MARS ORBITER OPTICAL LINK SCIENCE DEMONSTRATION FOR ATMOSPHERIC AND INTERIOR STRUCTURE. S. W. Asmar[1] , D. P. Hisnon[2], A. S. Konopliv[1], W. M. Folkner[1], K. Oudrhiri[1], and R. A. Preston[1], [1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, [2]Stanford University, Palo Alto, CA 94305.

Introduction: Radio scientists have utilized microwave links on Mars and other planetary orbiters to carry out investigations of atmospheres and gravitational fields, among other studies. In an era of optical communications, the links between the spacecraft and ground terminals can also be utilized to carry out experiments equivalent to Radio Science. We propose a hybrid radio/optical link experiment (Radio-Light) to demonstrate the first deep space link science with lasers combined with the radio signals typically utilized for mission communications and navigation.

Martian Atmosphere: For the atmospheric investigation, Radio-Light would be used for occultation sounding of the thermal structure and the distribution of aerosols in the middle atmosphere. Results would include accurate, high-resolution profiles of number density, temperature, pressure, and opacity versus radius. In the one-way optical link needed for these investigations, the spacecraft Ultra-Stable Oscillator (USO) will typically limit performance, as it does with current radio links., so a very good USO will be required to take full advantage of the inherent capability of the system. It will be difficult to extend the optical link profiles below roughly 10-20 km, owing to the large opacity of the atmosphere at this wavelength (1.0-1.5 microns). On the other hand, "interference" from the ionosphere of Mars is negligible at this wavelength, so it should be possible to extend the profiles to significantly higher altitudes, by perhaps 20-25 km, than is possible with current X-band experiments.

The profiles of aerosol opacity would be derived from measurements of optical signal intensity, and an early investigation of performance indicates that important new information about the atmosphere could be derived.

Interior Structure: For the gravity investigation, Radio-Light would improve the range-rate accuracy by nearly two orders of magnitude over the current X-band links, assuming orbit altitude and mission duration are comparable to current typical orbiters. A dual radio/optical link gravity experiment would improve the uncertainty in the gravity coefficients by 10 to 100 times and improve significantly the resolution of the gravity field, resulting in new information about Mars interior structure, tidal response and long wavelength time-varying gravity due to the seasonal mass exchange between the polar ice caps.

The potential of high precision ranging measurements, calibrated for tropospheric effects, could increase the number of asteroids mass estimates from about 25 currently to about 60 asteroids.

Trade-off Studies: This paper will discuss the scientific objectives and an implementation method. It will summarize the trade-off studies and describe the value of the combined radio/optical link system, two-way versus one-way links as well as the role of "paired one-way", a comparison with Ka-band links, and the potential use of an accelerometer. Finally, the paper will outline the benefits of the proposed demonstration to navigation work as well as the implications of reducing risk to operating future robotic and human missions.