mDOT

Miniaturized Distributed Occulter/Telescope for Direct Imaging of Extrasolar Dust Disks

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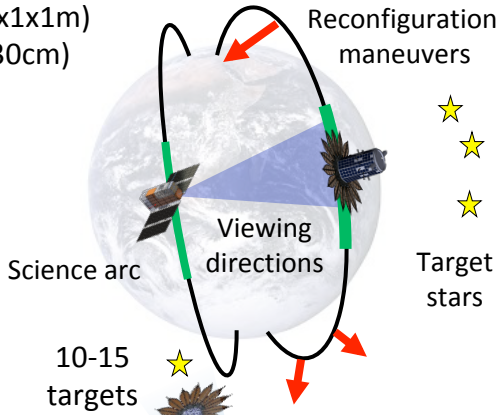
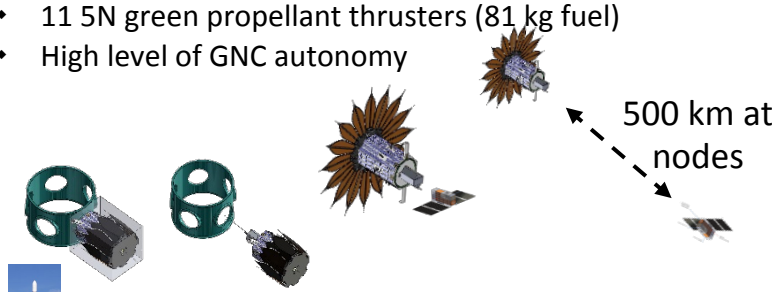
Starshades enable exoplanet imaging using a large free-flying occulter spacecraft to block the light of a star. mDOT uses novel orbit architectures and precision navigation and maneuvering to enable a small-scale starshade mission in Low Earth Orbit. Circumstellar dust disks trace the formation and evolution of planetary system, but could represent a potential obstacle to future exoplanet imaging missions. With the light of the target star suppressed mDOT will observe zodiacal-equivalent disks at unprecedented sensitivity

Objective	Targets and observations	Key Requirements
Constrain size and composition of dust particles near young stars	Measure short-wavelength brightness of known young-star debris disks	Inner working angle 2” 450 nm imaging 1” resolution Surface brightness 20-22 mag/square arcsecond
Determine ratio of scattered light to thermal emission for disks seen only in IR	Measure scattered-light surface brightness of mature nearby stars with IR excess	Inner working angle 1” 1” resolution Surface brightness 18-22 mag/square arcsecond
Measure presence of dust around nearby stars	Measure scattered-light surface brightness of mature nearby stars at 1-5 AU scales	Inner working angle 0.6” 1” resolution Surface brightness 21-23 mag/square arcsecond

- Microsatellite starshade (3-m starshade, 246kg, 192W, ~1x1x1m)
- Cubesat telescope (9 cm telescope, 12kg, 100W, ~10x20x30cm)
- Cubesat is hosted and ejected by microsatellite
- Orbit: Sun-synchronous (>500km, 98deg)
- 3-5 minute science observations during node crossings
- 1 to 9 observation passes per target
- Orbit precesses in RA to successive targets
- 11 5N green propellant thrusters (81 kg fuel)
- High level of GNC autonomy





<1 day	3 weeks	4 weeks	11 months	1 week
Launch	Deployment/ Commissioning	Formation acquisition	Science: 1-9 obs per target, New target every 1-4 wks	Decomm

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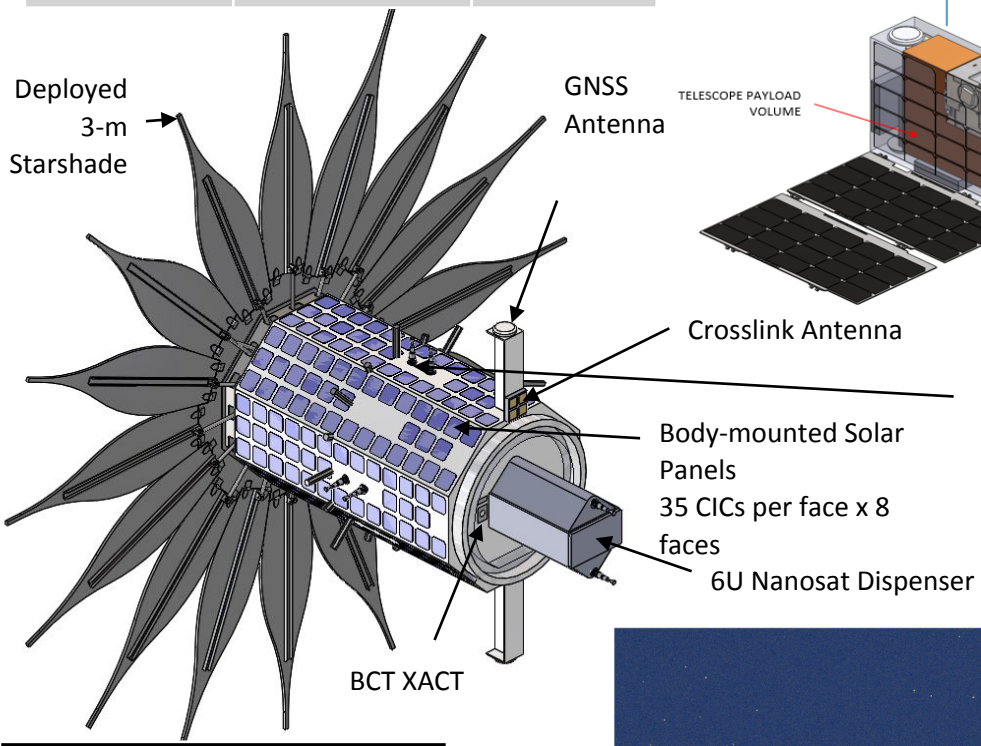
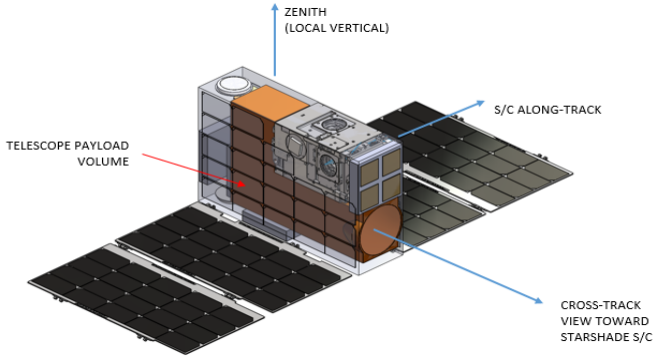
Starshade (Stanford, JPL, Tendeg)	
Diameter	3m (16 petals)
Suppression	10^{-7} (10 Fresnel)
Shape Tolerance	0.1 mm
Deployment	Single-stage motorized
Structure	Carbon-fiber with precision-etched amorphous metal foil

Telescope (Stanford, Ames, Planet)	
Aperture (f)	9.2cm (15.5)
Wavelength range	400-490 nm (B band)
Pixel Size (Nyquist)	3.45µm (0.5 arcseconds)
Resolution (Stability)	1'' (0.2'')
Image stabilization	Mirrorcle tip/tilt mirror
Detectors	2xIMPERX CMOS (1.2MP) (guiding and science)

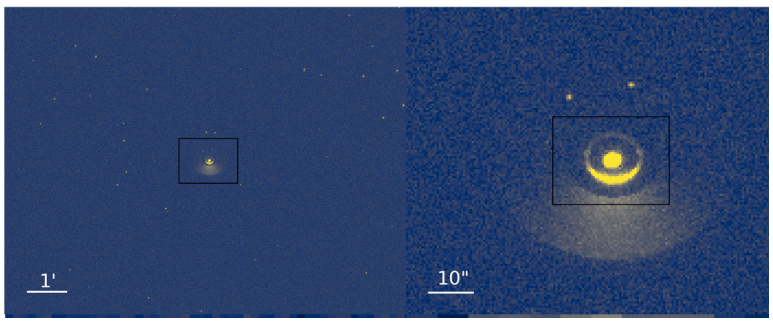
Microsat starshade (Ames)		
Rel nav	2 cm, 0.1 mm/s	DIGITAL
Att know/ctrl	0.2 deg/1 deg	Bus/ADCS
S/C DV	940 m/s	Green Prop

Nanosat Telescope (Blue Canyon)		
Rel nav	2 cm, 0.1 mm/s	DIGITAL
Att know/ctrl	0.1 deg/0.45 deg	Bus/ADCS





Science Targets for baseline DRM	
Known young disks	3
Dusty nearby stars	1
Other nearby stars	3
Reference stars	6



Simulated 8x5 min exposure of Epsilon Eridani showing inner, outer, and intermediate disk and background stars

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