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Shallow Probes to the Outer Planets

S. Bolton (1), T. Owen (2), S. Atreya (3), D. Gautier (4), T. Guillot (5), A. Ingersoll (6)

(1) Southwest Research Institute, (2) U. Hawaii, (3) U. Michigan, (4) Obs. Paris, (5) Obs. Cote d'Azur, (6) Caltech

The determination of the composition of giant planet atmospheres is one of the most fundamental investigations any planetary mission can undertake. The evidence we have so far indicates that volatile material from the cores of these planets is mixed into their atmospheres. Thus sampling those atmospheres is even more revealing than analyzing a suite of samples returned from the surface of a rocky planet in terms of the insight it provides. The information resulting from such studies yields critical constraints on models for the internal structures of these planets and gives important clues to the manner in which they formed and to the nature of the solar nebula that spawned them and by extension to the formation and evolution of extrasolar systems.

In recognition of this, much attention has been given to the need for deep probes into the atmospheres of the giant planets. While this is indeed a desirable goal, the technological challenges involved are so extreme that the possibility of achieving one of these missions within the next 50 years seems remote. In this paper, we present the science that can be achieved with shallow probes–to depths of 20 bars or less-and discuss scenarios in which the cost of such missions can be minimized, thereby making probe missions to Saturn, Uranus and Neptune possible within the next decade.