mDOT

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

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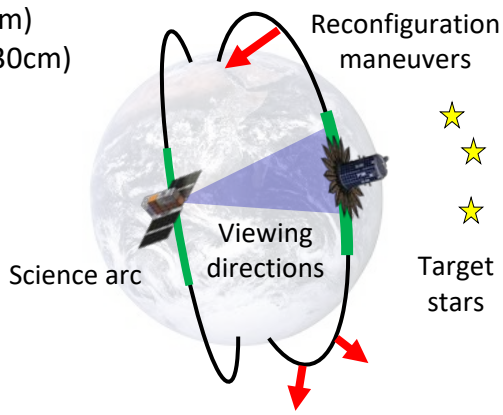
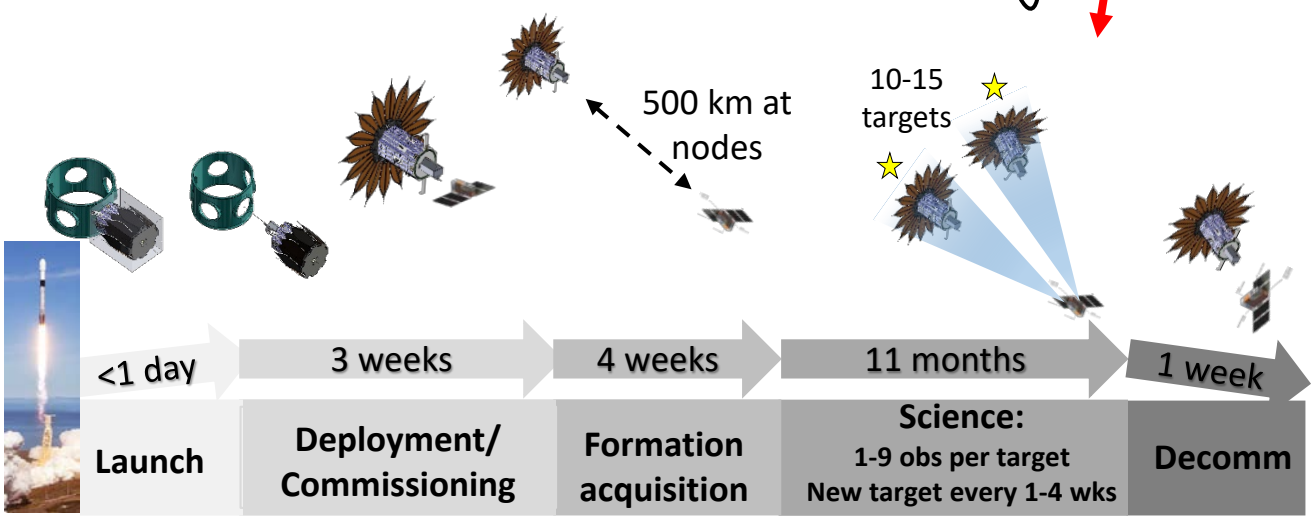
mDOT will provide the very first direct precise measurements of brightness and spectra of extrasolar dust disks in the near ultraviolet spectrum with unprecedented sensitivity to bring together a description of star emission models and better understand the processes behind planet formation. mDOT uses novel orbit design and spacecraft controls techniques to enable a smallsat starshade formation-flying 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.

Primary Objectives	Targets/Observations	Key Requirements
Constrain size and composition of dust particles near young stars	Measure short-wavelength brightness of known young-star outer (10-1000 AU) debris disks	Inner working angle 0.6 arcsec Wavelength 450 nm Resolution 1 arcsec Stability 0.2 arcsec Brightness 18-23 mag/arcsec^2 Contrast 10^{-7} Signal-to-noise ratio >10
Determine ratio of scattered light to thermal emission for disks seen only in infrared	Measure scattered-light surface brightness of mature nearby stars with infrared excess	
Detect and measure dust around nearby stars	Measure scattered-light surface brightness of mature nearby stars at 1-5 AU scales	
Secondary objective: technological pathfinder for starshades		

- SmallSat starshade (3m-starshade, 246kg, 177W, ~1x1x1m)
- CubeSat telescope (9cm-telescope, 12kg, 45W, ~10x20x30cm)
- CubeSat is hosted and ejected by SmallSat
- Orbit: Sun-synchronous (>500km, 98deg)
- 3-5 minute science observations during node crossings
- 1 to 9 repeat observation passes per target
- Orbit precesses in right ascension to successive targets
- 11x5N green propellant thrusters (81 kg fuel)
- High level of GNC autonomy





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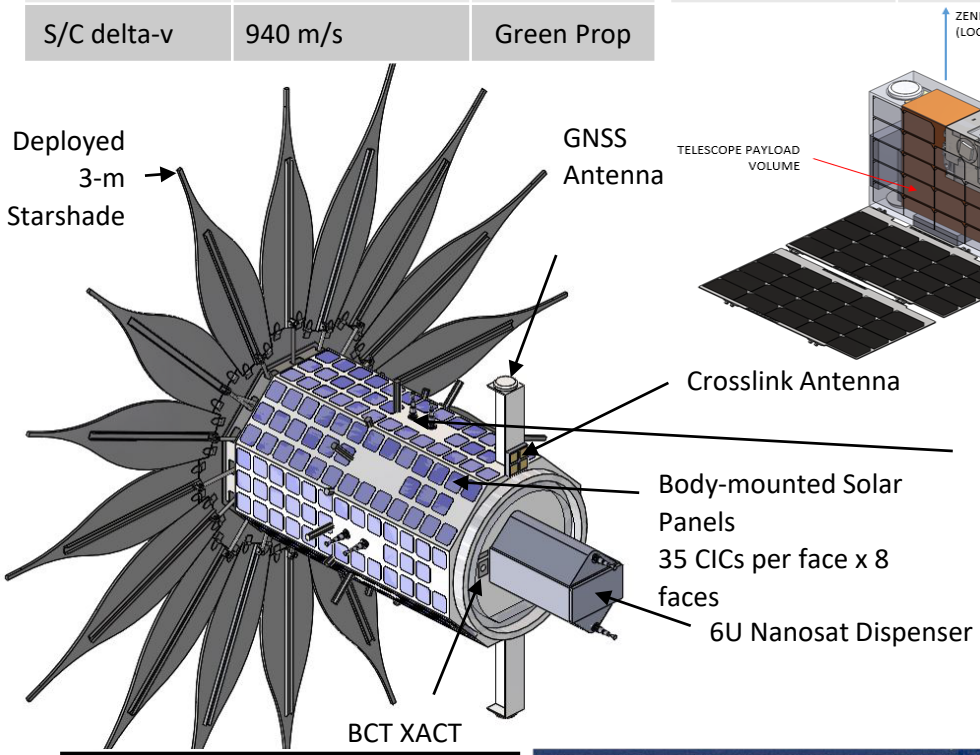
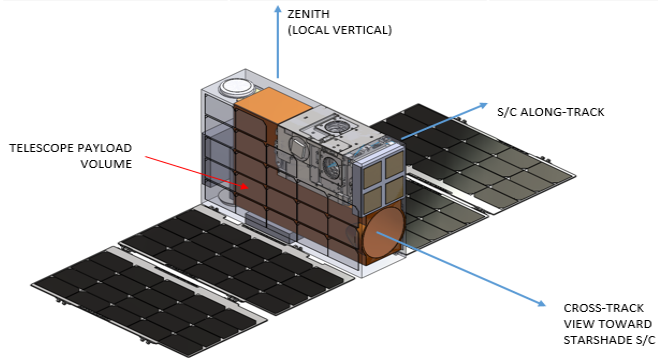
Starshade (Stanford, JPL, Tendeg)	
Diameter	3m (16 petals)
Suppression	10^{-7} (10 Fresnel)
Shape Tolerance	0.1 mm
Deployment	Single-stage motorized
Structure	Carbon-fiber with precision-etched amorphous metal foil

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)

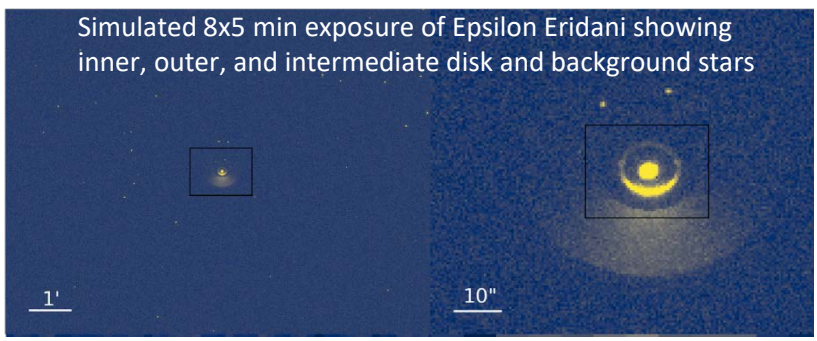
SmallSat Starshade (Ames)		
Rel nav	2 cm, 0.1 mm/s	DiGiTaL
Att know/ctrl	0.2 deg/1 deg	Bus/ADCS
S/C delta-v	940 m/s	Green Prop

CubeSat Telescope (Blue Canyon Tech)		
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



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