FLYBY DELIVERS MULTIPLE DEEP JUPITER PROBES. T. R. Spilker¹, W. B. Hubbard², and A. P. Ingersoll³,
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Introduction: In situ probes are the most reliable means for sampling composition and conditions deep in
giant planet atmospheres. While exceeding its baseline mission, the Galileo probe entered a distinctly non-
representative region of Jupiter (a “hot spot”) and apparently did not measure the full deep abundances of such
important species as H2O and H2S, whose measured abundances were still increasing at the deepest datum
[1], [2]. Multiple deep (~100 bar) in situ probes minimize the hot spot risk, and address spatial variations and
deep constituent abundances.

Science Objectives: The primary science goals are to understand:
1. Bulk composition & its gradients, especially as related to solar system formation & planetary
evolution
2. Atmospheric chemistry
3. Atmospheric structure & dynamics
4. Spatial variability in the troposphere & deeper
These are supported by the mission’s measurement objectives, in rough priority order:
1. Mixing ratios of the primary C, O, N, & S bearers, as a function of depth
2. Cloud composition, density, & particle size
3. Atmospheric temperature, pressure, & density as a function of depth
4. Bulk flow (wind) as a function of depth
5. Vertical radiant energy flux as a function of depth
6. Ortho- to para-H2 ratio
7. Noble gas & disequilibrium species mixing ratios; isotopic ratios for selected elements

The objectives address all three major topics of the SSE Roadmap Quest, “To Explain the Formation and Evolution
of the Solar System and Earth.”

Payload: Candidate instruments: GCMS; net flux radiometer; nephelometer; atmospheric structure package
with thermometers, pressure transducers, and accelerometers; sound speed instrument, for ortho-/para-H2 ratios;
USO for Doppler wind experiments.

Mission Design: Figure 1 illustrates the most important aspects of the mission design. About 6 months
before arrival via a “standard” transfer to Jupiter the Carrier-Relay Spacecraft (CRSC), with up to 3 or 4 100-kg
probes [3], is on the trajectory labeled “South Probe.” The probe is released, and a maneuver of ~30-50 m/s
places the CRSC and remaining probes on the “Equatorial Probe” trajectory, such that arrival is ~2-3 hours be-
fore the south probe arrives; that probe is then released. Another maneuver of 30-50 m/s places the CRSC and
north probe on the “North Probe” trajectory such that arrival is 2-3 hours before the equatorial probe, and that
probe is released. A final maneuver of ~70 m/s places the

CRSC on the polar flyby trajectory indicated. Probes deployed in this manner can reach latitudes up to ~25°
away from equatorial.

Data Relay: As the CRSC flies by Jupiter N-to-S, it receives the probes’ transmissions in non-overlapping order, storing them for later playback from heliocentric orbit. Planetary rotation carries the probes toward the CRSC “ground track” for the deepest parts of their missions.

Radiation: A polar flyby yields less than 1/3 the dose of the Galileo orbiter’s first perijove pass, less than
30 krad. The equatorial probe’s radiation environment is similar to the Galileo probe’s, while the N and S probes
experience less than that.

History & Status: In 1997 JPL’s Team X, under guidance from SSES' Astrophysical Analogs CSWG,
conducted preliminary studies of this new mission design. At that time the AACSWG made it their top near-
term priority. Delivery by other spacecraft, such as Solar Probe and Pluto-Kuiper Express, was examined and re-
jected. No more detailed studies have been conducted since that time.

Cost: The INSIDE Jupiter spacecraft, modified to substitute the probes and their deployment mechanism
for JI’s substantial (>500 kg wet) primary propulsion module, could function as the CRSC, so the CRSC and
mission could be implemented within a Discovery Program budget plus the cost of the probes. Probe development
would require ~$15M for heat shield R&D before project start [3].