A JPL Planetary Science Summer School Trojan and Centaur Reconnaissance Mission: Mission Design


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TRACER (Trojan And Centaur Reconnaissance) Mission Overview

TRACER would be the first spacecraft to visit a Trojan and a Centaur. The mission's scientific objectives are to determine if Trojans and Centaurs formed in their present positions, test dynamical models for the evolution of the solar system, and place Trojans and Centaurs in context with other small outer solar system bodies.

The following mission design was developed during the 2009 JPL Planetary Science Summer School by a group of graduate students and recent Ph.D. students in a variety of sciences and engineering fields working in conjunction with Team X at JPL.

This design is a response to the 2009 New Frontiers Announcement of Opportunity.

Spacecraft Overview

- Atlas 941 launch vehicle
- Dual cold redundant power
- No radiator
- Hexagonal box
- Communication: 4 m HGA
- 8.75 m MGA
- Solar Power
- 4 ultraflux arrays
- Propulsion: Solar Electric (Kerosene)
- Chemical (Hydrazine)
- Instruments
  - ASTERIA
  - GAEA
  - DELPHI
  - ILIAD
  - radio science

Mission Trajectory and Encounter Strategy

The trajectory includes the flybys of the Trojan Antenor on November 28, 2023 and the Centaur 2001 BL41 on March 12, 2019. This mission would be the first to conduct such measurements in the outer solar system and place Trojans and Centaurs in context with other small outer solar system bodies.

Science Objectives and Instrumentation

- Determine the formation region of the Trojans and Centaurs
- Determine the physical properties (size, mass, density) of a Trojan and a Centaur
- Measure dust fluxes in the outer solar system
- Determine the chemical composition of Trojan and Centaur volatiles, ices and organic compounds
- Map the color, albedo and surface morphology of a Trojan and Centaur at high resolution

Instrument

<table>
<thead>
<tr>
<th>ASTERIA</th>
<th>GAEA</th>
<th>DELPHI</th>
<th>ILIAD</th>
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<tbody>
<tr>
<td>Visible and near infrared spectrometer</td>
<td>Ion and neutral mass spectrometer</td>
<td>Narrow angle camera</td>
<td>Dust counter</td>
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<tr>
<td>- images of 3 mrad/pixel, two 640 x 480 HgCdTe detectors</td>
<td>- Sensitivity of 0.1 m/s at 1 AU</td>
<td>- 1 to 100 amu range, M/SME100</td>
<td>- 0.1 m collector</td>
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<tr>
<td>- Spectral resolution of 5 cm from 0.4-2.5 µm and 10 cm from 2.5-5 µm</td>
<td>- Minimum source density of 10⁻¹⁰ µmol/cm³</td>
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<td>- Up to 10 µm impacts per second</td>
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<td>- Capable of detecting: H₂, CO, CO₂, NH₃, H₂O, H₂S, HD, HD⁺, Ar, and chain/dinated hydrocarbons</td>
<td>- Capable of measuring particles 10⁻¹⁰ to 10⁻⁰ kg</td>
<td>- Capable of measuring particles 10⁻¹⁰ to 10⁻⁰ kg</td>
<td>- Up to 10⁴ impacts per second</td>
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The TRACER mission is designed to provide new insights into the evolution and composition of the outer solar system by making in situ measurements of Trojans and Centaurs.

Acknowledgements

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