Considering Starshades for the Habitable Worlds Observatory

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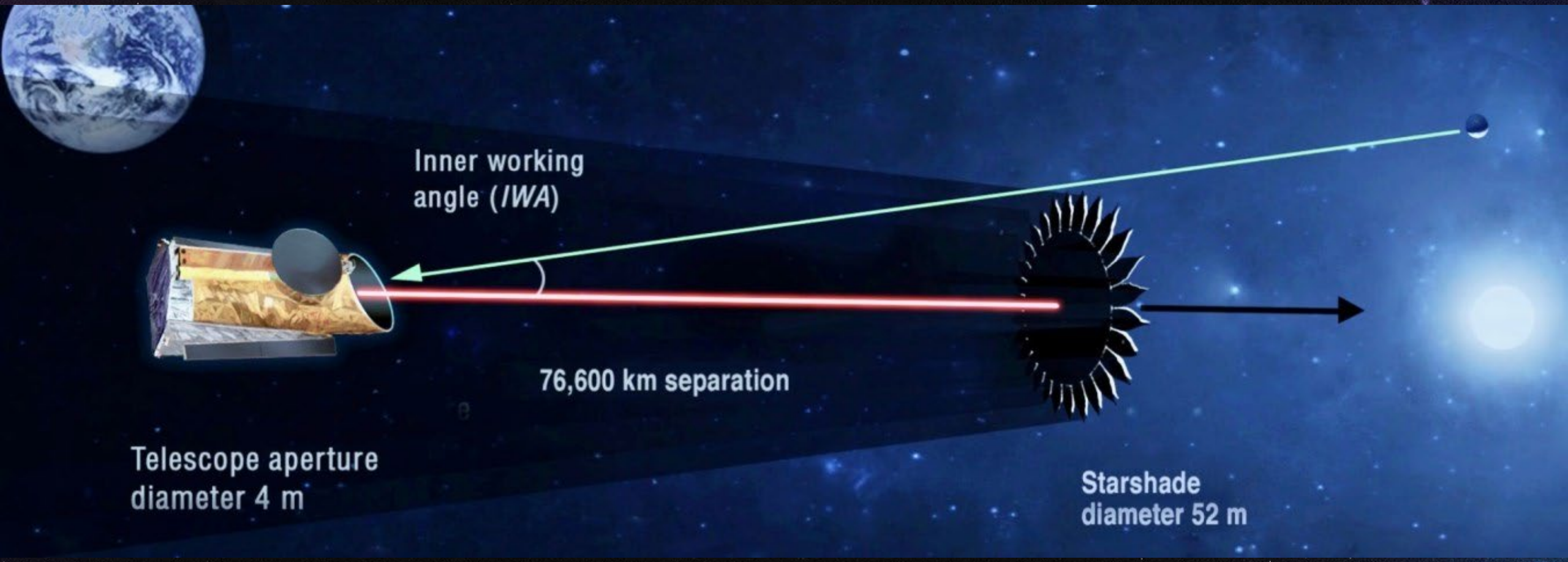
HabEx

Starshade



STARSHADE STRENGTHS

High throughput

Broad instantaneous bandpass

Highly stable telescope & active wavefront correction not required

Smaller inner working angle (IWA)

- For coronagraphs, typical IWA ≈ few x λ / D
- For starshades, minimum IWA ≈ 1.2 x λ / D

Outer working angle set only by size of detector

STARSHADE DRAWBACKS

Large, precisely shaped deployable

Full-scale optical system test on the ground not possible

– Sub-scale lab and field tests possible

Limited number of movements

Long times between targets

Key issue for Habitable Worlds Observatory

Shade must be much wider than telescope because of diffraction

	HabEx	LUVOIR-B	LUVOIR-A
Telescope Circumscribed Diameter	4 m		
Telescope Inscribed Diameter	4 m		
Starshade Diameter	52 m		
Bandpass	0.20 – 1.8 µm		

Key issue for Habitable Worlds Observatory

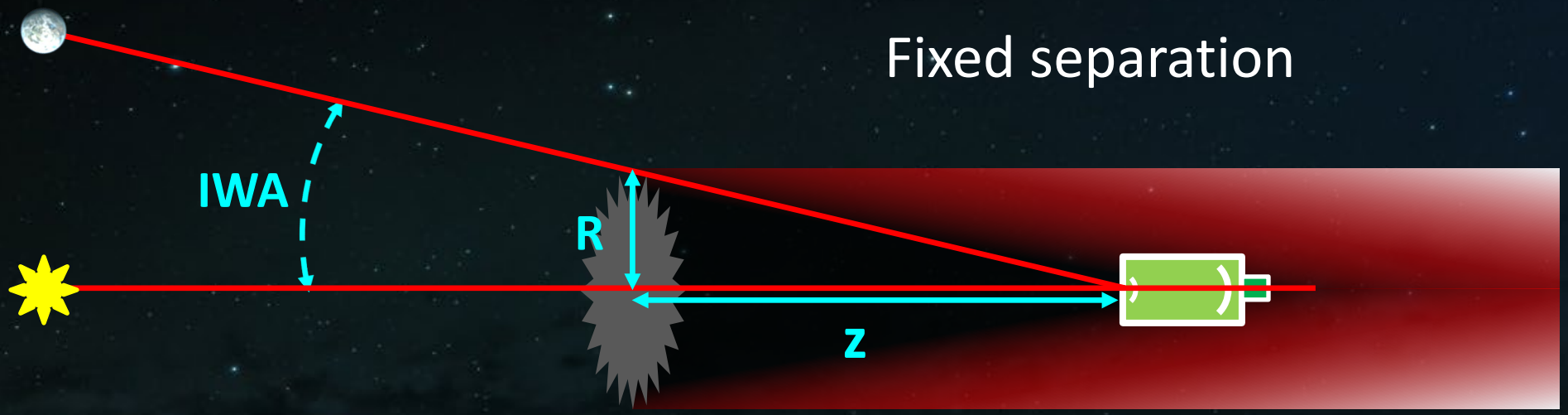
Shade must be much wider than telescope because of diffraction

	HabEx	LUVOIR-B	LUVOIR-A
Telescope Circumscribed Diameter	4 m	8 m	15 m
Telescope Inscribed Diameter	4 m	6.7 m	12.5 m
Starshade Diameter	52 m	> 200 m	> 200 m
Bandpass	0.20 – 1.8 µm	0.25 – 2.5 µm	0.25 – 2.5 µm

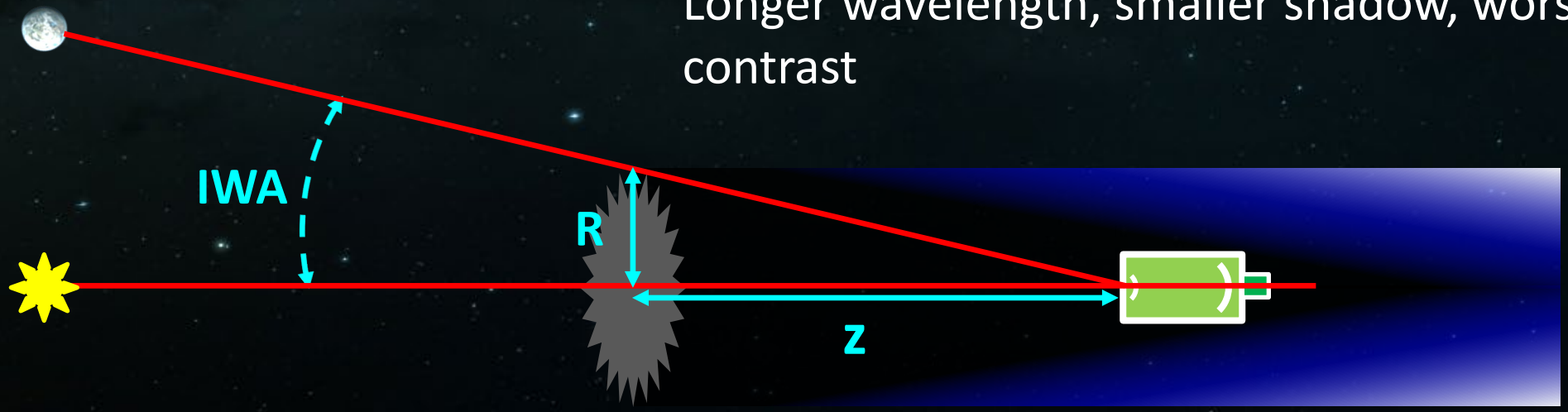
Credit: Eric Cady (JPL)

WAVELENGTH DEPENDENCE

Fixed separation



Longer wavelength, smaller shadow, worse contrast



Shorter wavelength, larger shadow, better contrast

An interesting starshade for HWO?

Need high-contrast spectroscopy down to ~0.2 µm to observe ozone, a key biosignature gas

- NUV channel in coronagraph is likely to be especially challenging

	HWO	LUVOIR-B	LUVOIR-A	LUVOIR-A
Telescope Circumscribed Diameter	?			
Telescope Inscribed Diameter	6 m			
Starshade Diameter	56 m			
Bandpass	0.50 – 1.0 µm			

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	HWO	LUVOIR-B	LUVOIR-A	LUVOIR-A
Telescope Circumscribed Diameter	?	8 m	15 m	
Telescope Inscribed Diameter	6 m	6.7 m	12.5 m	
Starshade Diameter	56 m	~ 95 m	~ 160 m	
Bandpass	0.50 – 1.0 µm	0.25 – 1.0 µm	0.25 – 1.0 µm	

An interesting starshade for HWO?

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	HWO	LUVOIR-B	LUVOIR-A	LUVOIR-A
Telescope Circumscribed Diameter	?	8 m	15 m	15 m
Telescope Inscribed Diameter	6 m	6.7 m	12.5 m	12.5 m
Starshade Diameter	56 m	~ 95 m	~ 160 m	~ 46 m
Bandpass	0.50 – 1.0 µm	0.25 – 1.0 µm	0.25 – 1.0 µm	0.25 – 0.40 µm

NUV / Blue starshade for Habitable Worlds Observatory might be reasonably sized