

CASE

CONTRIBUTION TO ARIEL SPECTROSCOPY OF EXOPLANETS

PI: Mark Swain (JPL)



Jet Propulsion Laboratory
California Institute of Technology

CASE is a NASA Partner Mission of Opportunity, partnering with the ESA M4 mission
ARIEL.

CASE ExoPAG Presentation June 18 2020

Mark Swain, Principal Investigator

Featuring LCHS Advanced Art II

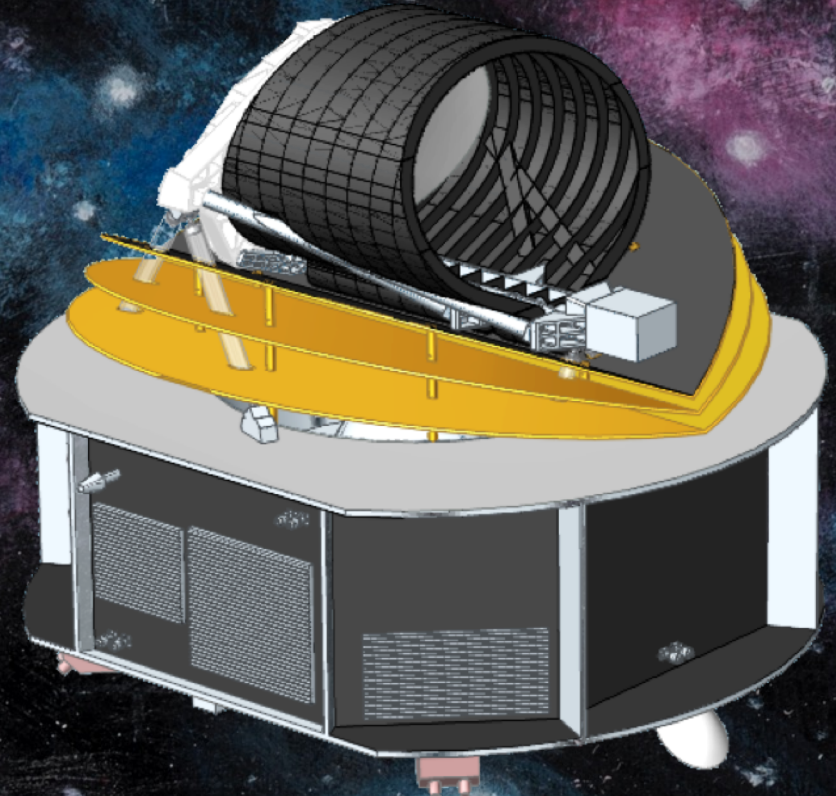
The Landscape for CASE



- Partner mission contribution to ARIEL (ESA M4)
- Conditionally selected July 2017
- Selected for implementation November 2019
- Studies atmospheres of planets found by Kepler and TESS
- Addresses NASA Science Plan (2014) objective: “Discover and study planets around other stars, and explore whether they could harbor life.”

ARIEL Mission Overview

- ESA M4 mission
- Launch 2028
- L2 orbit
- 3.5 year prime mission
- Telescope 1 m effective diameter
- 0.5-7.8 μm wavelength coverage
- Surveys exoplanet atmospheres
- Observers ~1000 planets
- Tiered survey strategy
- Payload consortium consists of 17 ESA member states + US contribution
- <https://arielmission.space>



ARIEL Survey

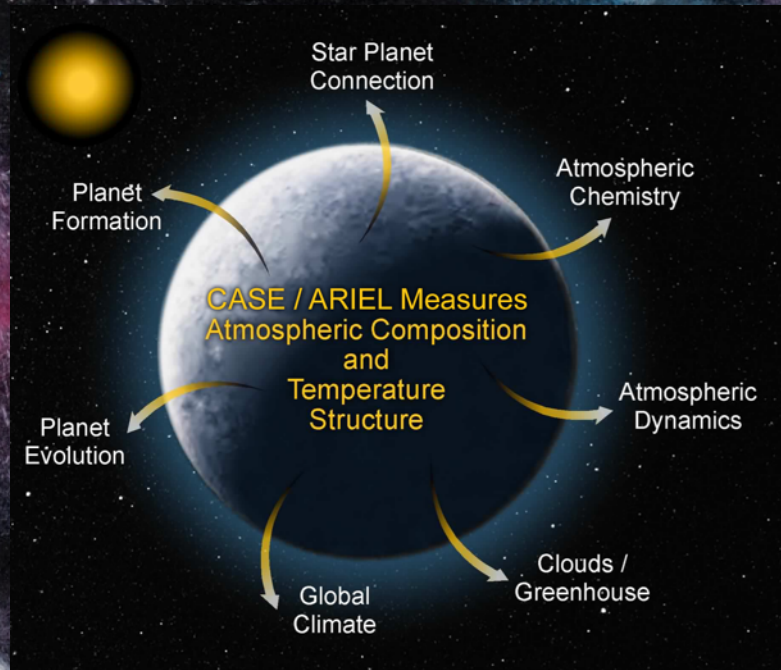
What are planets made of?

How do planets form?

How do planets and their
atmospheres evolve?



CASE/ARIEL Survey Synergistic with JWST and Planetary Community



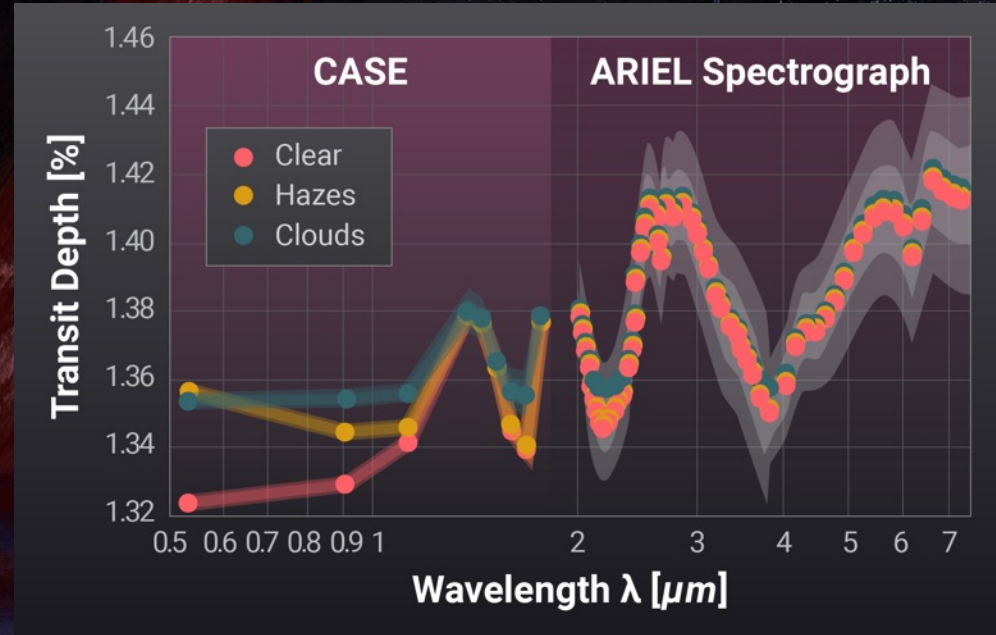
- Connects: Astrophysics and planetary fields
- Reveals how JWST exoplanet observations fit into the larger exoplanet family

CASE and ARIEL revolutionize the field of exoplanet atmospheres

Probing Atmospheres on Kepler and TESS Planets

CASE Science Objectives

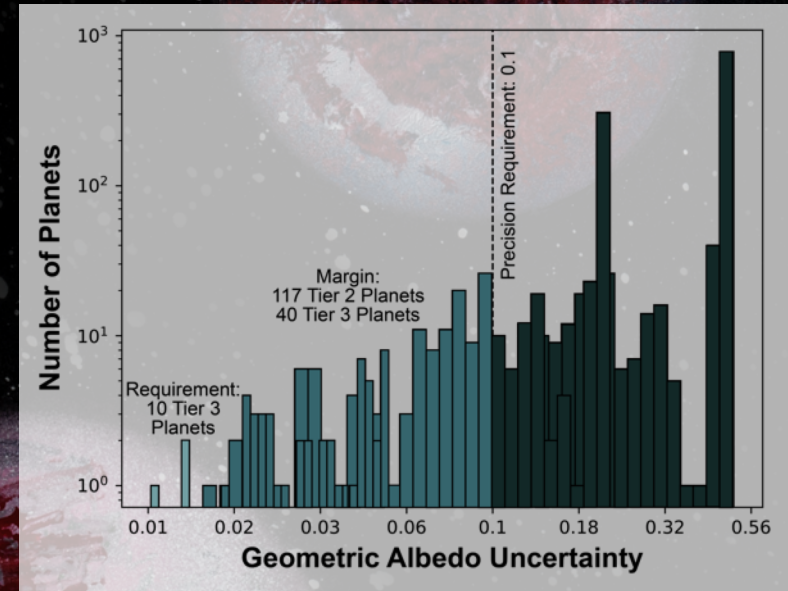
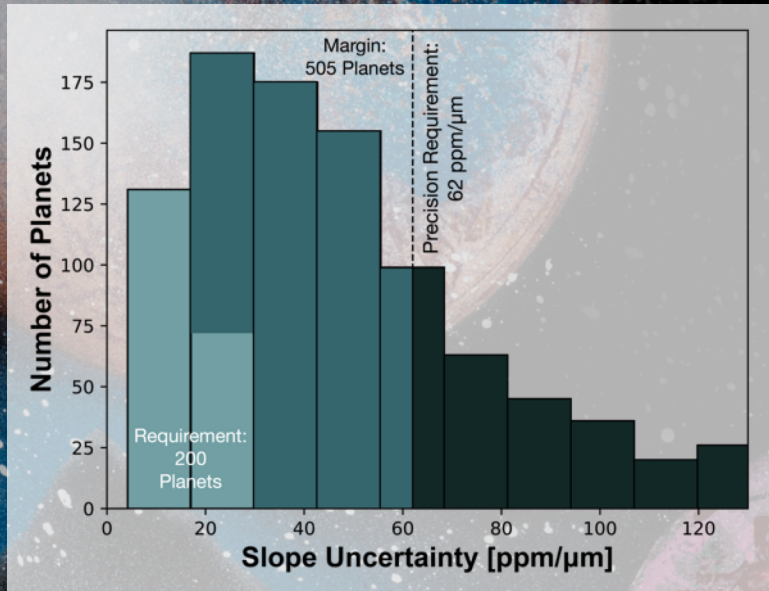
- Determine the occurrence rate of aerosols (clouds and hazes)
- Measure the geometric albedo of exoplanet atmospheres to constrain aerosol composition



CASE provides aerosol and albedo data products

Large Science Margins

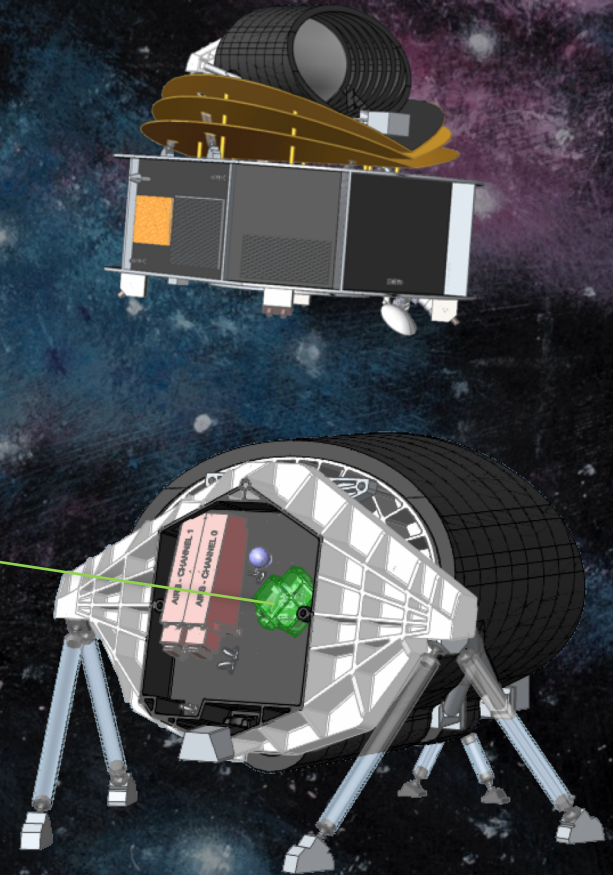
- Aerosol slope precision requirement 310 % margin
- Albedo precision requirement 400 % margin



CASE and the ARIEL Payload

- Off-axis 1.1 m × 0.7 m elliptical telescope
- ARIEL Infrared Spectrometer (AIRS):
Resolution $\lambda/\Delta\lambda=30-200$), 1.95 – 7.8 μm
- Fine Guidance System (FGS)
 - Vis-Phot: 0.50 μm – 0.55 μm
 - FGS1: 0.8 μm – 1.0 μm
 - FGS2: 1.0 μm – 1.2 μm
 - NIR-Spec: 1.25 μm – 1.95 μm ($\lambda/\Delta\lambda=10$)

CASE



CASE Delivers Simple, Well-Defined Hardware

Focal Plane Modules (FPM) x2

Sensor Chip Assemblies

FPM Enclosure

Focal Plane Electronics (FPE) x1

FPE Radiator

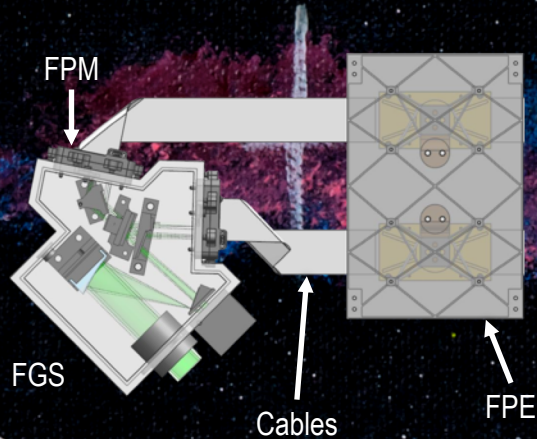
Cold Front End Electronics x2

Cables (CFC) x2

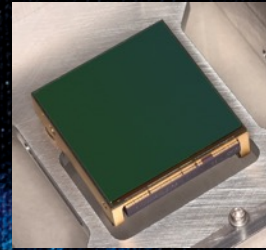
FPE Enclosure & Struts

CASE Context and Heritage

CASE is a subsystem of the ARIEL FGS



CASE reuses Euclid hardware designs



SWIR Detector from Euclid



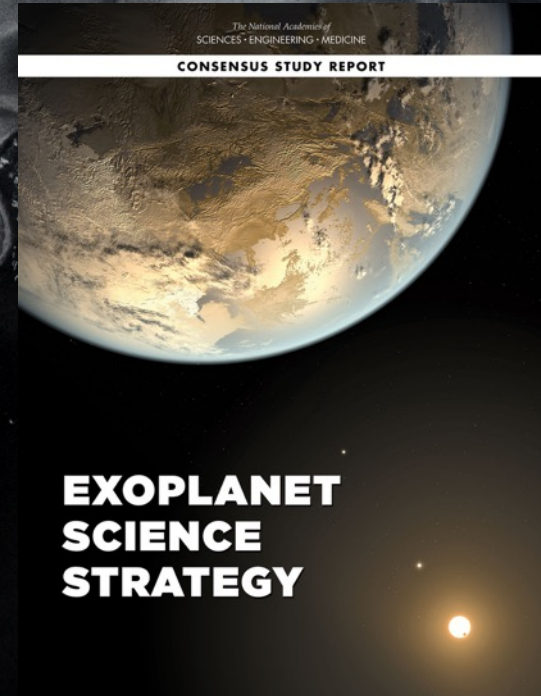
SIDECAR SCE electronics from Euclid

The CASE team is well-integrated with the ARIEL payload team

National Academy of Science

Consensus Study Report: Exoplanet Science Strategy

- “The U.S. exoplanet community would benefit from participation in ARIEL.”
- “U.S. scientists would benefit from the CASE mission by participating in the planning, execution, and exploitation of the ARIEL survey.”



What are Exoplanets Really Like?

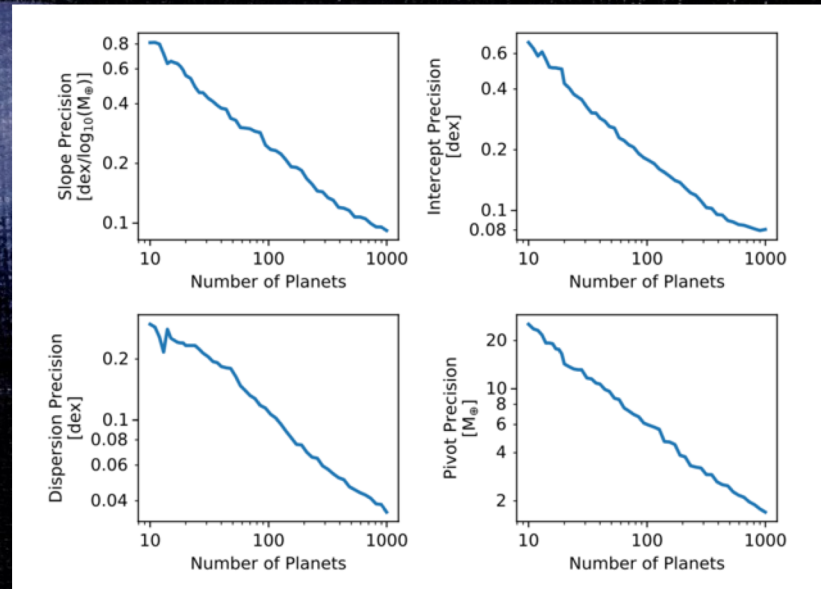
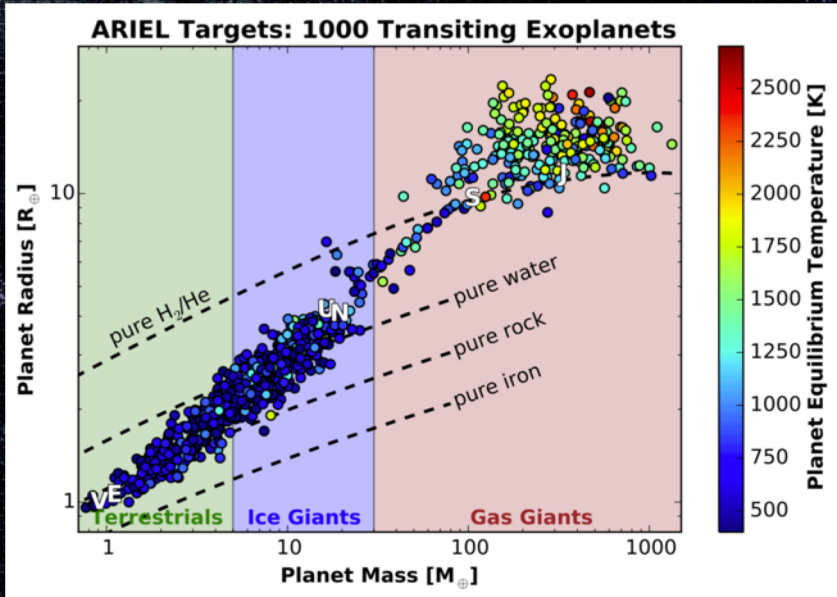
Capturing the Imagination



The
Unknown

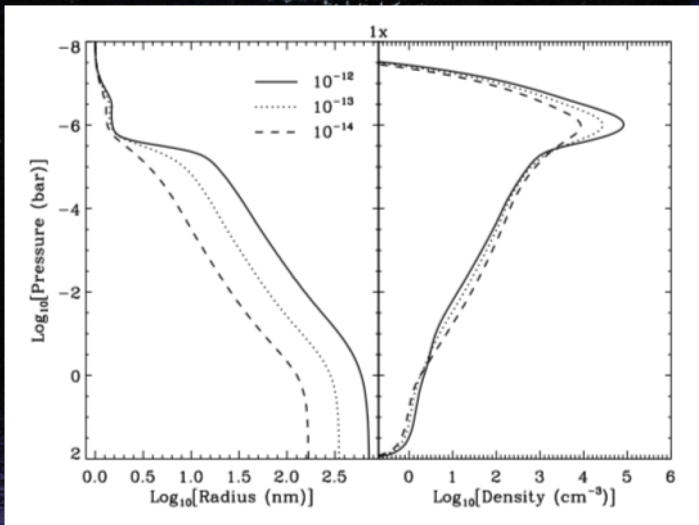
Extraordinary Value

CASE team simulation finds ARIEL Tier 1 survey sample provides excellent constraints on the mass-metallicity relation

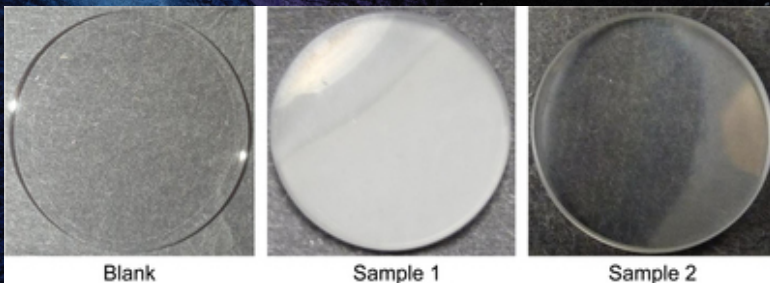


Zellem et al. 2019

Relevant New Results

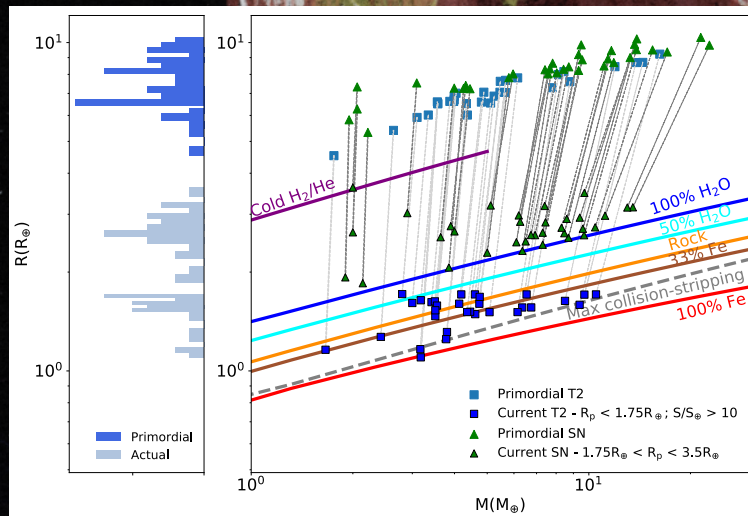


Micro physics model of haze formation
Lavvas et al. 2019



Simulated hot-Jupiter
atmosphere produces
aerosol material

Fleury et al. 2019



Sub-Neptune & super-Earth envelope
evolution Estrela et al. 2020

CASE Science Community Engagement



- **Three major community engagement areas**
 - Input on defining the observing priorities – JWST results will likely have a significant impact
 - Precursor observations (examples include ephemeris maintenance, improved planet and stellar parameters, system characterization)
 - Access to CASE/ARIEL data products
- **CASE project will provide science data products to the community through NExSci**
 - Aerosol and albedo data products
 - NExSci will also mirror ARIEL science archive data products
- **CASE science team community engagement**
 - Community meetings planned to start later this year
 - Opportunity for US community to provide input on ARIEL observing priorities through the CASE Science Team
 - Opportunity to participate in CASE modeled on the TESS community science team

CASE/ARIEL Benefit to the US Community

- CASE/ARIEL data will be used for decades to come, providing a context for future discoveries
- CASE/ARIEL results will be the foundation of the emerging field of exoplanet atmospheres, the field in which the discovery of life outside of our solar system will be made
- A legacy that goes beyond the science and shows, for the first time, how our solar system fits into the extended planet family