Livin' on the Wedge, or *JWST*/NIRCam Bar Coronagraphy

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Giant planets emit a significant fraction of their total flux between 3-5 microns, a wavelength range shaped by molecular species that are sensitive tracers of atmospheric physics and composition. *JWST/*NIRCam (1-5 micron) houses two types of coronagraph: round and bar masks, with their associated Lyot stops. The round masks have been used to great success following the commissioning [1] and ERS [2] programs that demonstrated the WFE stability of the telescope contributes to exceptional post-processing starlight subtraction performance. The round masks (IWA=6λ/D) have been predominately deployed in Cycles 1-3 because of their unbiased field of view and deeper contrast at wide separations, but in principle the bar masks (IWA=4λ/D) provide up to an order of magnitude better contrast at key spatial separations where giant planets are found [3]. There is potentially even greater performance to be gained by ignoring the filter dependent positions along the bar and using a shared-risk "narrow" position that decreases the IWA by 2-4x [4]. The JWST-TST has used GTO to observe two emblematic direct imaging systems to characterize the performance of this mode and shed new light on their atmospheres

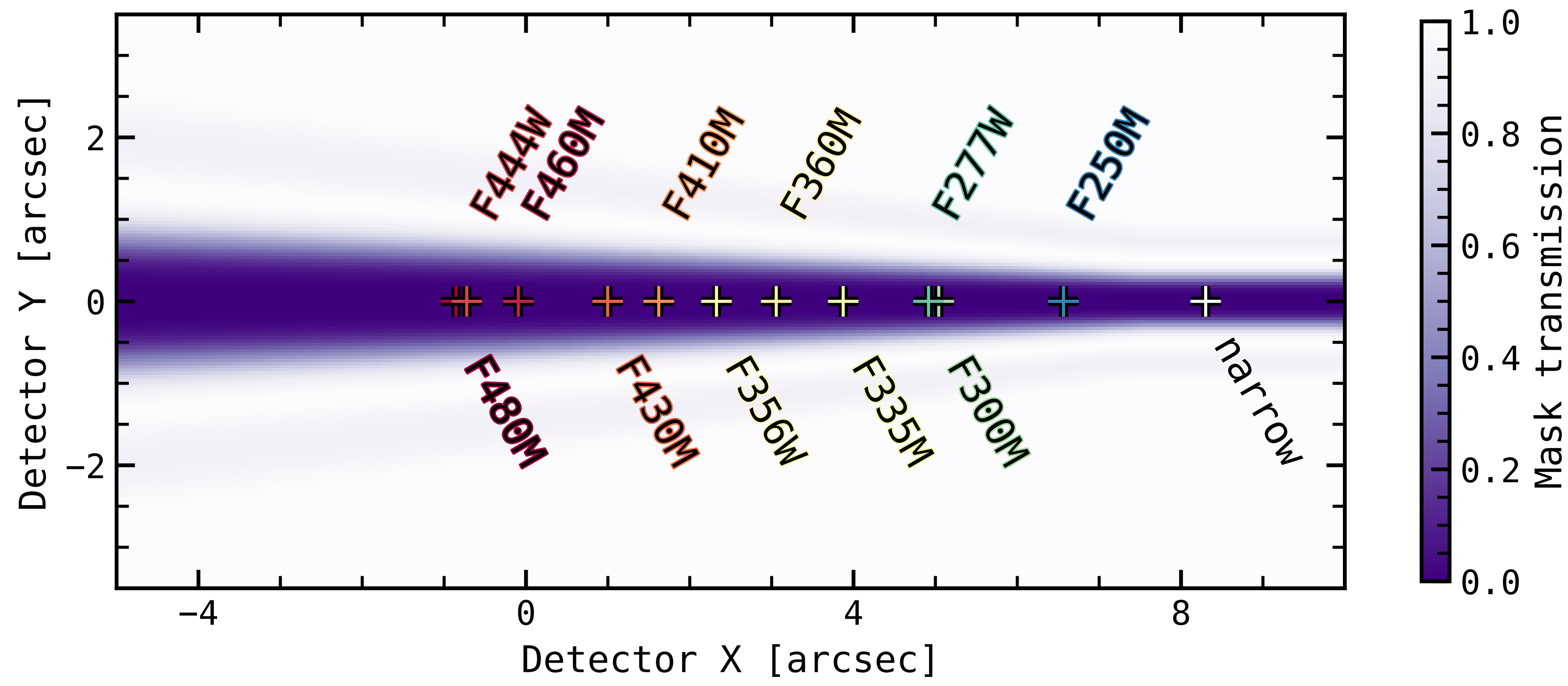


Figure 1: NIRCam LWBAR transmission function and filter dependent offset positions (plus narrow)

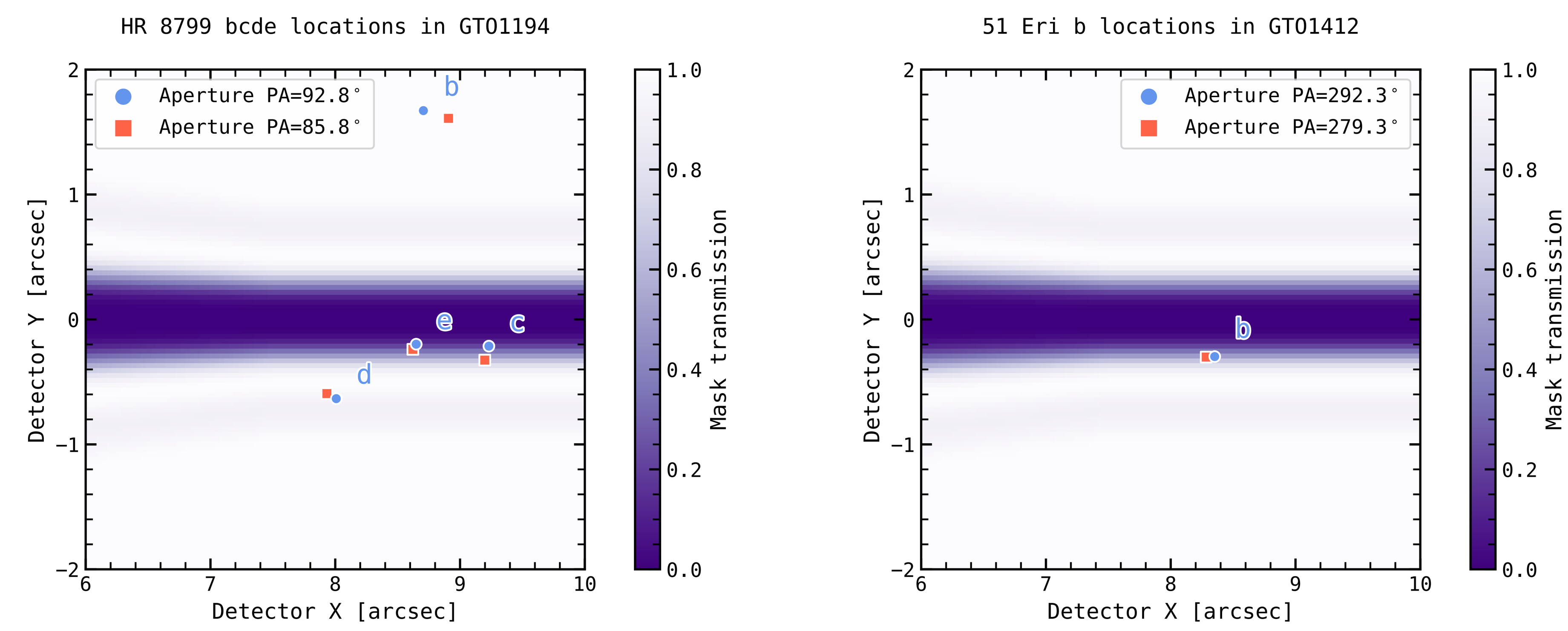


Figure 2 & 3: Planet positions w.r.t the narrow offset position for our observations

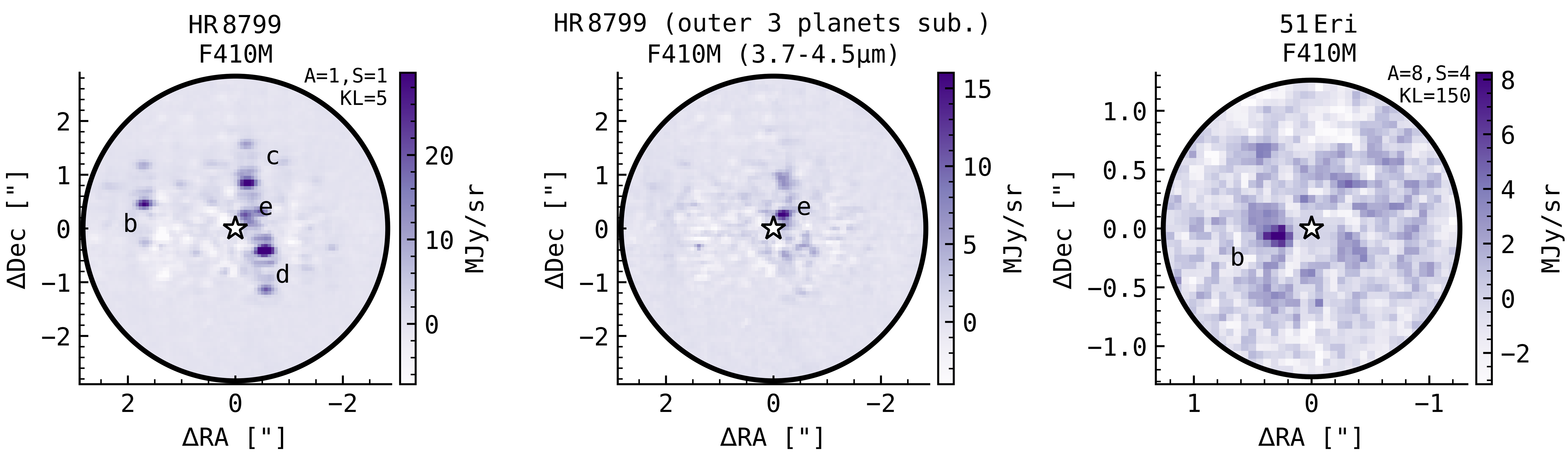
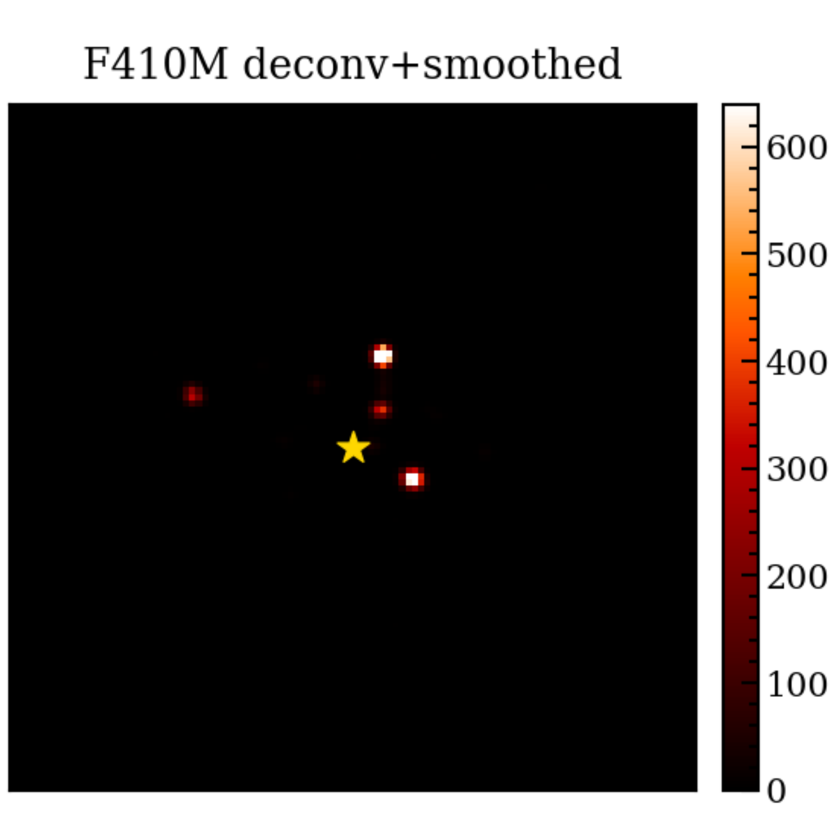


Figure 4: Post-KLIP images. *Left* HR 8799 bcd, *Middle* HR 8799 e, *Right* 51 Eri b



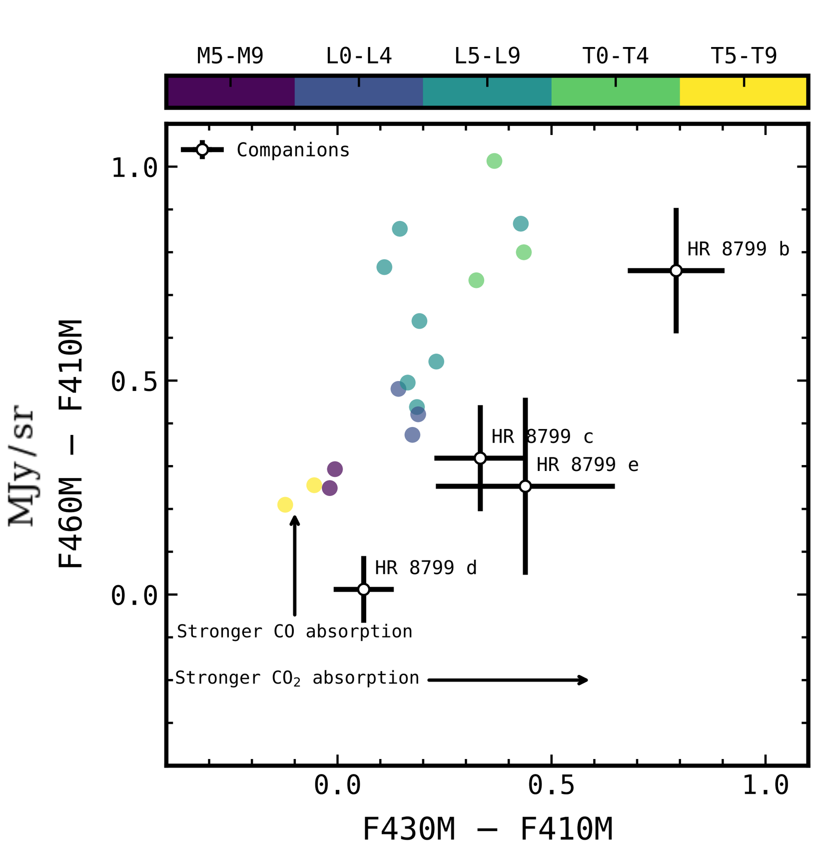
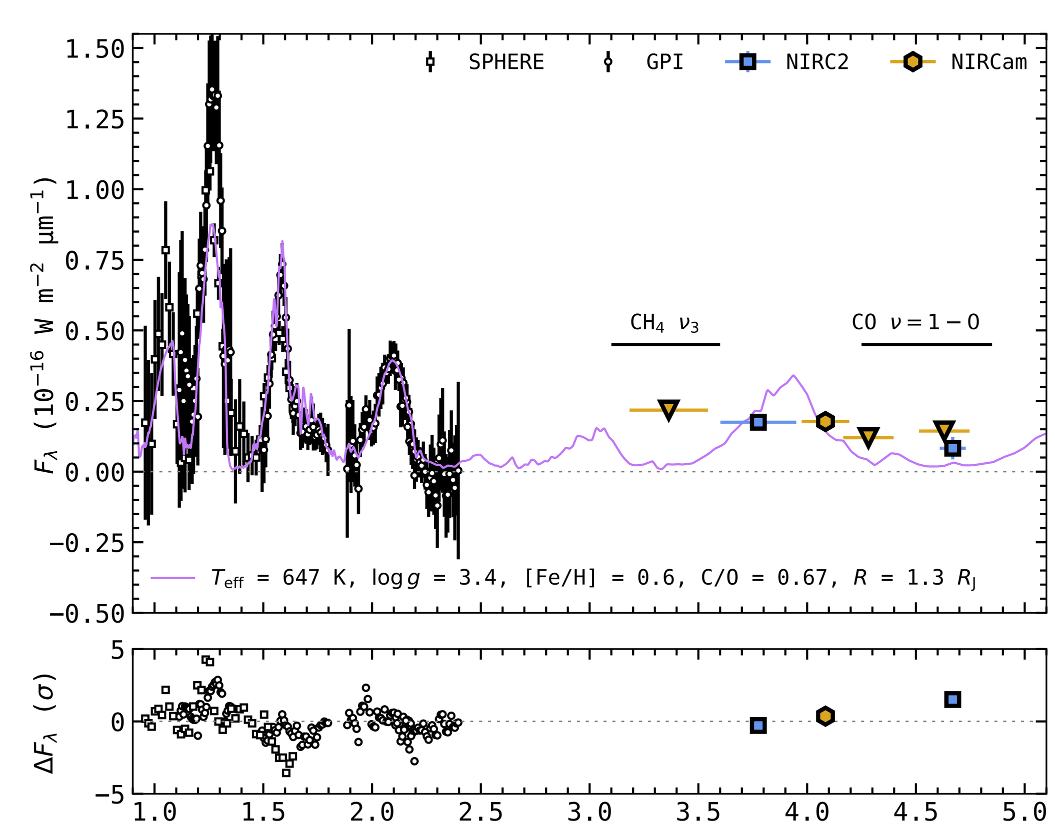


Figure 5 (left): Post-KLIP images deconvolved with position dependent off-axis PSF. Figure 6 (middle): color-color diagram of HR 8799, showing different colors between b, c, d. Figure 7 (right): ExoREM RCE model fit to 51 Eri b observations.



Early atmospheric modeling shows that the chemistry of each atmosphere is in disequilibrium (as anticipated). The HR 8799 planets each have different [F410M]-[F430M] and [F410M]-[F460M] colors, in particular there is a gradient from b, c, d with bluer 4-5 micron slopes, indicating potential composition or mixing differences between the planets moving radially outwards. Our best fitting models for 51 Eri b are consistent with evolutionary tracks for 2Mj at 16,24 Myr. 51 Eri b astrometry favors eccentric orbits (e=0.6), but what could drive that high eccentricity?

References: [1] Girard et al. 2022 *SPIE*, [2] Carter et al. 2023 *ApJ*, [3], Kammerer et al. 2022 *SPIE*, [4] Perrin et al. 2018 *SPIE*