What does Gravitational Lensing Bias mean for James Webb Space Telescope and its Deep Surveys of the First Light Epoch?

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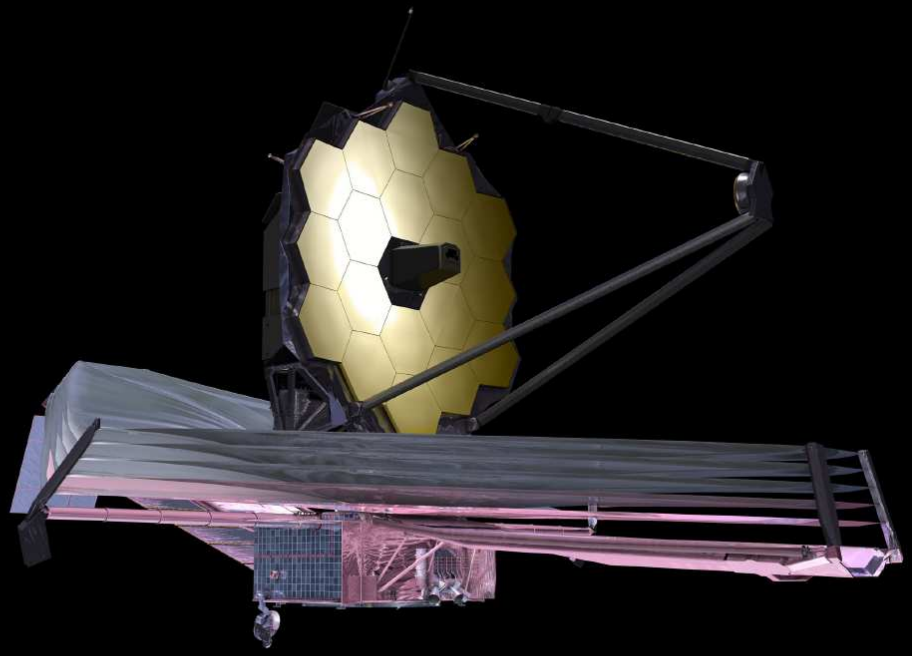
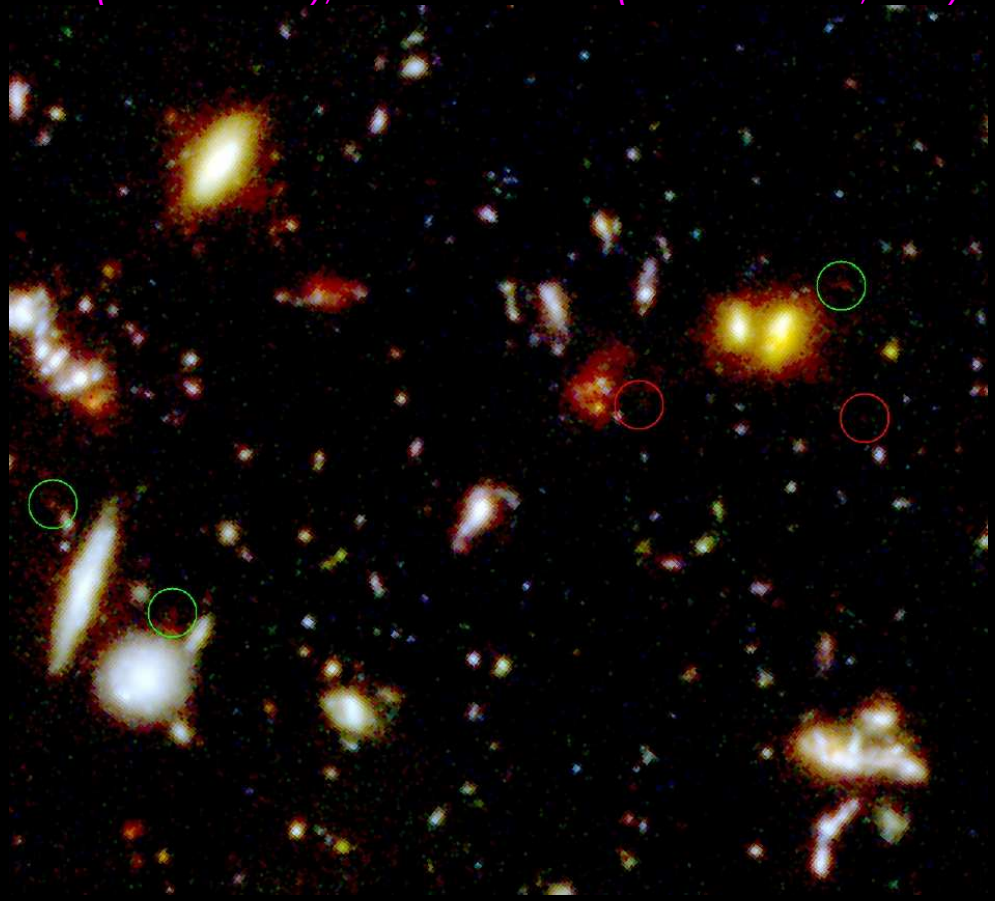


JWST and ...



Gravitational Lensing Bias

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http://hubblesite.org/newscenter/2011/04/ or http://www.asu.edu/clas/hst/www/nature11/

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What have we learned about Gravitational Lensing Bias?

(1) The very distant Universe is throwing us some enormous curve-balls here: 20–40% of z$\simeq$8–10 candidates lensed by foreground galaxies?

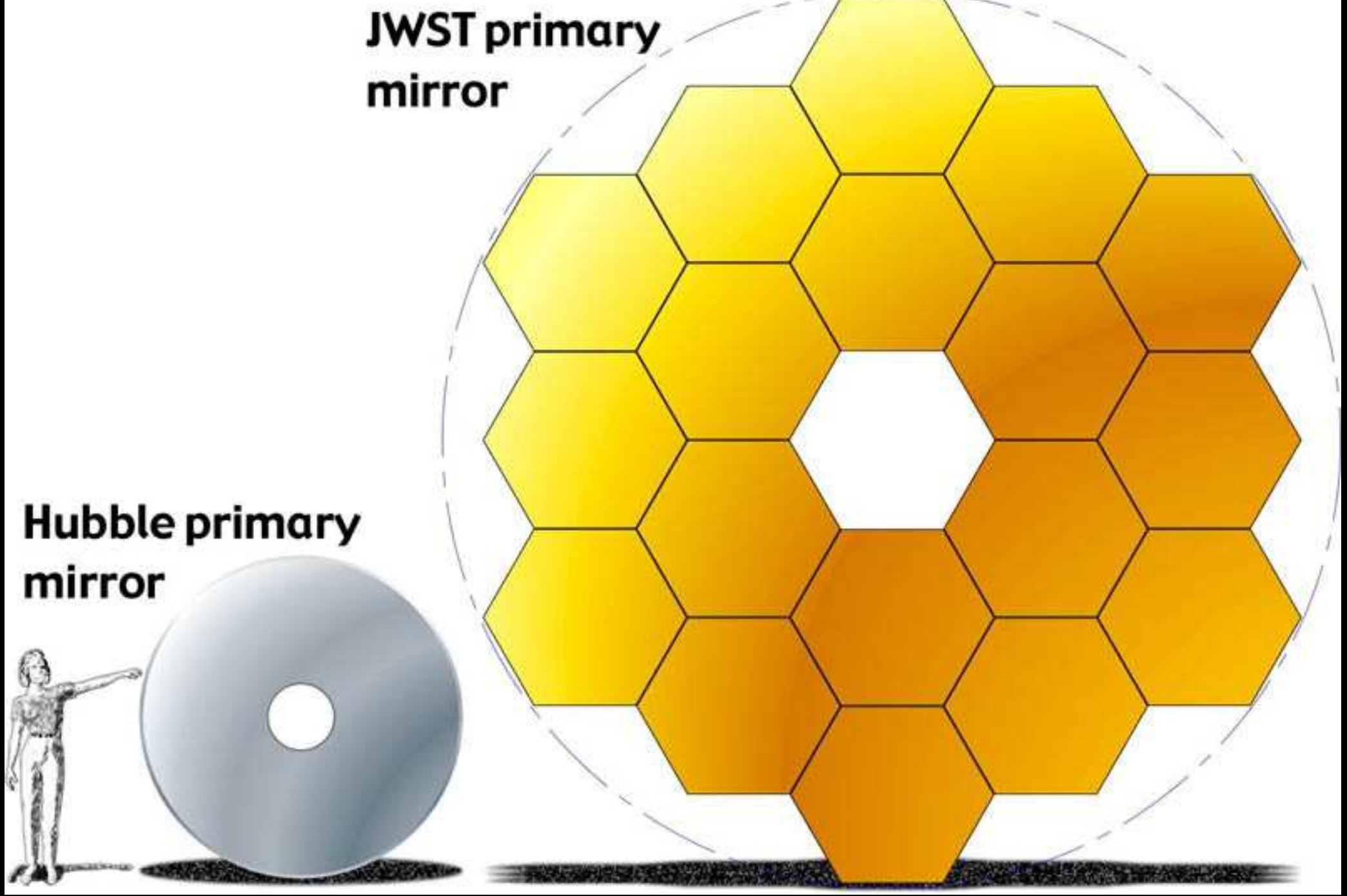
- Hubble doesn't have the capability to properly field all of these: Need spectroscopic confirmation, but beyond capability of Hubble or ground.

(2) The very distant Universe acts like a cosmic "House of Mirrors":

- There may be fewer direct lines-of-sight to a very distant object.
- Their images may reach us often via a gravitationally-bent light path.
- What you see is NOT what you've really got!

(3) Finding these very distant lensed objects is like searching for a few needles in the "Mother-of-all-Haystacks":

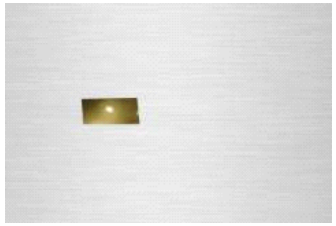
- Mother Gravity hides those needles where the hay is densest !
- At Hubble's resolution, one literally can no longer see the whole "Forest for the Trees" at these extreme distances.
- We are reaching the limit of Hubble's ability at redshifts z$\gtrsim$8–10.



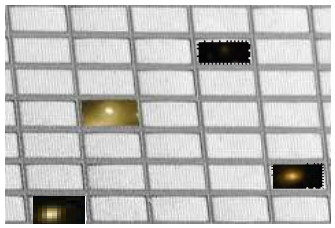
Webb is $\sim$2.5$\times$ larger than Hubble, so at $\sim$2.5$\times$ larger wavelengths:
Webb has the same resolution in the near-IR as Hubble in the optical.

Lensing bias may occur for $\gtrsim$50% of the objects at z$\gtrsim$12. (506 orbits HUDF in BVizYJH).

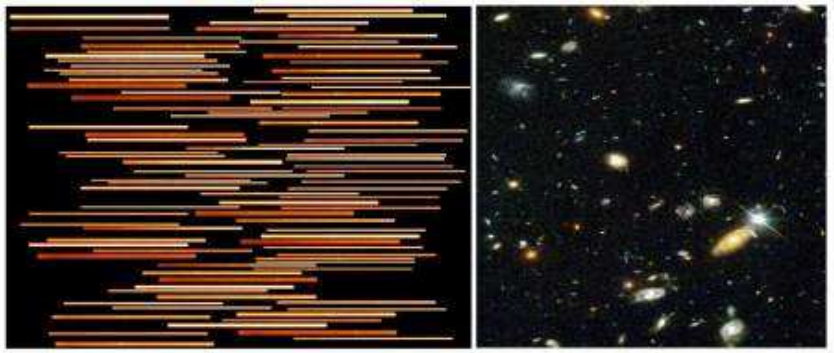
Micro Shutters

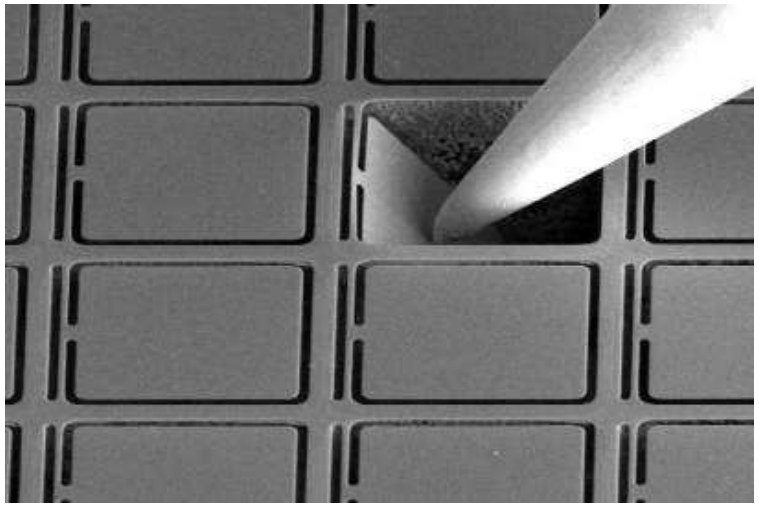


Metal Mask/Fixed Slit



Shutter Mask





Only Webb's multiplexing spectroscopic capabilities can provide the essential confirmations of objects seen via Gravitational Lensing bias.

CONCLUSIONS

(1) The distant Universe ($z \gtrsim 8$–10) is throwing us enormous curve-balls:

- Only JWST will have the batting average to properly field these:

(2) Only the Webb telescope – when it gets finished as designed — will have the exquisite resolution, sensitivity and wavelength range to disentangle the "First Light forest from the foreground trees".

(3) Webb is designed and being built just right to deal with Gravitational Lensing bias. No changes are needed, we just need JWST launched!

(4) Lensing bias in very distant galaxy samples affects how we carry out surveys for First Light objects — a central part of Webb's mission:

- Deeper surveys suffer less from lensing bias, but have more object overlap.
- The Webb survey strategy will need to accommodate lensing bias.
- JWST spectroscopy is needed to confirm lensing bias candidates.

(5) We need a next generation of object finding algorithms that is designed to find these rare, faint objects behind such dense foregrounds.

REFERENCES & URLs FOR THIS PRESS TALK and POSTER 347.09

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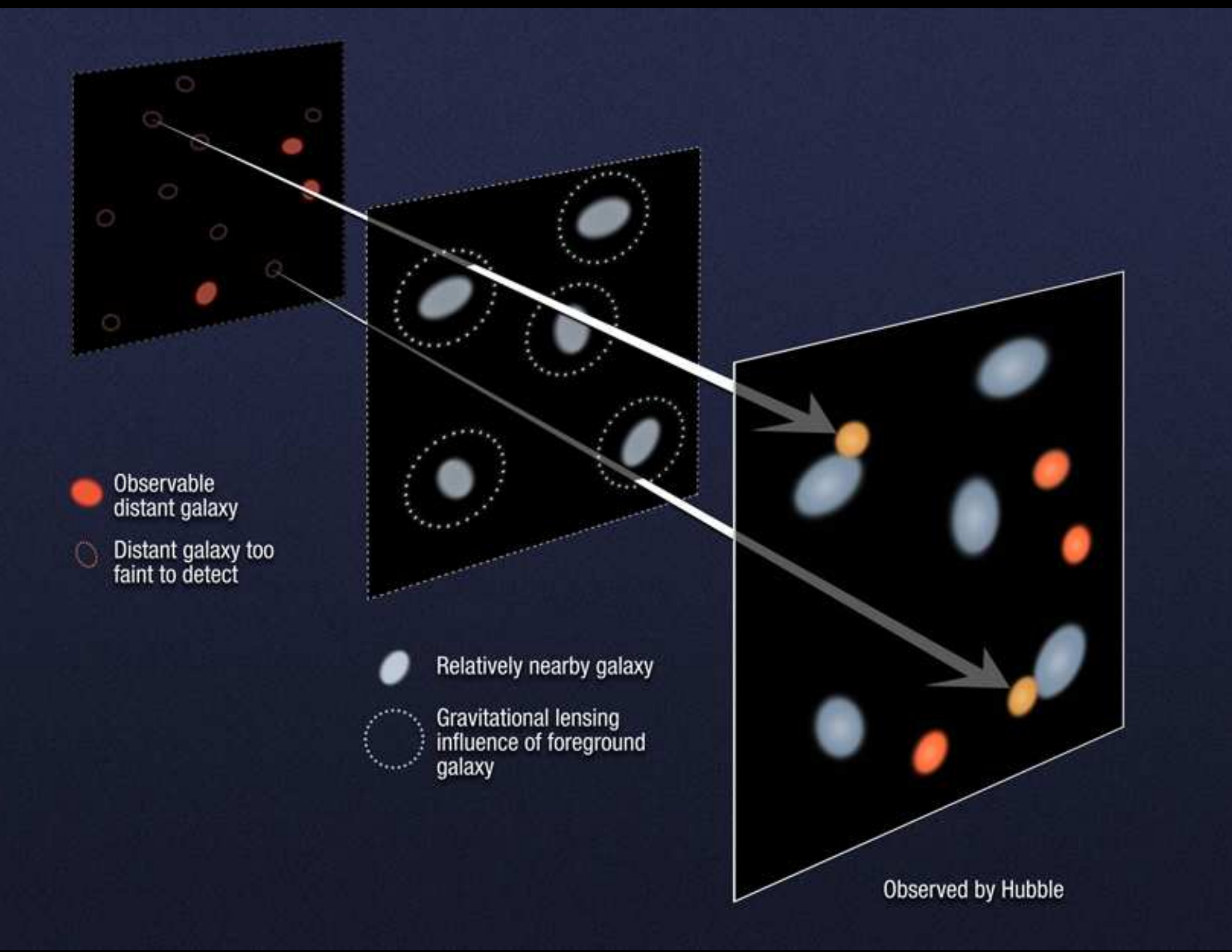
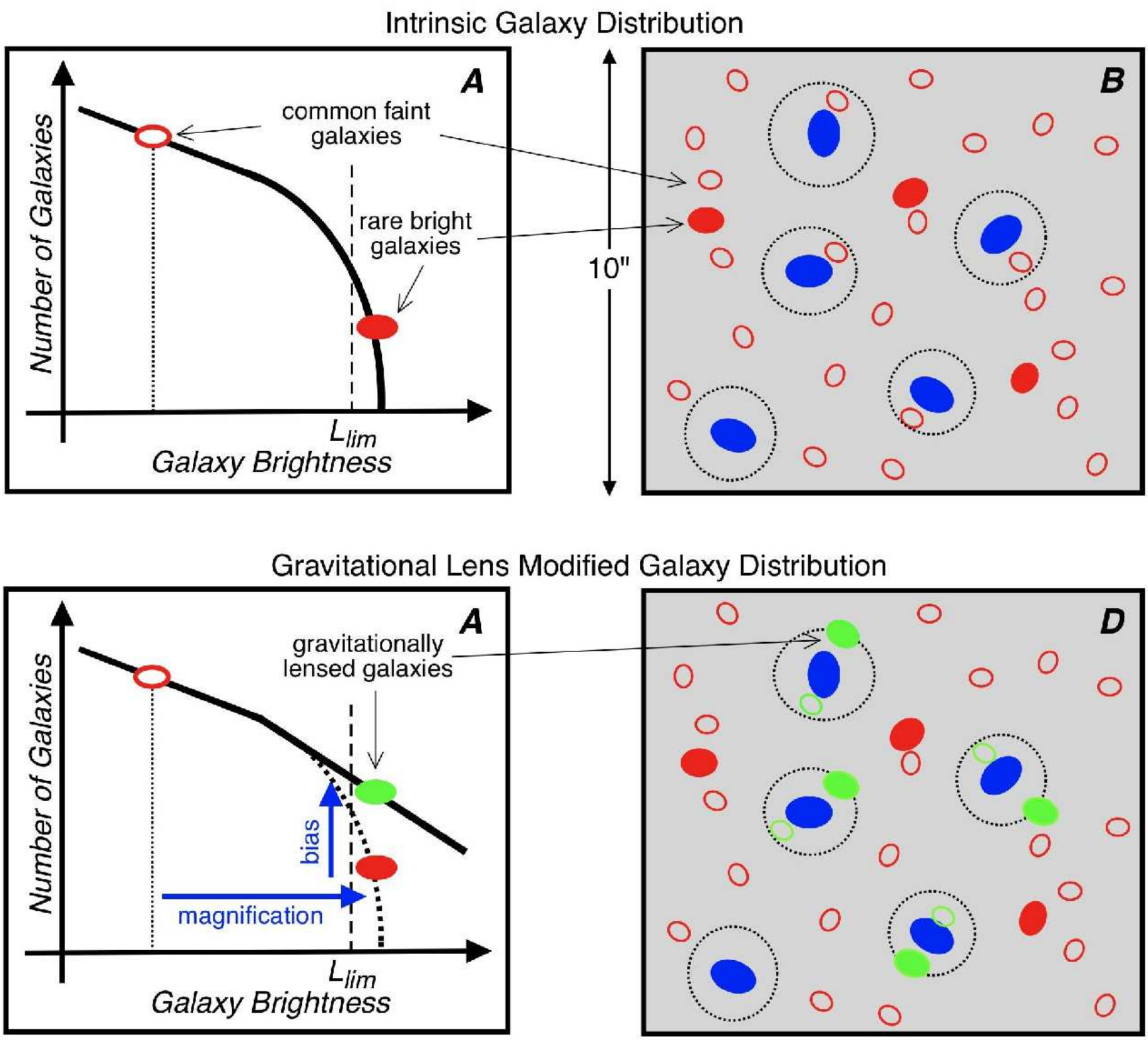
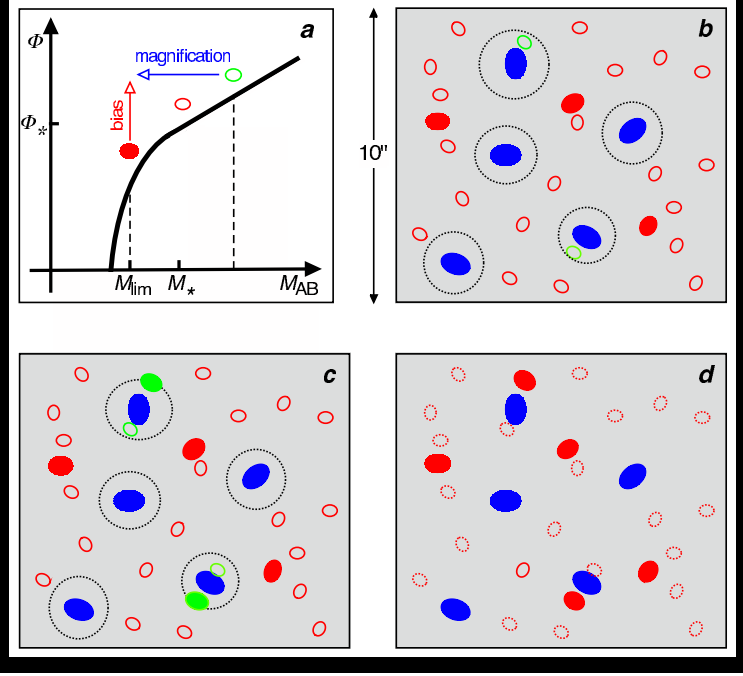
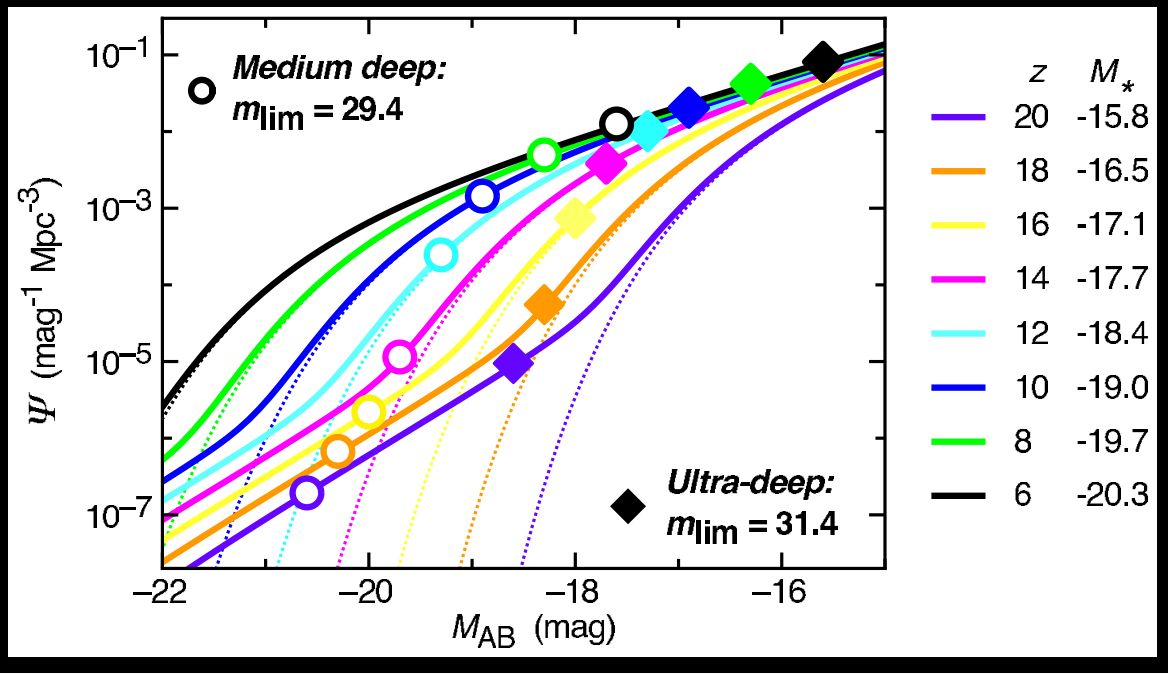
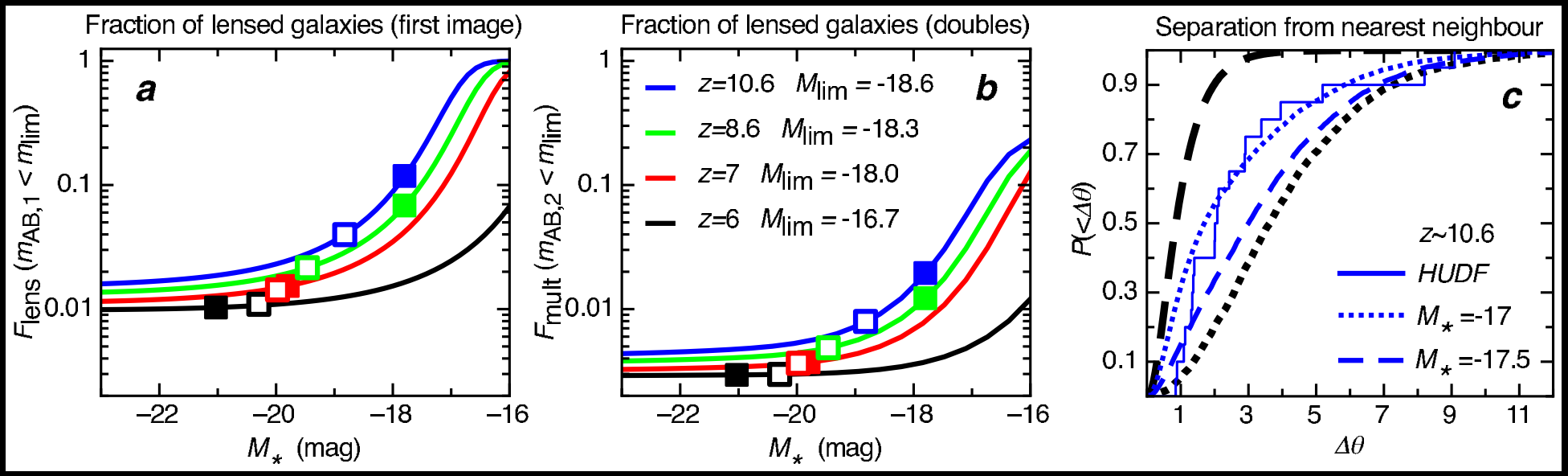
SPARE CHARTS


Observable distant galaxy
Distant galaxy too faint to detect
Relatively nearby galaxy
Gravitational lensing influence of foreground galaxy
Observed by Hubble


Intrinsic Galaxy Distribution
A
common faint galaxies
rare bright galaxies
Number of Galaxies
L_{lim}
Galaxy Brightness
10"
B
Gravitational Lens Modified Galaxy Distribution
A
gravitationally lensed galaxies
bias
magnification
Number of Galaxies
L_{lim}
Galaxy Brightness
D







Wyithe et al. (2011, Nature, 469, p. 1–4): With a steep faint-end LF-slope $\alpha \gtrsim 2$, and a characteristic faint $M^* \gtrsim -19$ mag, foreground galaxies (at $z \simeq 1$–2) will cause significant boosting by gravitational lensing at $z \gtrsim 8$–10.

- This will change the landscape for JWST observing strategies.