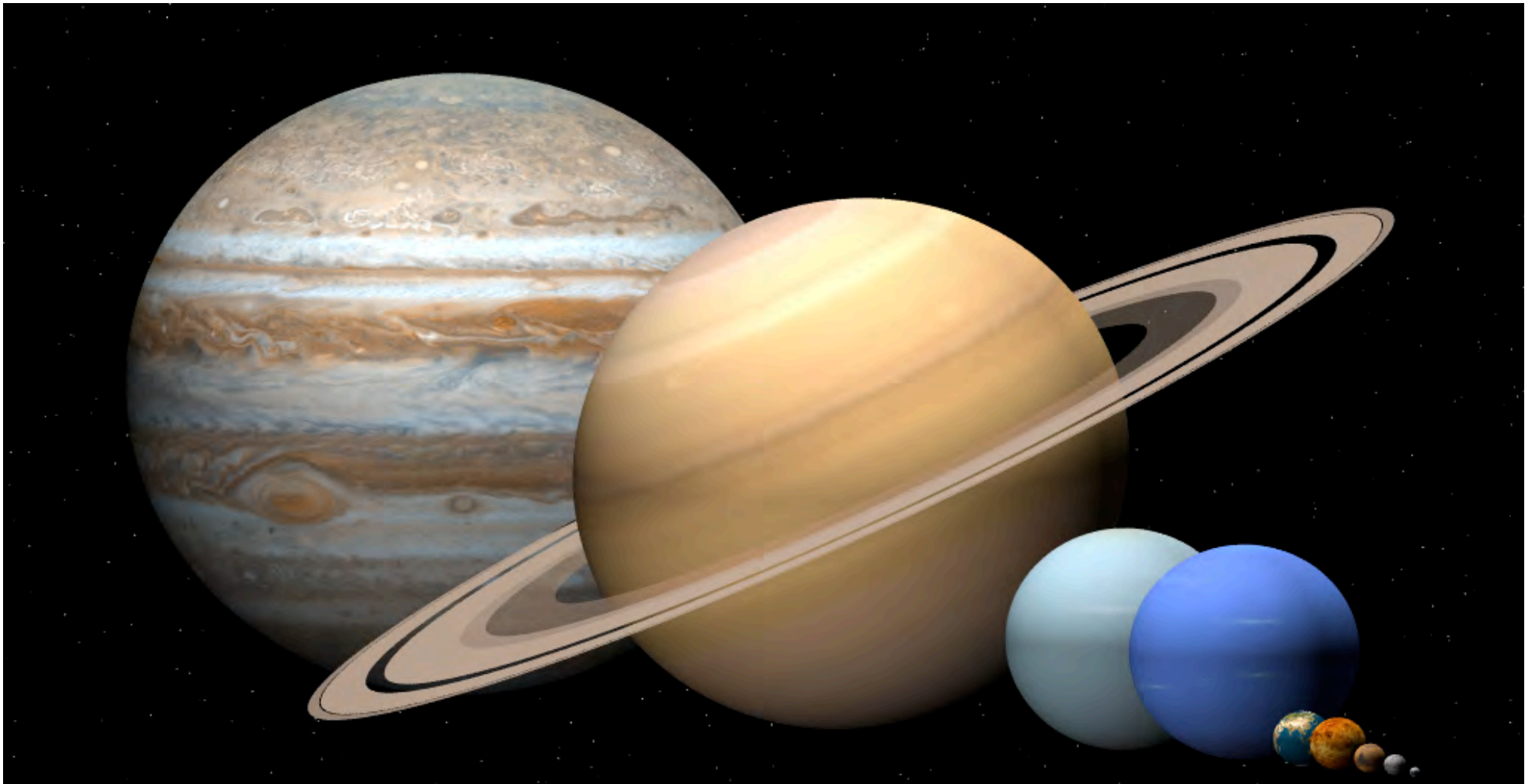


# Planets and Exoplanets

## Introduction

# Outline

- Course Content
- Web Page
- Recommended Book and Lecture Copies
- Schedule and Requirements
- Exams and Grades
- Lecture Overview
- Presentation Topics

# Course Goal

Understand the wonders (and physics) of our own solar system planets and the recently discovered exoplanets around other stars.

# People

**Christoph Keller**, UU
Professor of Experimental Astrophysics

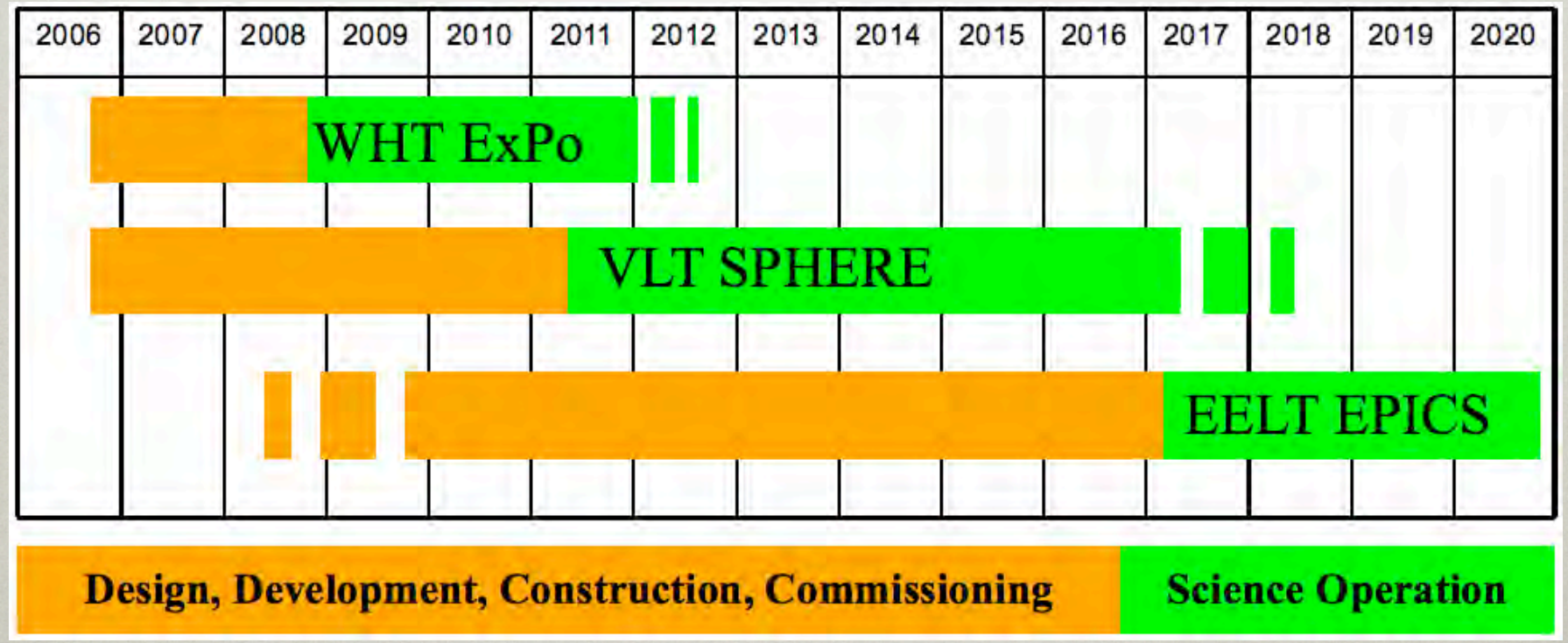
**Daphne Stam**, SRON
Senior Researcher of the Planetary Sciences Group

**Theodora Karalidi**, SRON
PhD student with Daphne Stam, Christoph Keller

**Catherine Fischer**, UU
PhD student with Christoph Keller

# (Exo-)planetary Research at UU

- Detection and characterization of exoplanets in polarized light
- Instruments for spectropolarimetry of solar-system planetary atmospheres



# (Exo-)planetary People at UU

**Hector Canovas**, PhD Student, ExPo, polarimetric data analysis

**Sandra Jeffers**, Postdoc, ExPo, polarimetric observations

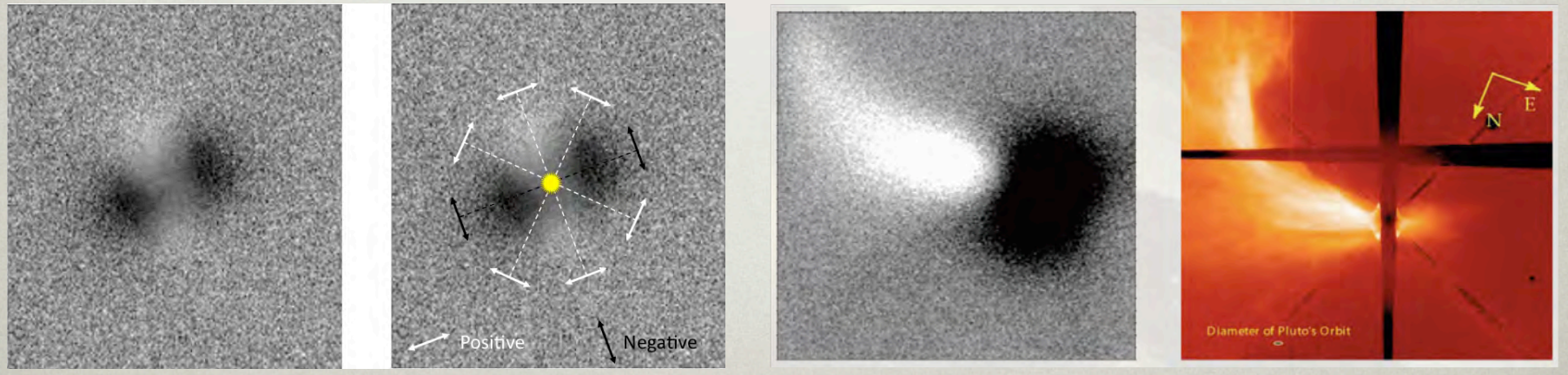
**Maria de Juan Ovelar**, PhD student, EPICS, polarimetry

**Christoph Keller,** Prof., ExPo, administration and bureaucracy

**Michiel Min**, Postdoc, Modeling of circumstellar disks

**Michiel Rodenhuis**, PhD Student, ExPo, polarimetry instrument

**Frans Snik**, Postdoc, EPICS, SPEX, polarimetry instruments



# Planetary research at SRON

SRON divisions:

- High Energy Astrophysics — X-ray/gamma-ray regime (XMM, Chandra, IXO, ...)
- Low Energy Astrophysics — infrared/submm (ISO, HIFI, ALMA, SPICA, ...)
- Earth Oriented Science — UV/vis/infrared (GOME, SCIAMACHY, OMI, TROPOMI, ...)*
- Sensor Research and Technology — detector development
- Engineering Division — mechanical/electronics design

SRON
Netherlands Institute for Space Research

* Also: Solid Earth Science (LISA, GOCE, ...)

# Planetary research at SRON's EOS Division

Research:

- Atmospheres of Solar System planets and exoplanets
- Spectropolarimetry of Solar System planets and exoplanets

People:

- Dr. Daphne Stam - polarized radiative transfer, (exo)planetary atmospheres, remote-sensing of Solar System planets
- Theodora Karalidi (PhD student) - polarized radiative transfer of terrestrial exoplanets
- Dr. Martijn Smit - instrument (spectropolarimeter) development for Solar System missions
- Dr. Jeroen Rietjens - instrument (spectropolarimeter) development for Solar System missions

SRON

# Communication

- Blackboard
  - Students sign up themselves
  - Everybody else provide solis-ID and will be signed up on Blackboard only
- Email:

C.U.Keller@uu.nl

D.M.Stam@sron.nl

T.Karalidi@sron.nl

C.E.Fischer@uu.nl

# Course Web Page

- www.astro.uu.nl/~keller/Teaching/Planets_2010
  - contact information
  - course schedule, subscribe to iCal link
  - lecture presentations, exercises, exercise materials
  - presentation topics and assignments
- course web page takes precedence over OSIRIS

# Book


- Planetary Sciences, 2nd ed.
- By Imke de Pater and Jack J. Lissauer
- Published by Cambridge University Press
- Available at bookstores, www.amazon.co.uk, www.cambridge.org
- Lectures, exercises available online on course web page

# Course Schedule

| Day | Time | Room | Type |
|---|---|---|---|
| Tuesday | 13:15-15:00 | OL 260 | Lecture |
| Tuesday | 15:15-17:00 | OL 260 | Exercises |
| Thursday | 11:00-12:45 | OL 260 | Presentations |

# Course Requirements

- Exercises are integral part of course
- Home work and some exercises have to be submitted by deadline
- Submitted work will be checked and/or discussed
- Exercise solutions will not be made available in writing or online

# Exams and Grades

- Relevant documents for open-book exam:
  - Lectures
  - Exercises and home work
  - Presentations
- Written exam after course, oral exams after that
- Grade composition
  - 20% presentations
  - 20% exercises and home work
  - 60% exam

# Lectures

| Title | Chapter | Instructor |
|---|---|---|
| Solar System Structure and Orbital Mechanics | 1,2 | Keller |
| Exoplanet Detections | 13 | Keller |
| Planet Formation and Migration | 12 | Stam |
| Planetary Interiors and Surfaces | 5, 6 | Stam |
| Planetary Atmospheres | 4 | Stam |
| Radiative Transfer | 3, 4 | Stam |
| Observations of Solar System Planets | | Keller |
| Observations of Exoplanets | | Keller |

# Solar System Structure and Orbital Mechanics

- Inventory of the solar system
- Solar system planet properties
- Two-body problem
- Three-body problem
- Tides
- Other forces

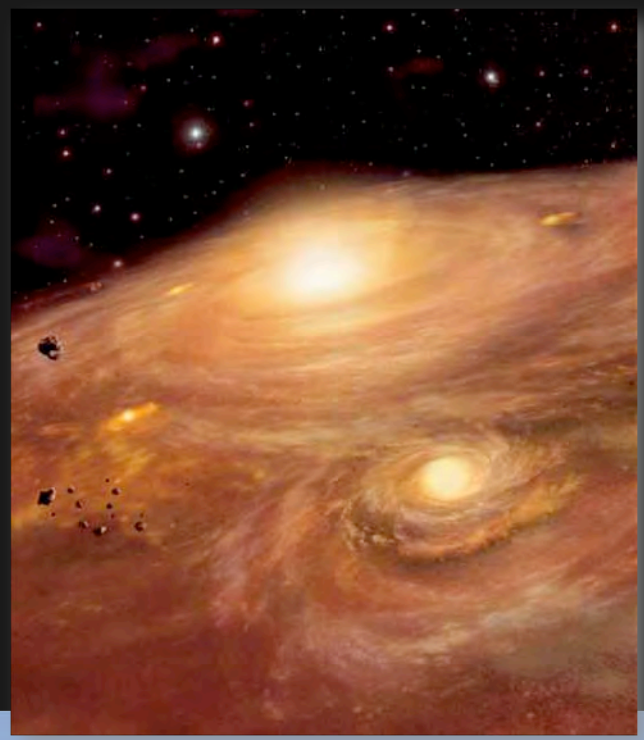
# Exoplanet Detections

- Radial velocity
- Transits
- Microlensing
- Imaging

# Planetary formation and migration

**Planetary Sciences Chapter 12**

- Observational constraints
- Star formation
- Early stages of planet formation
- Terrestrial planet formation
- Giant planet formation
- Planetary migration
- Asteroids and comets
- Moons and rings



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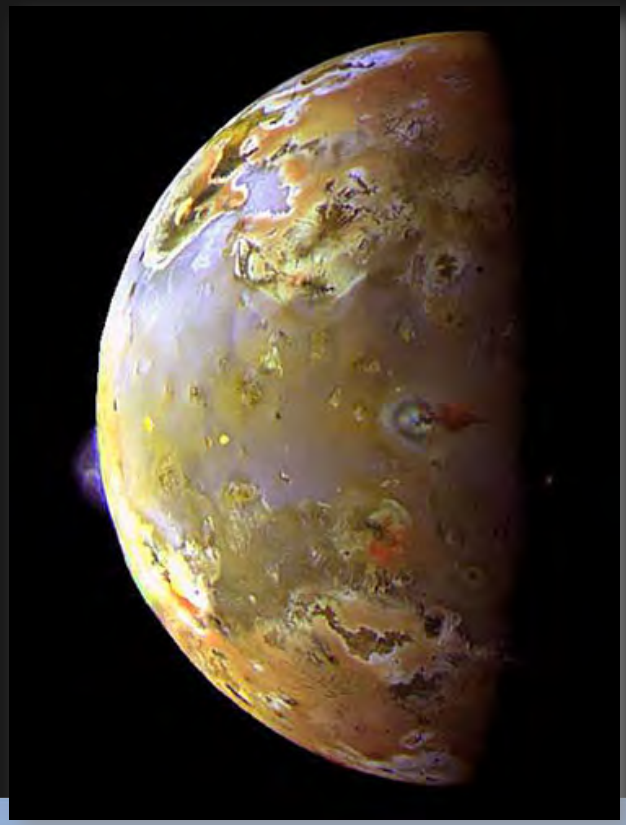
# Planetary interiors and surfaces

**Planetary Sciences Chapters 6 and 5**

- Modelling the interior structure of a planet
- Interiors of terrestrial planets
- Interiors of giant planets
- Magnetic fields
- Surface morphology
- Impact cratering
- Surfaces of individual bodies



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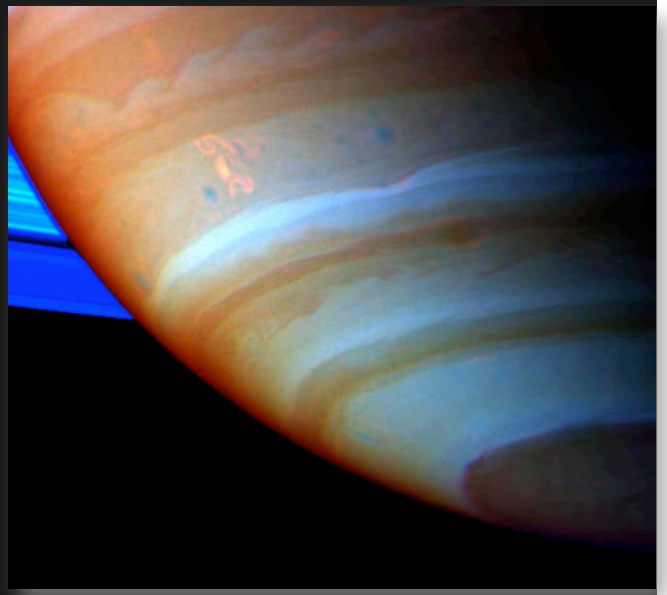
# Planetary atmospheres

**Planetary Sciences Chapter 4**



- Origin of planetary atmospheres
- Pressure and temperature profiles
- Atmospheric composition
- Cloud formation
- Meteorology
- Photochemistry
- Evolution of atmospheres

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# Radiative transfer

**Planetary Sciences Chapters 3 and (parts of) 4**

- Description of radiation
- Thermal radiation
- Scattering and reflection
- Polarisation
- Planetary spectra

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# Observations of Solar System Planets

- Surfaces
- Atmospheres
- Interior
- Moons
- Rings
- Asteroids
- Comets
- Kuiper Belt

# Observations of Exoplanets

- Orbits; distances, periods, eccentricities
- Masses
- Temperatures
- Atmospheres

# Presentations

- always 2 students together
- select one space mission and present science results to classmates
- 15-minute presentation in English or Dutch
- questions
- public and private discussion of presentation
- grade is for level of science understanding

# Presentation Topics

- Messenger (Mercury)
- Venera 13, 14 (Venus)
- Magellan (Venus)
- Venus Express (Venus)
- Lunar Reconaissance Orbiter (Moon)
- Mars Express (Mars)
- Spirit, Opportunity (Mars)
- Phoenix (Mars)
- Near Earth Asteroid Rendezvous (Mathilde, Eros)
- Hayabusa (asteroid Itokawa)
- Galileo (Jupiter)
- Cassini (Saturn)
- Huygens (Titan)
- Voyager (Uranus)
- Voyager (Neptune)
- Pluto Express (Pluto)
- Giotto (Comet Halley)
- Deep Impact (Comet 9P/Tempel)
- Corot (Exoplanets)
- Kepler (Exoplanets)