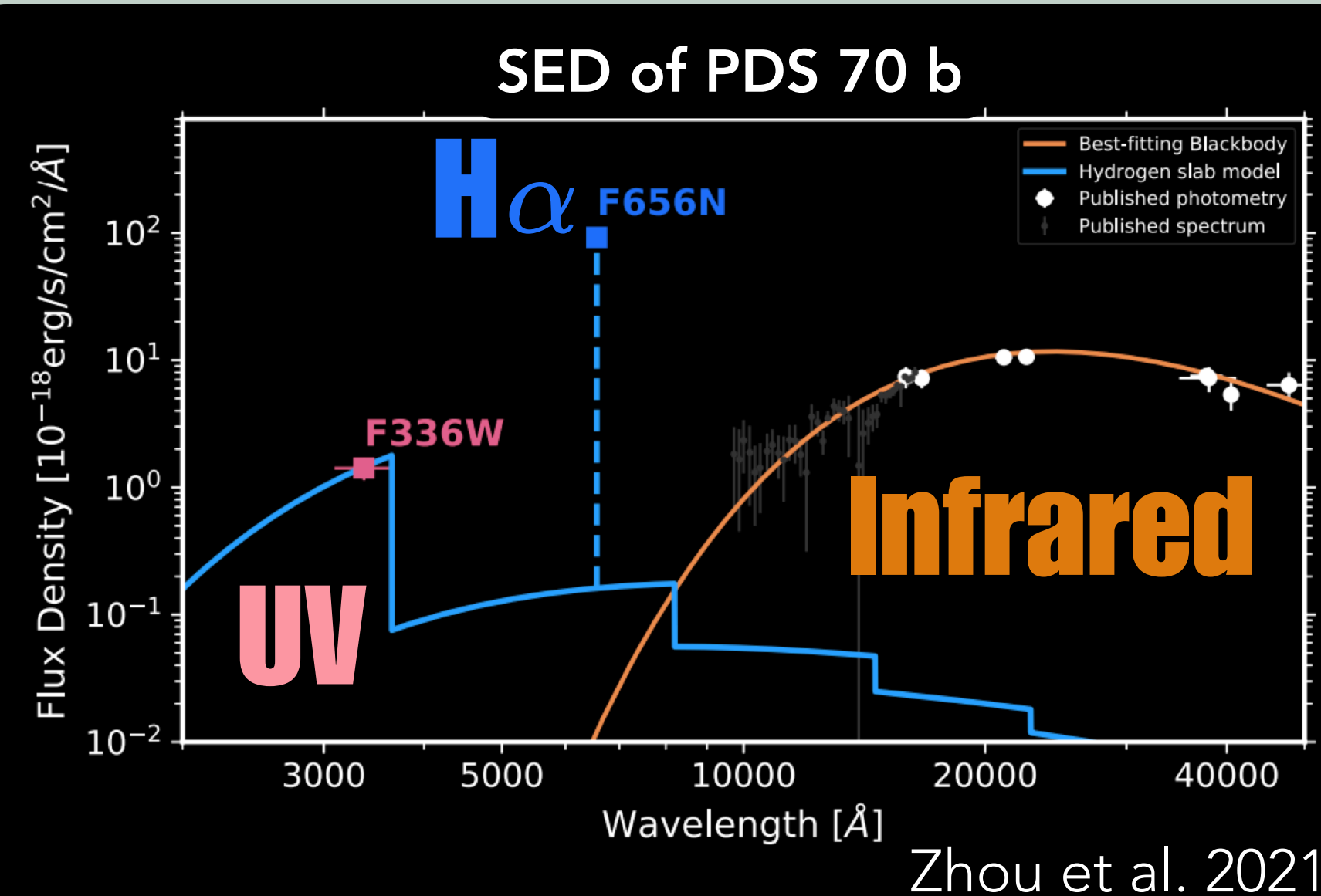
Tobin et al. (2016)

Cloud Fragmentation

Guszejnov et al. (2021), Offner et al. (2023)

Dynamical Capture

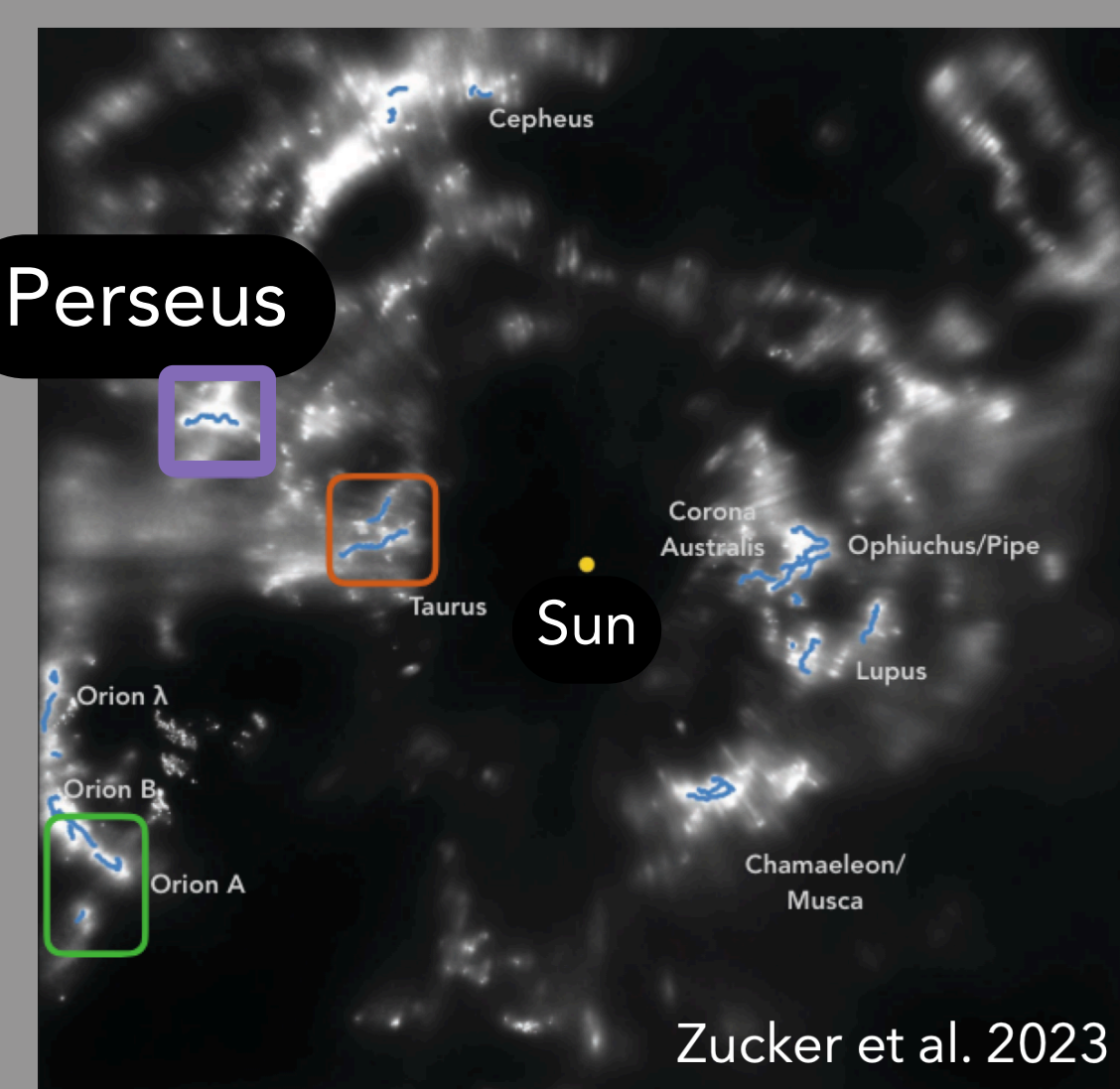
Munoz et al. (2015), Offner et al. (2023)



H α emission can be used as a beacon to directly image young accreting planets, irrespective of their formation history.

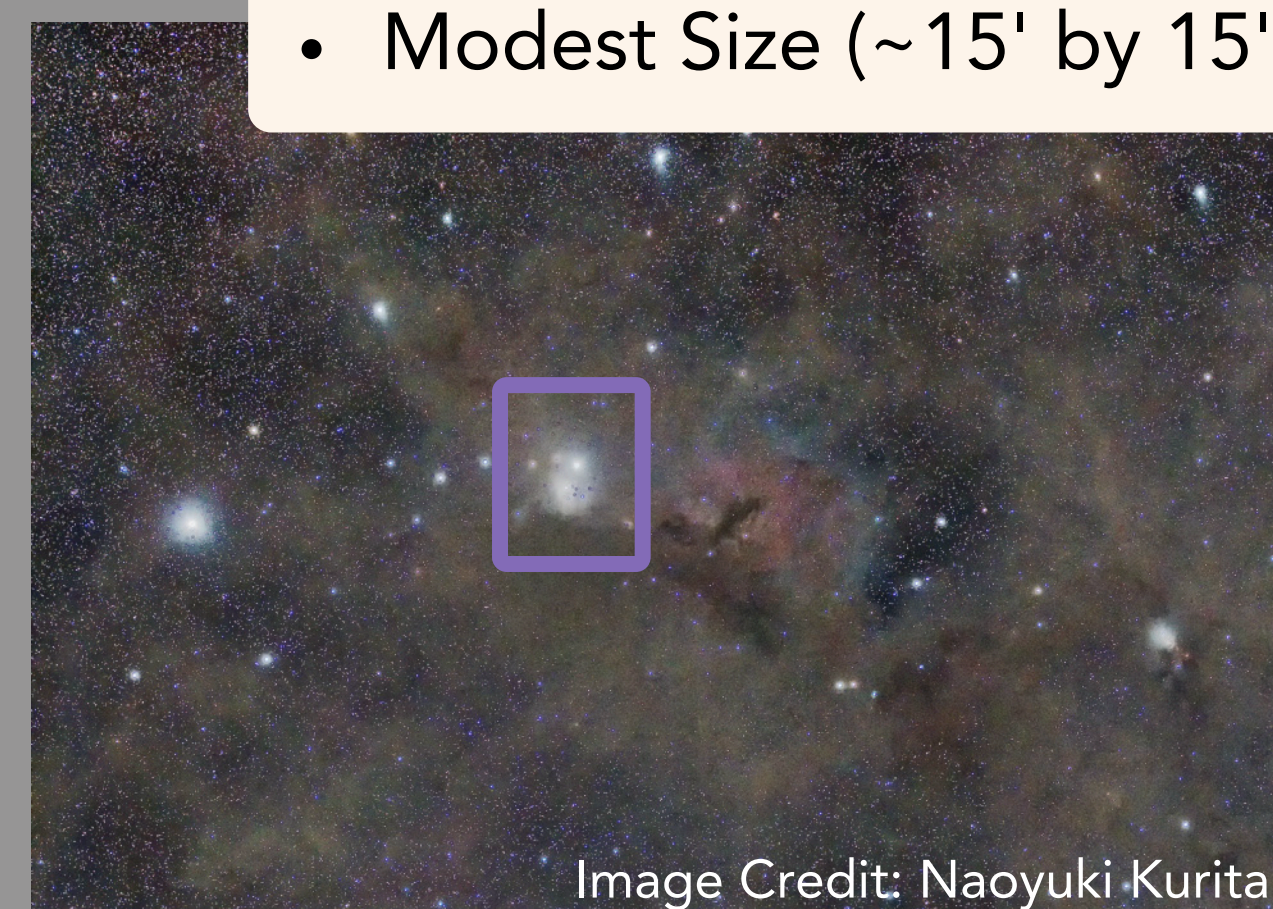
(e.g., Baraffe et al. 2003, Marley et al. 2007, Fortney et al. 2008, Bowler 2016)

1 Perseus Cloud

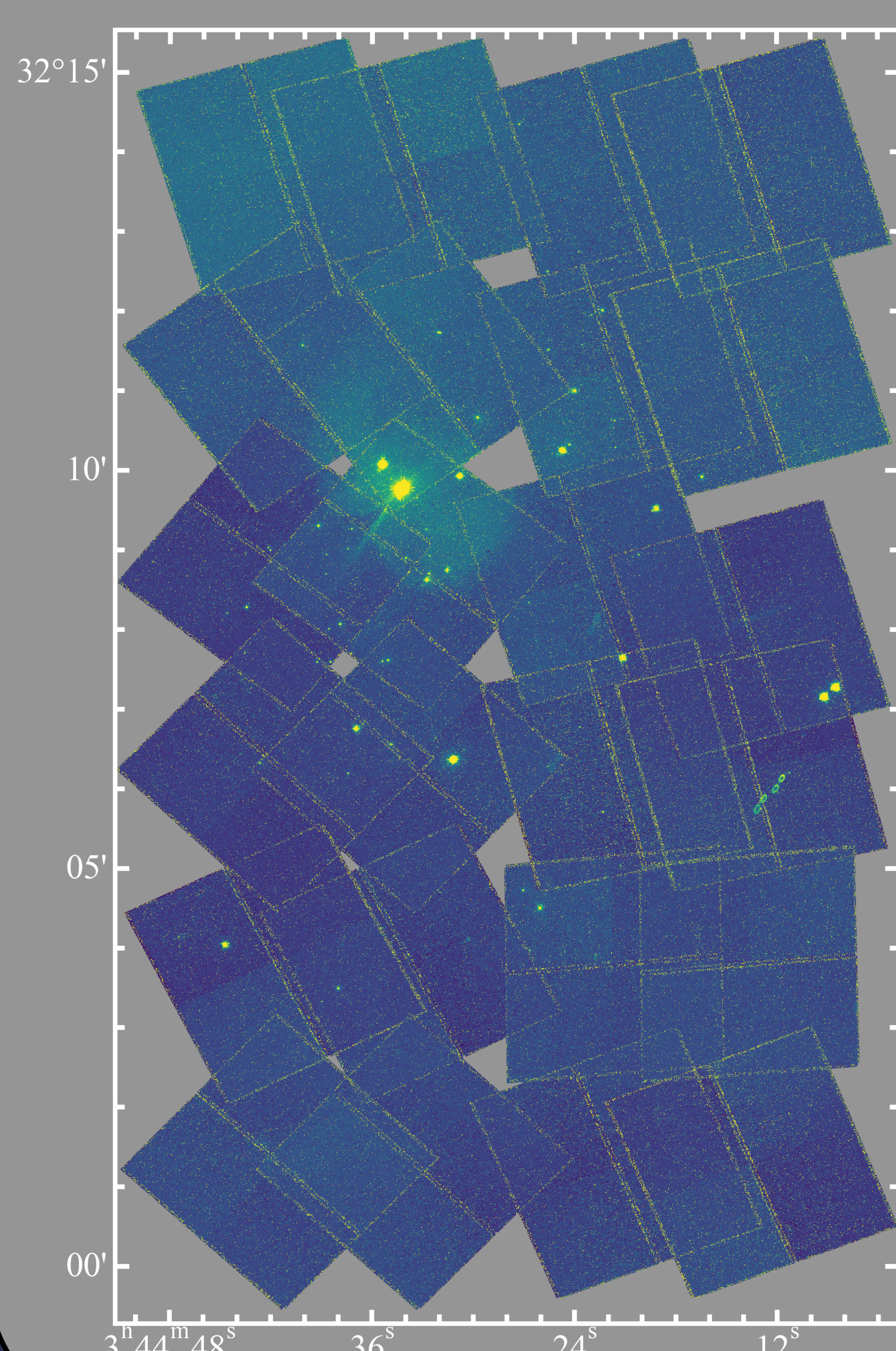


2 IC 348

- Young (~2 Myr)
- Nearby (~320 pc)
- Compact (~400 members)
- Modest Size (~15' by 15')



3 Efficient H α Imaging of Accreting Planets in IC 348



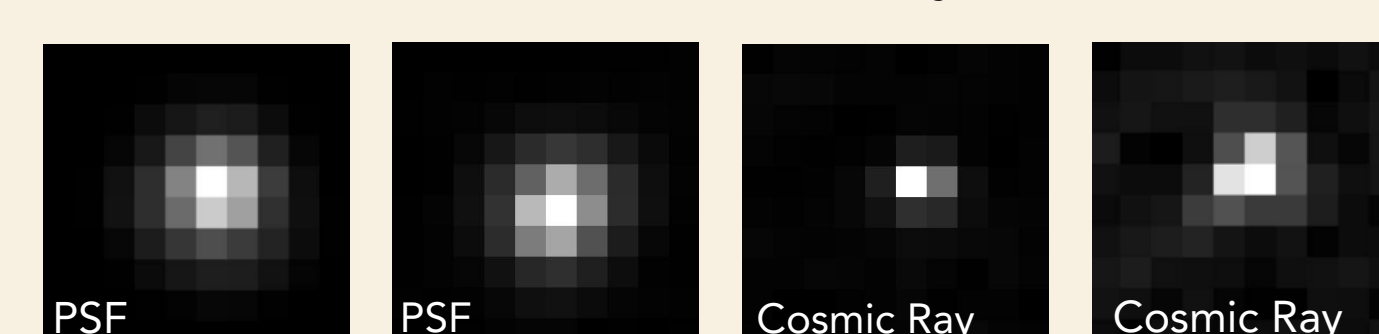
Goals:

- Search for hot- and cold-start giant planets in an unbiased manner
- Explore sub-Saturn-mass planets at wide wide separations
- Measure the occurrence rate of accreting planets at ~100-1000 AU

- HST WFC3-UVIS F656N Filter
- 12 orbits, one dither pattern, ~20 mins per field (GO 14172)
- 227 known members fall into the field-of-view of our HST mosaic footprint.

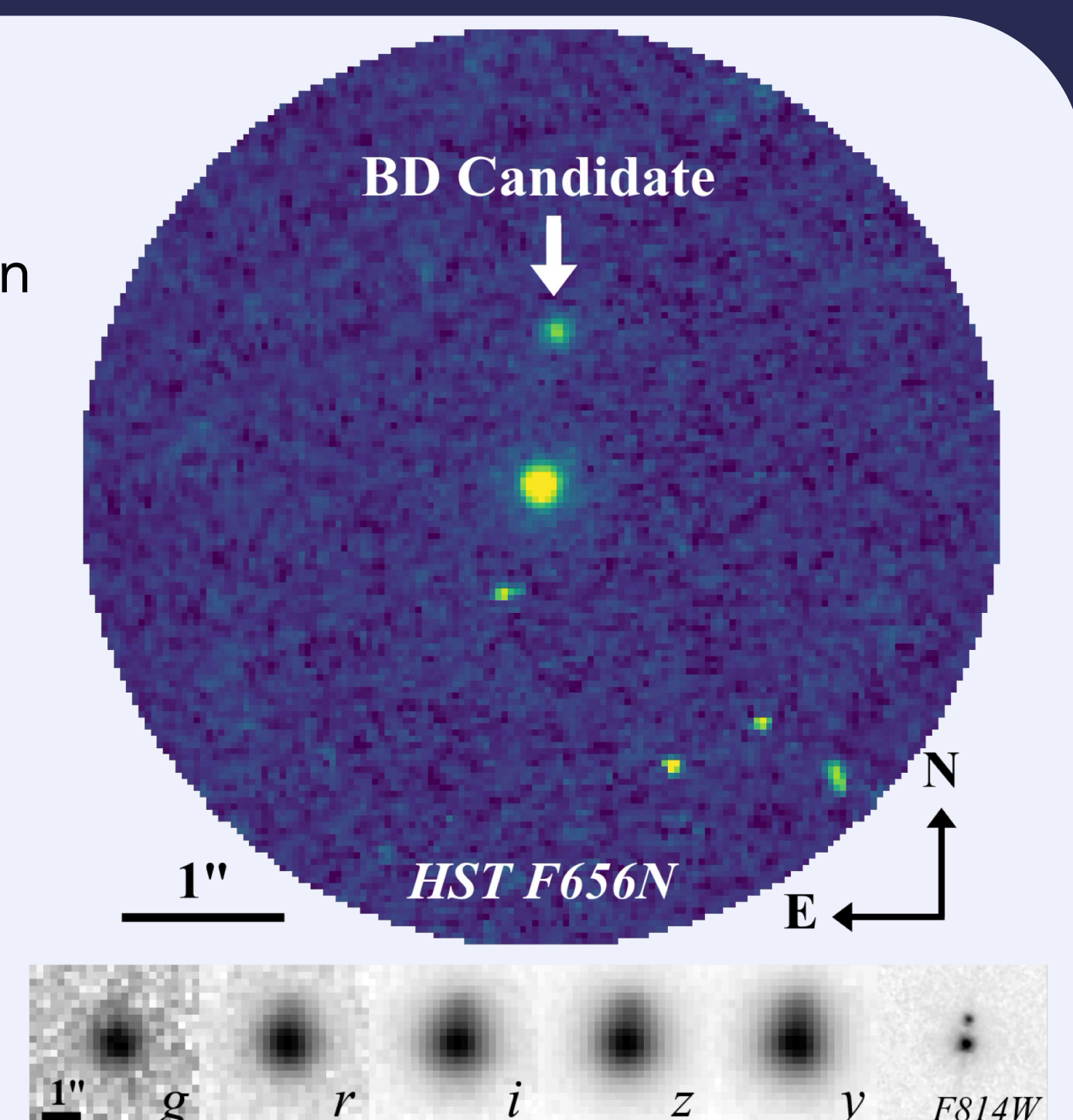
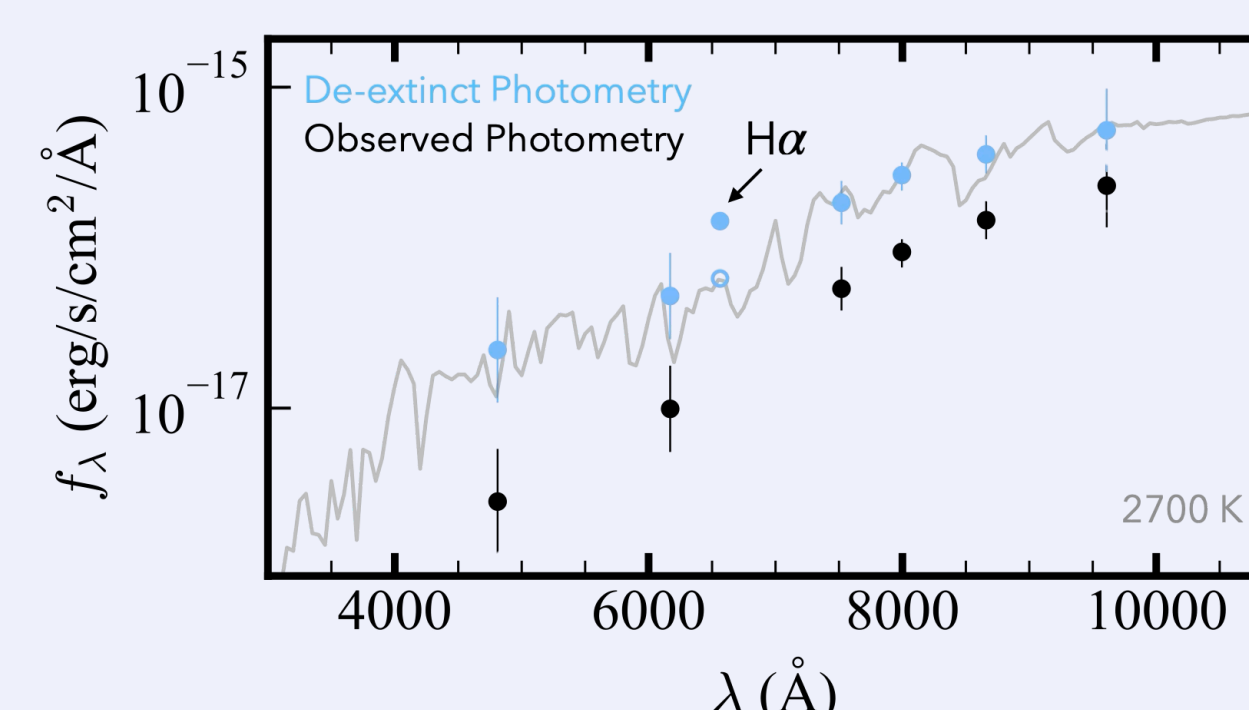
4 Image Classification Model

We develop a Convolutional Neural Network (LeCun et al. 2015) model to distinguish point sources from cosmic ray events.



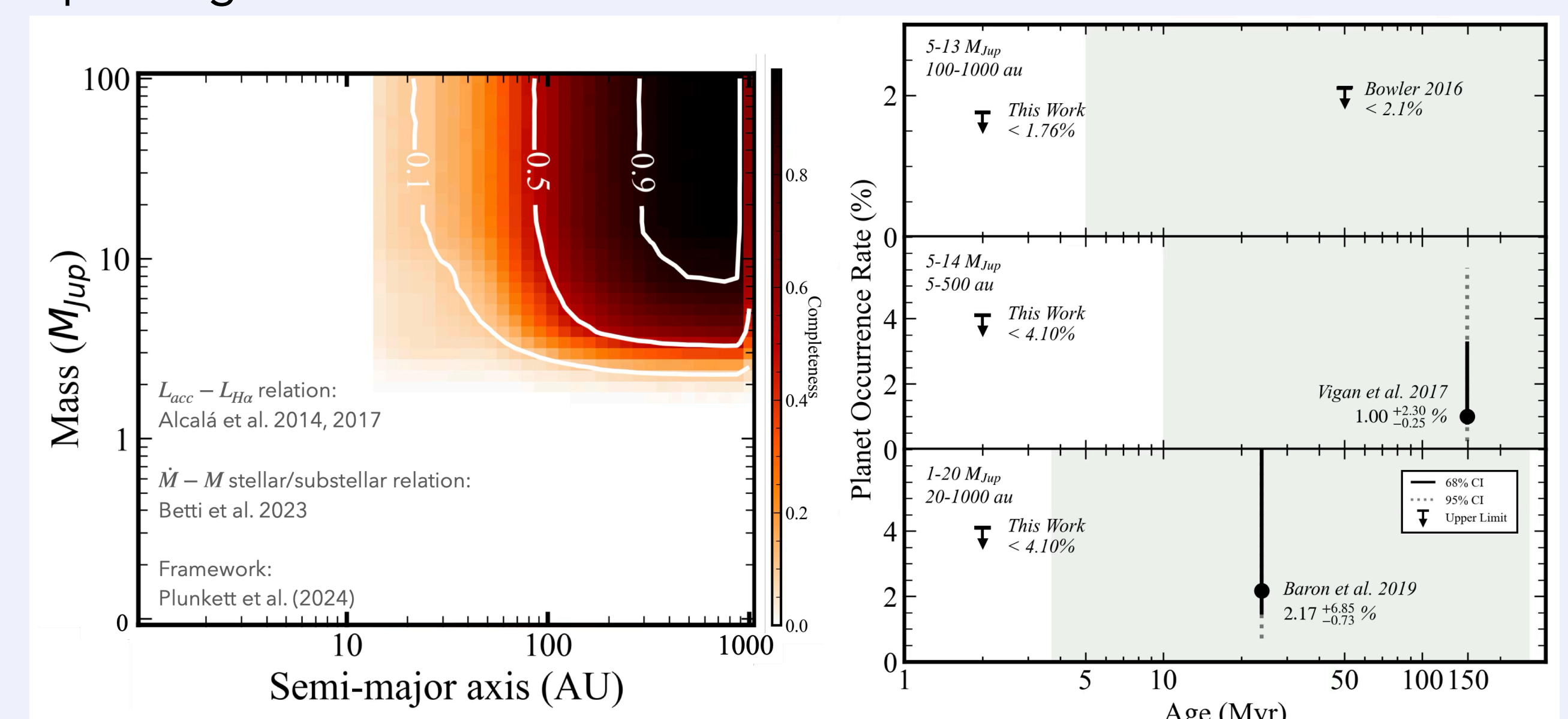
5 Results:

Discovery of a new accreting brown dwarf companion (~30 M_{Jup}) at 0.99" (305AU) in IC 348.



No planets were found.

We find the occurrence rate of 5-13 M_{Jup} wide-orbit protoplanets spanning 100 – 1000 au in IC 348 is < 1.8%.



Do giant planets at ultra-wide orbits experience significant stripping over time?

No, there is no observed decreasing trend in their occurrence.

Could there be a hidden population of cold-start planets at ultra-wide orbits?

Unlikely, as a declining trend would be expected if such planets were as common as hot-start planets.

Could accretion variability explain the observed trends?

Possibly. If accretion is highly variable, we may be only seeing a portion of the long-period accreting planets
(see Close et al. 2025, Zhou et al. 2025, Bowler et al. 2025).