ORIGINS Space Telescope

From the first stars to life

National Aeronautics and Space Administration

The Mid-Infrared Imager/Spectrometer/Coronagraph Instrument (MISC) for the Origins Space Telescope

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ABSTRACT and DISCUSSION

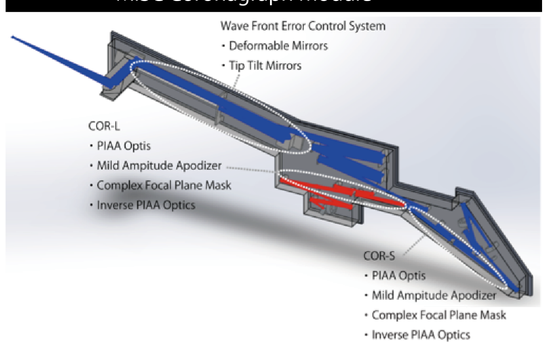
The Origins Space Telescope (OST) is one of four potential flagship missions that have been funded by NASA for study for consideration in the upcoming Astrophysics Decadal Review expected in 2020. The OST telescope will be up to 9.3 meters in diameter, cooled to ~4K, and the mission will be optimized for efficient mid and far-infrared astronomical observations. An initial suite of five focal plane instruments are being baselined for this observatory. The Mid-infrared Imager Spectrometer Coronagraph (MISC) instrument will observe at the shortest wavelengths of any of these instruments, ranging from 5 to 38 microns, and consists of three separate optical modules providing imaging, spectroscopy, and coronagraph capabilities. The imaging camera covers a 3 arcmin x 3 arcmin field with filters and grisms from 6-38 microns. The spectrometers have spectral resolving powers R~1,000 from 9-38 microns (with a goal of 5-38 microns) and R~25,000 for 12-18 and 25-38 microns. The coronagraph covers 6-38 microns. There is a special densified pupil spectrometer channel provides R~100-300 exoplanet transit and emission spectroscopy from 5-26 microns with very high spectro-photometric stability. As the shortest wavelength focal plane imager the MISC instrument will also be used for focal plane guiding as needed for the other OST science instruments. The science MISC on OST enables ranges from studying episodic accretion in protostellar envelopes, tracing the rise in metallicity and dust over cosmic time (when combined with FIR measurements), measuring dust in galactic outflows, assessing feedback from supernovae and AGN on the multi-phase ISM in galaxies, characterizing the AGN and starburst power in normal and massive galaxies to detecting exoplanet atmospheric biosignatures and direct imaging of Jovian planets orbiting older stars at separations of 5-20 AU. In particular, MISC on OST will supply crucial information on the top OST science cases related to cosmology and the study of exoplanets. The presence of reducing molecules (such as methane) in an oxidizing atmosphere (ozone or nitrous oxide) is a fundamental indicator of life. The MISC transit spectrometer is expected to be able to detect evidence of ozone (9.6 μm), methane (7.7 μm), nitrous oxide (17 μm), carbon dioxide (15 μm) and water (6.3 and 18+ μm).

MISC Observational Capabilities and Performance

Module	MISC Imager & Spectrometer			MISC Transit Spectrometer	MISC Coronagraph
	Imager/Low-Res Spec.	Medium-Res Spec.	High-Res Spec.	(Densified Pupil Spec.)	(PIAA)
	WFI-S/-L	MRS-S/-M/-L*	HRS-S/-L	TRA-S/-M/-L	COR-S/-L
Bandpass (μm)	6--38	10--36 (goal: 5--36)	12--18, 25--38	5--26	6--38
Spectral Resolution	5-10 [Imager] 300 [Low-Res Spec.]	1000-1500	20,000-30,000	>100 (TRA-S, TRA-M) 300 (TRA-L)	300
Full FOV	3 arcmin x 3 arcmin [Imager]	3 arcsec x 5 arcsec [with IFU]		3 arcsec x 3 arcsec	5.5 arcsec x 5.5 arcsec
Slit for Spectroscopy	Length; 3 arcmin Width; 0.26 arcsec (WFI-SG1) 0.40 arcsec (WFI-SG2) 0.65 arcsec (WFI-LG1) 1.00 arcsec (WFI-LG2) [low-resolution Spec.]	Length; 3 arcsec (MRS-S/MRS-M/MRS-L) Width; 0.33 arcsec (MRS-S) 0.55 arcsec (MRS-M) 1.0 arcsec (MRS-L) # of Slices; 11 (MRS-S) 9 (MRS-M), 5 (MRS-L)	Length; 1.0 arcsec (HRS-S) 2.0 arcsec (HRS-L) Width; 0.5 arcsec (HRS-S) 1.0 arcsec (HRS-L)		Length; 1 arcmin Width; 0.26 arcsec (COR-SG1) 0.40 arcsec (COR-SG2) 0.65 arcsec (COR-LG1) 1.00 arcsec (COR-LG2)
Detectors	2kx2k Si:As (30μm/pix) [S] 2kx2k Si:Sb (18μm/pix) [L]	2kx2k Si:As (30μm/pix) [S] 2kx2k Si:As (30um/pix) [M] 1kx1k Si:Sb (18μm/pix) [L]	2kx2k Si:As (30μm/pix) [S] 1kx1k Si:Sb (18μm/pix) [L]	2kx2k Si:As (30μm/pix) [S] 2kx2k Si:As (30μm/pix) [M] 2kx2k Si:As (30um/pix) [L]	2kx2k Si:As (30μm/pix) [S] 1kx1k Si:Sb (18μm/pix) [L]
pixel scale	0.088 arcsec/pix	0.0615 arcsec/pix (MRS-S) 0.10 arcsec/pix (MRS-M) 0.15 arcsec/pix (MRS-L)	0.17 arcsec/pix [S] 0.34 arcsec/pix [L]	0.1 arcsec/pix	0.05 arcsec/pix (COR-S) 0.10 arcsec/pix (COR-L)
Specification (Sensitivity/ Stability/ Contrast)	**Sensitivity [Imager] ;** *1-hour 5σ Continuum Sens . for a Point Source* 0.031μJy@5μm, 0.18μJy@10μm, 0.29μJy@15μm, 0.41μJy@20μm, 0.61μJy@25μm, 0.70μJy@30μm, 0.78μJy@35μm **Sensitivity [Low-Res Spec.];** *1-hour 5s Continuum Sens. for a Point Source* (R=300) 0.68μJy@5μm, 1.5μJy@10μm, 4.5μJy@15μm, 5.6μJy@20μm, 9.9μJy@25μm, 13.8μJy@30μm, 43μJy@35μm	**Sensitivity;** *1-hour 5s Continuum Sens. for a Point Source (R~1200)* 3.4μJy@7μm, 11μJy@15μm, 34μJy@24μm,114μJy@32μm *1-hour 5s Line Sens. for a Point Source* $1.1x10^{-21}$ W/m² @7μm, $2.3x10^{-21}$ W/m² @15μm, $3.4x10^{-21}$ W/m² @24μm, $1.1x10^{-20}$ W/m² @32μm	**Sensitivity;** *1-hour 5s Line Sens. for a Point Source* $1.2x10^{-21}$ W/m² @15μm, $3.6x10^{-21}$ W/m² @30μm	**Photometric stability;** 3-5 ppm on timescales of hours to days (excluding the fluctuation of detector gain)	**Average contrast;** $7x10^{-6}$ for 10% band $1x10^{-6}$ for 4% band in 0.88-3.6λ/D

*MRS-S is an option in the Concept 1 study.

MISC Coronagraph module



MISC Transit Spectrometer Module

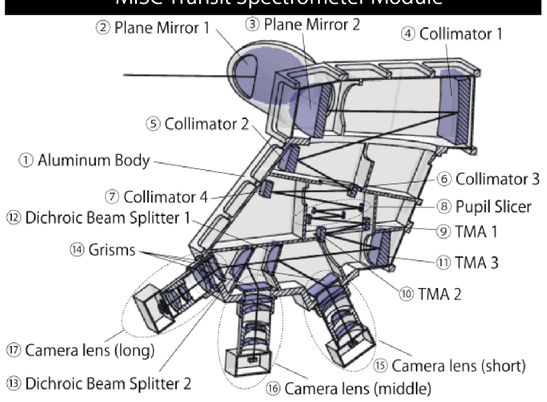


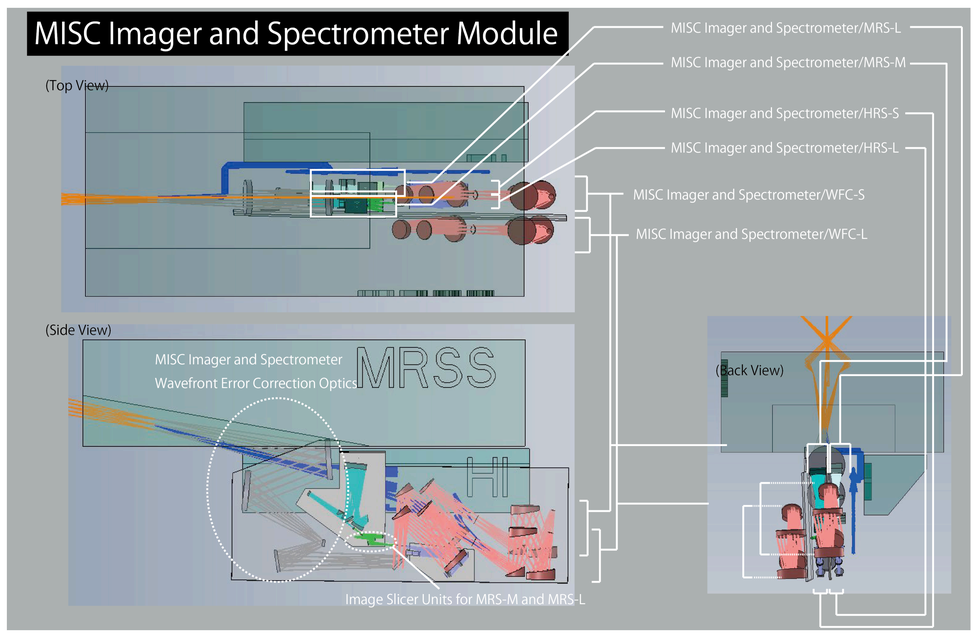
Figure Captions

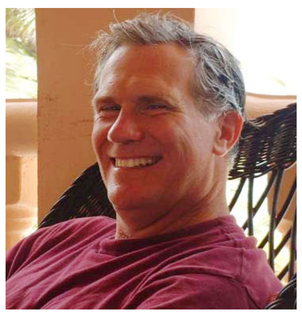
Left-top: The optical-mechanical layout of the MISC Coronagraphic Module. The volume occupied by this module is approximately 3.5 x 2.5 x 0.20 m³.

Left-bottom: The optical-mechanical layout of the MISC Transit Spectrometer Module. The volume occupied by this module is approximately 2.0 x 2.5 x 0.40 m³.

Right: The optical-mechanical layout of the MISC Imager and Spectrometer Module shown in the OST Instrument Accommodation Module (IAM). The volume occupied by this module is approximately 4.0 x 2.5 x 0.8 m³. The allocated volume in the IAM for two other OST instruments, the Heterodyne Instrument (HI) and Medium-Resolution Survey Spectrometer (MRSS) are also indicated.

MISC Imager and Spectrometer Module





The Presenter
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The **Origins Space Telescope** is the mission concept for the **Far Infrared Surveyor**, a study in development by NASA in preparation for the *2020 Astronomy and Astrophysics Decadal Survey*.

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Secret OST Word: Trappist