# Exploring our outer solar system – The Giant Planet System Observers

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As space-faring peoples now work together to plan and implement future missions that robotically prepare for landing humans to explore the Moon, and later Mars, the time is right to develop evolutionary approaches for extending this next generation of exploration beyond Earth's terrestrial planet neighbors to the realm of the giant planets. And while initial fly-by missions have been hugely successful in providing exploratory surveys of what lies beyond Mars, we need to consider now what robotic precursor mission capabilities we need to emplace that prepare us properly, and comprehensively, for long-term robotic exploration, and eventual human habitation, beyond Mars to the outer reaches of our solar system. To develop practical strategies that can establish prioritized capabilities, and then develop a means for achieving those capabilities within realistic budget and technology considerations, and in reasonable timeframes, is our challenge.

We suggest one component of such an approach to future outer planets exploration is a series of Giant Planets System Observer (GPSO) missions that provide for long-duration observations, monitoring, and relay functions to help advance our understanding of the outer planets and thereby enable a sound basis for planning their eventual exploration by humans. We envision these missions as being comparable to taking Hubble-class remote-sensing facilities, along with the space physics capabilities of long-lived geospace and heliospheric missions, to the giant planet systems and dedicating long observing lifetimes (HST, 16 yr.; Voyagers, 29 yr.) to the exhaustive study and characterization of those systems. GPSO missions could feature 20-yr+ extended mission lifetimes, direct inject trajectories to maximize useful lifetime on target, placement strategies that take advantage of natural environment shielding (e.g., Ganymede magnetic field) where possible, orbit designs having favorable planetary system viewing geometries, comprehensive broadband remote sensing capabilities, a complementary and redundant science instrument suite, fully autonomous operations, high bandwidth science data downlink, advanced solar power technologies (supplemented where necessary), functional interfaces that are compatible with future small fly-by missions, and fail-safe features for mission operations and planetary protection,

among other considerations.

We describe in this paper one example of a GPSO-type mission our team has been formulating as a practical approach that addresses many of the most highly-rated future science exploration needs in the Jovian system, including the exploration of Europa, observation of Io and Ganymede, and characterization of the Jovian atmosphere. We call this mission concept the Ganymede Exploration Observer with Probes (GEOP), and describe its architecture, mission design, system features, science capabilities, key trades, and notional development plan for implementation within the next decade.