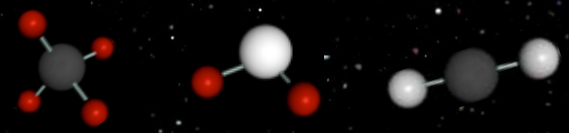
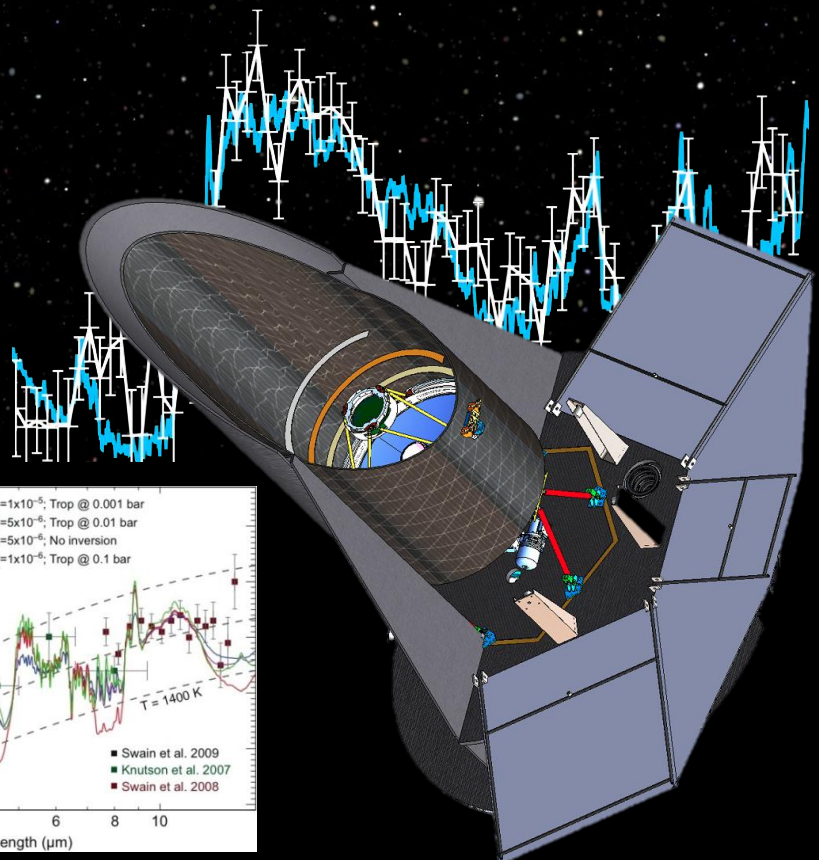
FINESSE Fast Infrared Exoplanet Spectroscopy Survey Explorer

Exploring New Worlds Around Other Stars

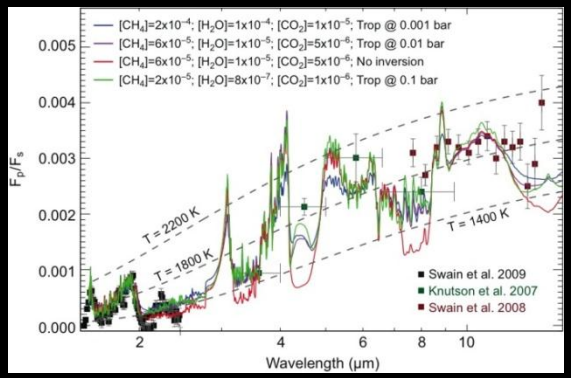
FINESSE is the first mission dedicated to the characterization of the rapidly growing number of newly discovered worlds.



Methane Water Carbon Dioxide



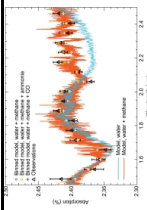
- Building on the legacy of exoplanet discovery.
- Taking the next step … characterizing the diverse exoplanet family.



FINESSE: Humankind's Journey

JPL

Ball

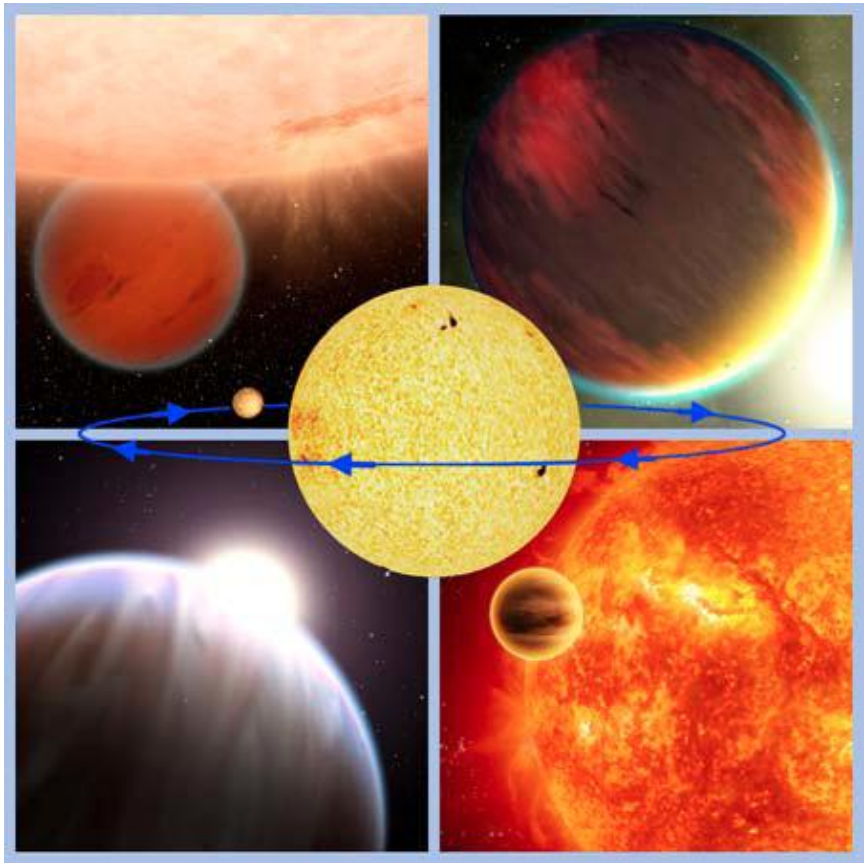


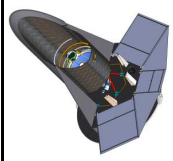
FINESSE

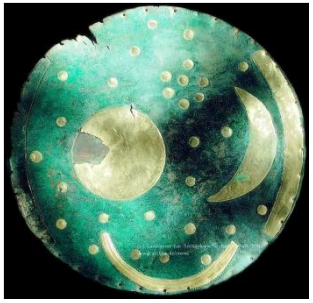
Many Worlds – Many Suns

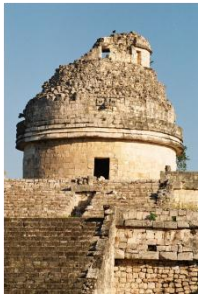
Today we know that our solar system is part of a much larger family of planets that is both vast and incredibly diverse.

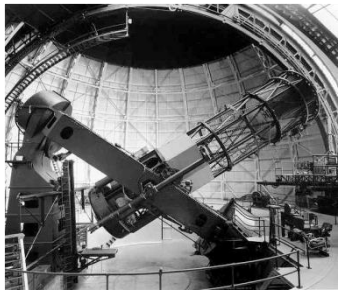
For thousands of years, human kind has pondered our place in the cosmos. By characterizing a large and varied sample of exoplanets, FINESSE will answer a major part of this question by showing us how our own planet, and the planets in our solar system, fit into the vast, and varied, extended family of planets that pervade the galaxy.

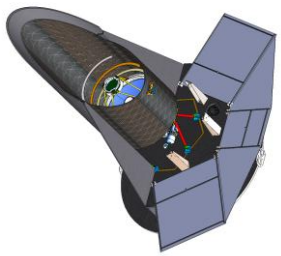








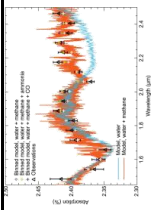


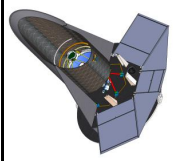


Science Team

Small & experienced team with well-defined roles

Tem Member	Institution	Role
Mark Swain (PI)	JPL	Overall responsibility for FINESSE mission
Rob Green (dep. PI)	JPL	Instrument scientist, spectrometer design and calibration
Rachel Akeson	Caltech	Data products and archive lead
Linda Brown	JPL	Molecular opacities
Adam Burrows	Princeton	Modeling planetary atmospheres
Pieter Deroo	JPL	Algorithm development lead
Tom Greene	NASA Ames	Instrument modeling
Caitlin Griffith	U. Arizona	Modeling planetary atmospheres – emission spectra
Carl Grillmair	Caltech	Target and calibrator target selection and observing plan lead
Thomas Henning	MPIA	Modeling planet-disc coevolution
Giusi Micela	INAF	Modeling star spots and stellar variations
Glenn Orton	JPL	Planetary atmospheres and solar system context
Giovanna Tinetti	UCL	Modeling planetary atmospheres – transmission spectra
Gautam Vasisht	JPL	Instrument architect





FINESSE Overview

JPL

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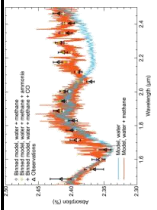
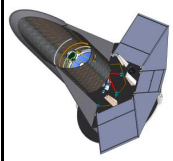


FINESSE



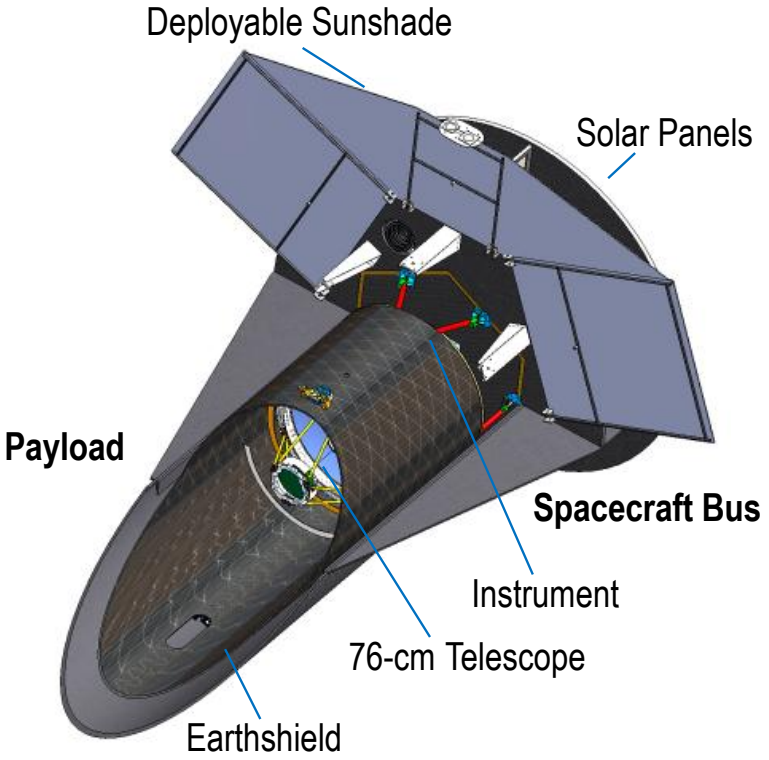
Mission Summary

- Sun-synchronous, circular, 570 km altitude orbit, similar to WISE
- Compatible with Taurus 3210 & Athena II
- Ground-system and mission operations adapted from WISE with four 8-min S-band passes/day to Near Earth Network
- Unrestricted launch period
- Two-year mission duration
- Major trades closed

Payload

Single, high-stability spectrophotometer:

- Telescope, 76 cm, RESPONDER-1™-based
  - passively cooled to 140 K
- Spectrometer, 0.7–5.0 μm, M3-based
  - $\lambda/\Delta\lambda$ = 1000, actively cooled to 90 K
  - Detector, HgCdTe JWST/NIRspec copy
  - actively cooled to 70 K
- Pulse tube cryo cooler, 2 stage, pulse tube
  - GOES & ABI-based
- Fine Guidance System
  - 2 Hz bandwidth, guides on science target
  - Guide camera, e2v CCD-57
  - Fine steering mirror, piezo-based

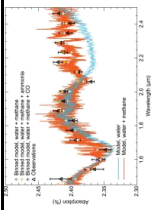


National Aeronautics and Space Administration

An Extraordinary Opportunity

JPL

Ball

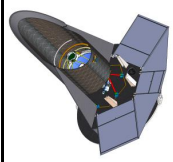


- Astronomers have discovered hundreds of exoplanets, but we know very little about these exciting objects.
- By systematically exploring a large sample of these new worlds, we have the rare and extraordinary opportunity to dramatically advance the emerging field of comparative exoplanetology.

FINESSE provides a transformational data set.

FINESSE

- FINESSE will answer two key questions:
  1. What is the composition and temperature of exoplanet atmospheres?
  2. How does the composition and temperature change from the dayside to the nightside and with time?



National Aeronautics and Space Administration

Many Questions Addressed

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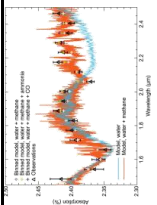

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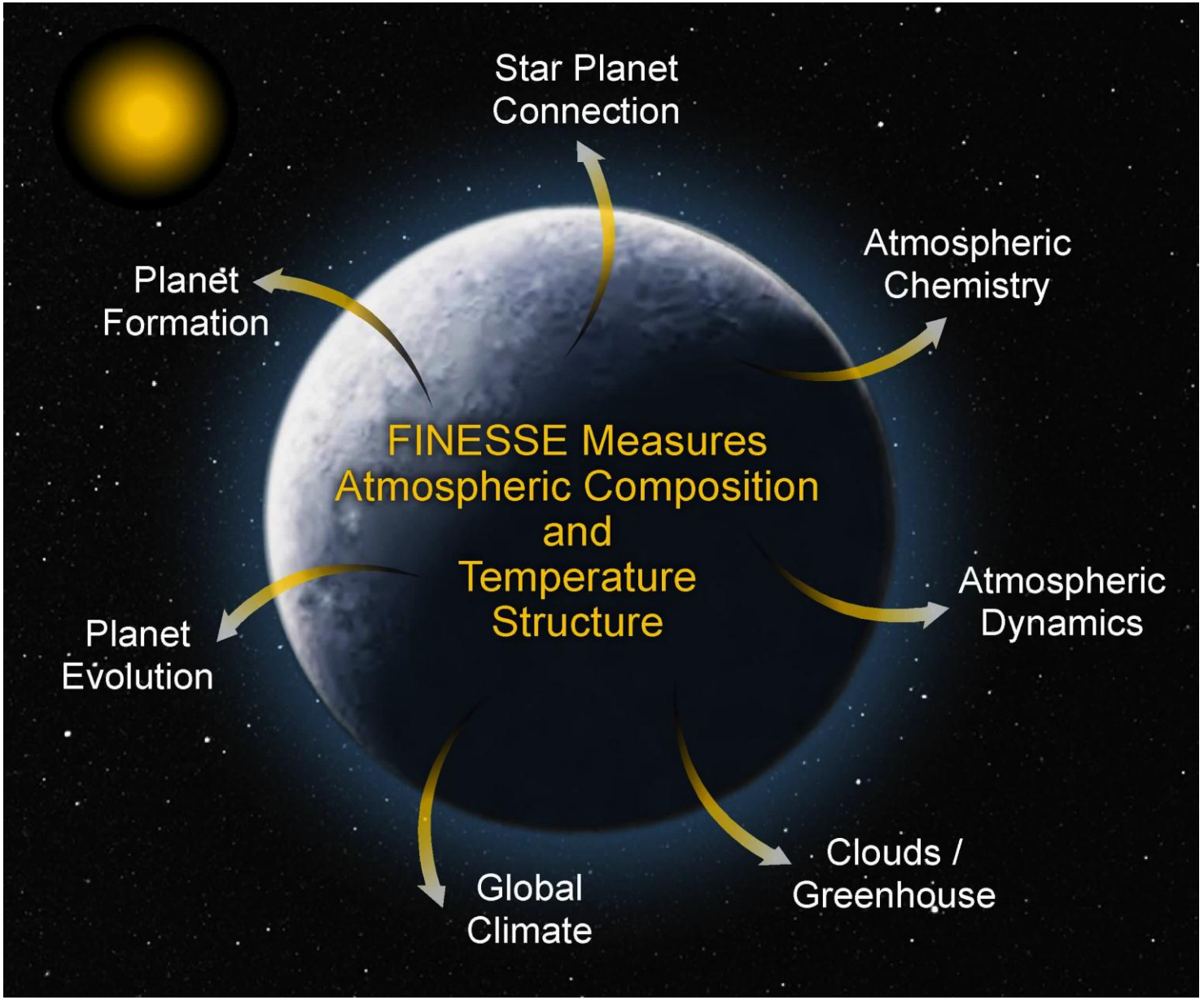
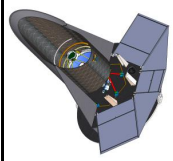
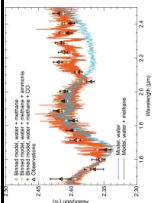




The FINESSE Survey

FINESSE will characterize the “extended family” of exoplanets, as a class of objects, by observing 200 exoplanets drawn from three broad categories, using a consistent observing method.



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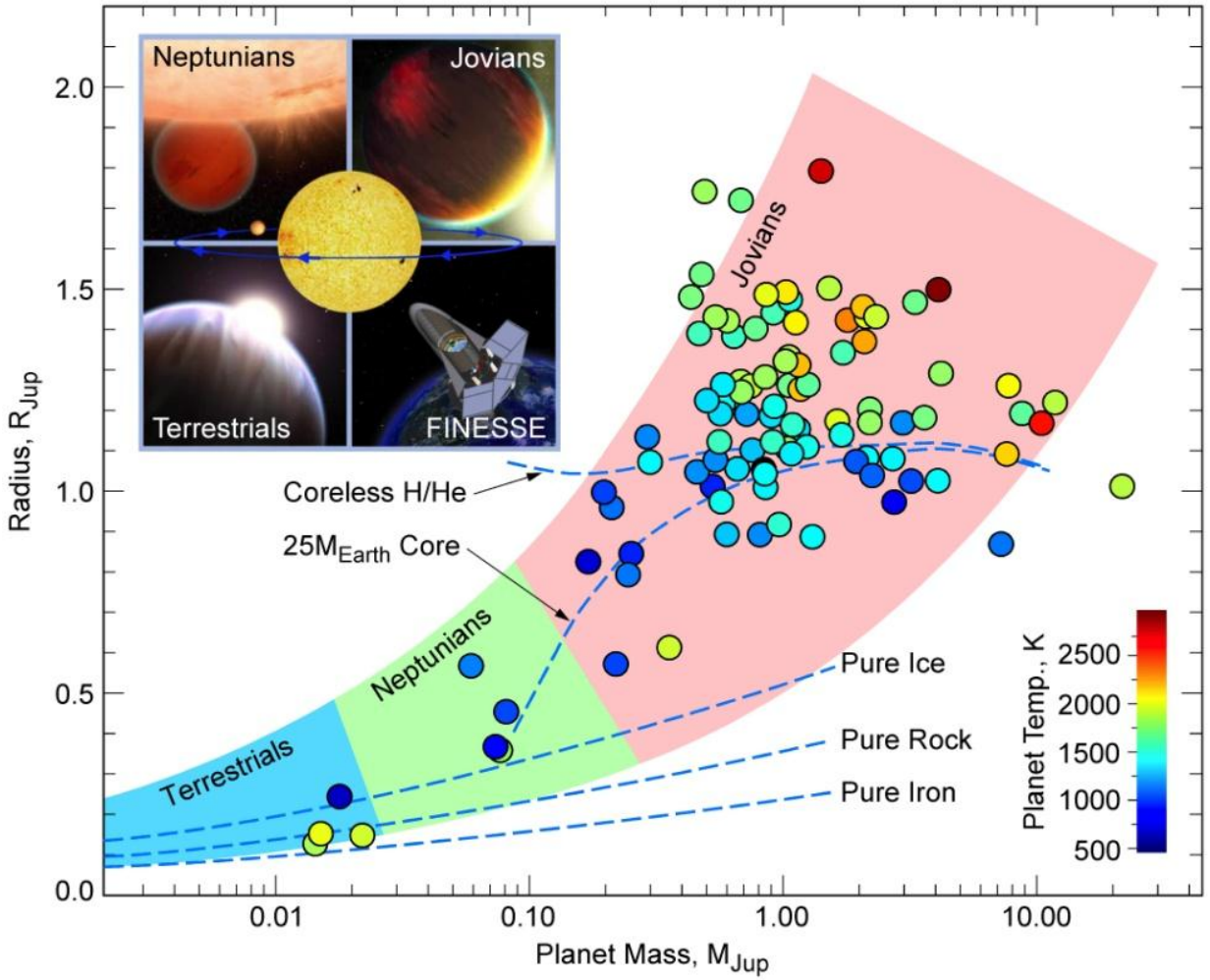

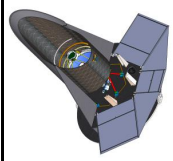

Characterization via Detecting Molecules

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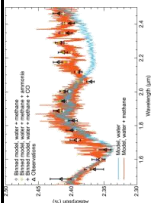


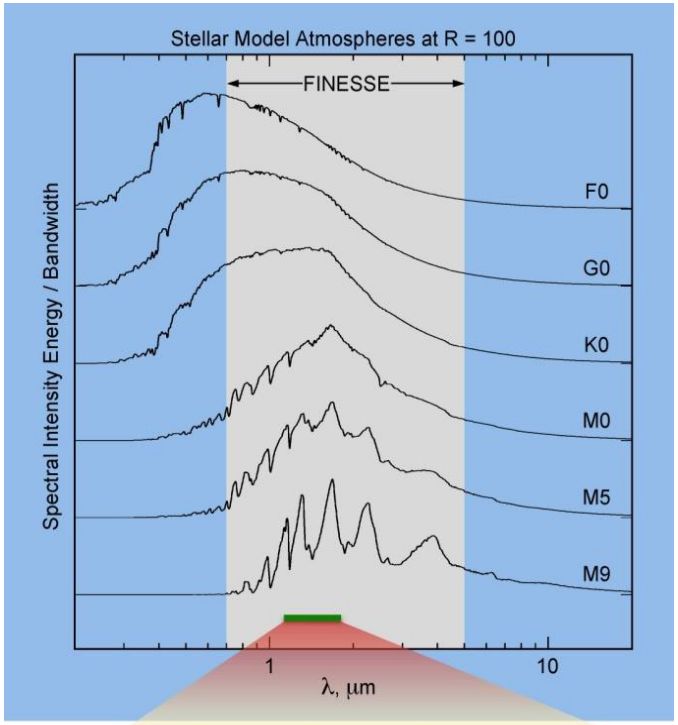
FINESSE

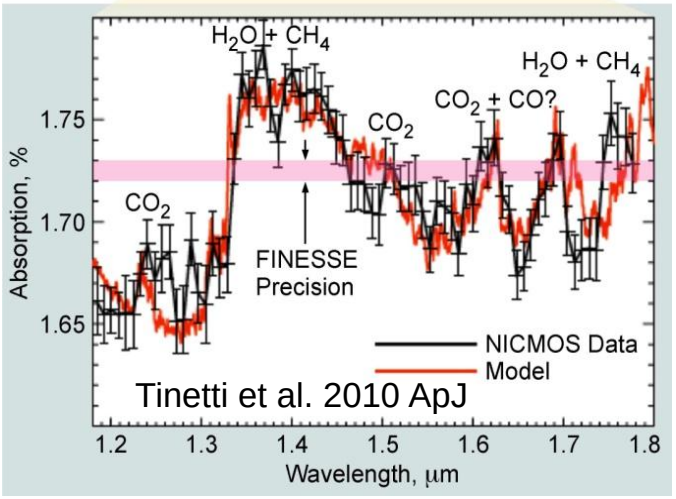
Key diagnostic molecules:

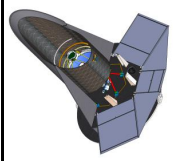
- H2O, CH4, CO2, CO
- Trace C/O and non-equilibrium chemistry
- Detected via spectroscopy in 3 planets to date

Table D.1-1: Molecules and locations of their prominent bands to be targeted by FINESSE.

	Molecule	0.7–3.0 μm	3.0–5.0 μm
Key Diagnostic	H_2O	0.82, 0.94, 1.13, 1.38, 1.9, 2.69	
	CH_4	0.79, 0.86, 1.65, 2.2, 2.31, 2.37	3.3
	CO_2	1.21, 1.57, 1.6, 2.03	4.25
	CO	1.57, 2.35	4.7
Additional Possible Molecules	C_2H_2	1.52	3.0
	HCN		3.0
	O_3		4.7
	O_2	0.76, 1.27	
	NH_3	0.93, 1.5, 2, 2.25, 2.9	3.0
	C_2H_4		3.22, 3.34
	H_2S	2.5	3.8
	SO_2		4
	N_2O	2.8	3.9, 4.5
	TiO	0.7–3.0	3.0–3.5
	VO	0.7–2.5	







National Aeronautics and Space Administration

The FINESSE measurement method

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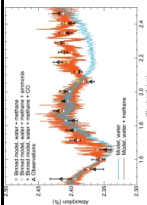

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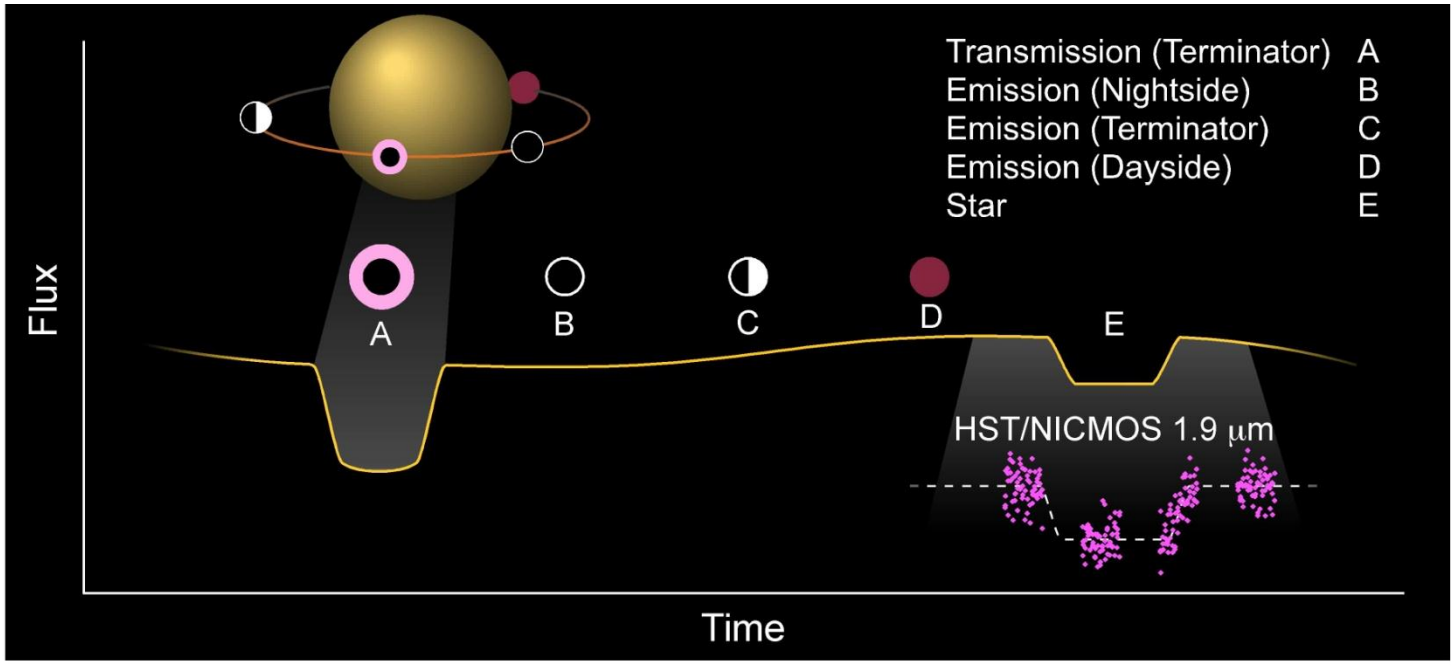
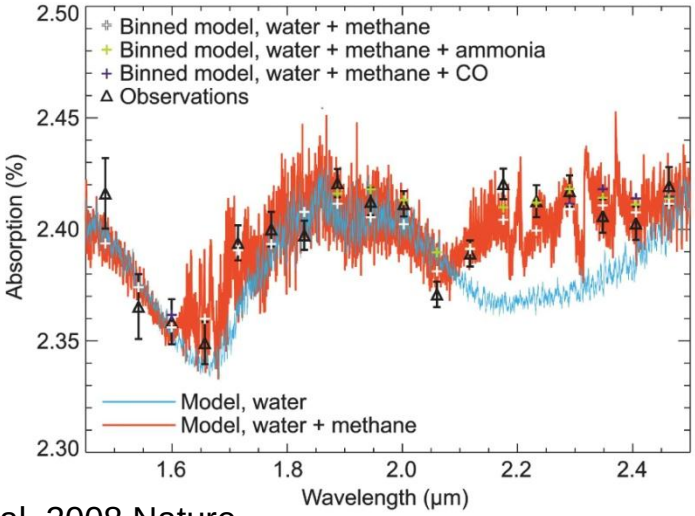
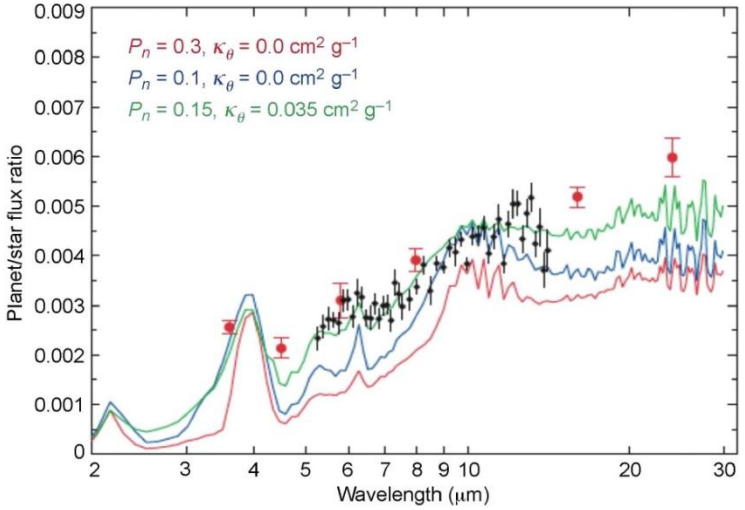
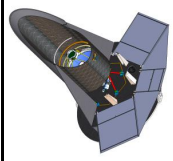




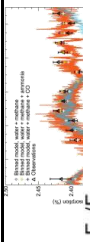
Swain et al. 2008 Nature

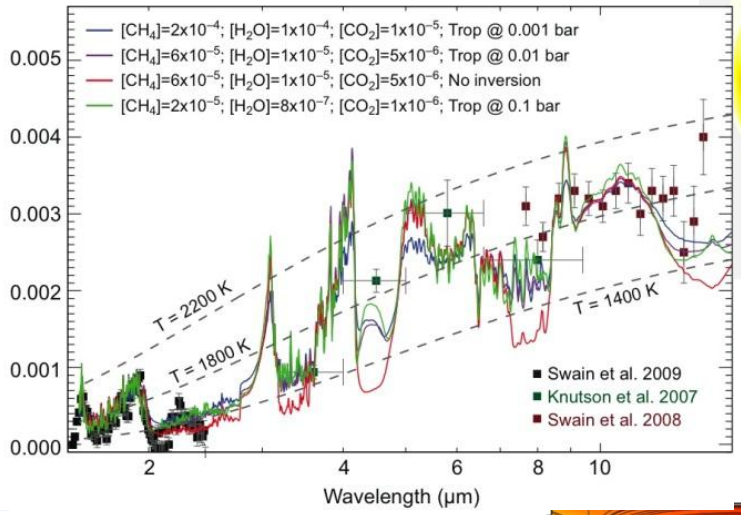


Grillmair et al. 2008 Nature

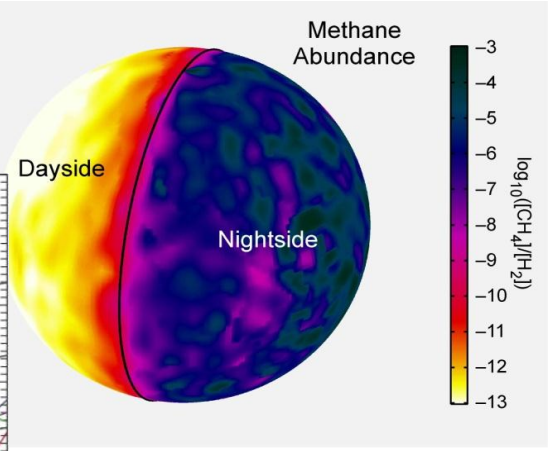


Day/Night Composition and Climate



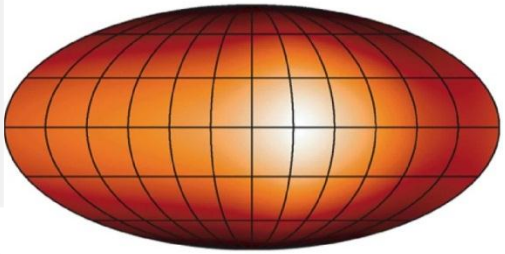


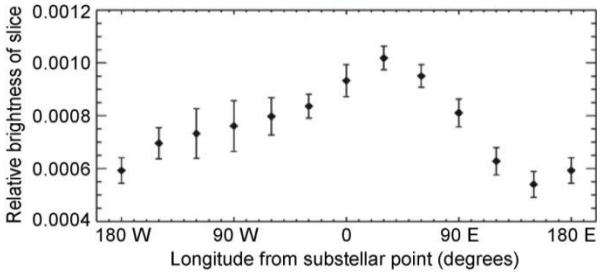
Swain et al. 2009 ApJ

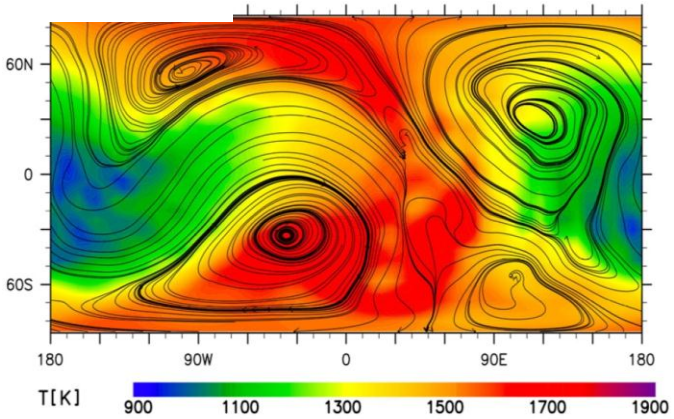


Burrows et al. 2010 ApJ

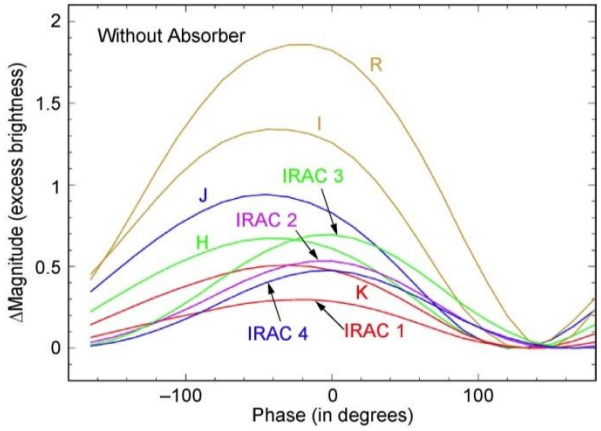
Knutson et al. 2007 Nature

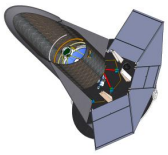






Thrastarson et al. 2010 ApJ

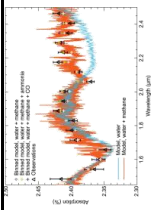




Unique FINESSE capabilities

JPL

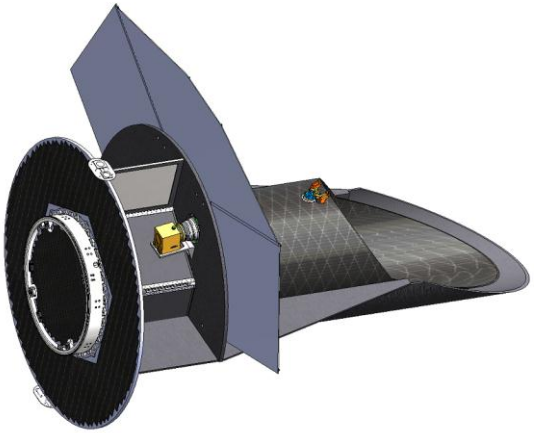
Ball



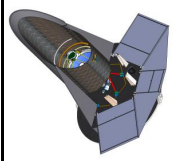
FINESSE

- *FINESSE provides a combination of stability and spectroscopic coverage that is unlike any other instrument.*

- Optimized design means
  1. No decorrelation required
  2. Broad, continuous coverage
  3. Long term stability - calibrators
  4. Large, uniformly measured sample
  5. Bright target capability



- Directly addresses NASA Strategic Priorities.



Optimized for Stability

JPL

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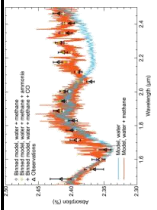
Optimization for Stability



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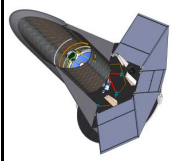
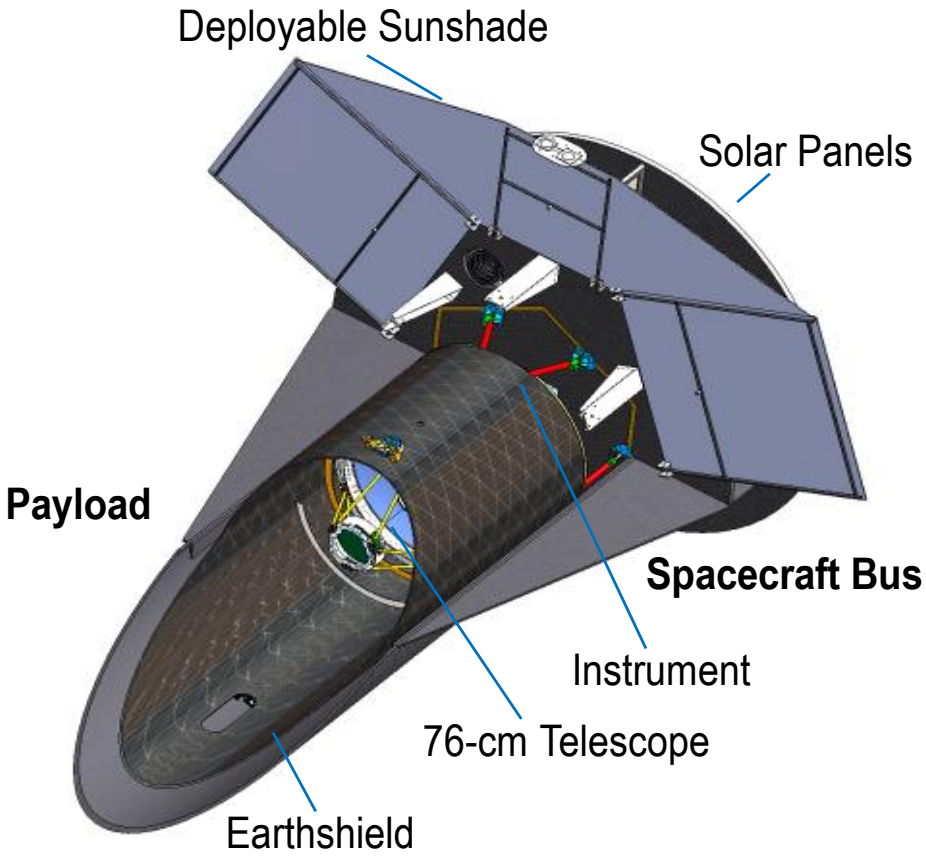
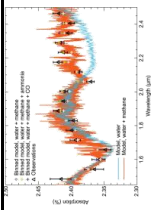




Science Community Engagement



FINESSE

- **The objective is to rapidly extract maximum science from a transformative data set.**
- Completed sets public in 6 months or less.
  - Includes all Level 1-4 data products
  - Includes spectral retrieval results
- Meeting prior to launch with synthetic data products
  - Allows community to "practice" analysis of FINESSE results.
- Participating Scientist Program:
  - Observational component – joint observing for ground-space bootstrap
  - Theory component – modeling beyond scope of the proposal team
  - Non-transiting planets