isotopic abundance. The $^{129}Xe$ to $^{132}Xe$ ratio was measured with an uncertainty of 70%, but none of the other isotope ratios for these species were obtained. Accurate measurement of the Xe and Kr isotopic abundance in this atmosphere provides a important data point in testing theories of planetary formation and atmospheric evolution. The measurement is also essential for a stringent test for the martian origin of the SNC meteorites, since the Kr and Xe fractionation pattern seen in gas trapped in glassy nodules of an SNC (EETA 79001) is unlike any other known solar system resevoir. Current flight mass spectrometer designs combined with the new technology of a high-performance vacuum pumping system show promise for a substantial increase in gas throughput and the dynamic range required to accurately measure these trace species.

The wide dynamic range of present space flight mass spectrometer analyzer/detector systems allows ionization pressures to be pushed toward the point where the gas mean free path in the ion source is limiting. However, the fixed capacity of miniaturized high-vacuum pumping systems has put significant constraints on several previous mass spectrometer experiments, including the Viking mass spectrometer. The noble gases are not pumped by chemical pumps and with a very limited capacity by miniaturized ion pumps. In addition, an ion-pumped system can release previously pumped material with a corresponding loss of accuracy.

A recent commercial development in high-vacuum pumping technology is that of wide-range turbomolecular/molecular drag pump hybrids where both stages are attached to the same rotating shaft. The natural exhaust pressure of the molecular drag stage is approximately 10 mbar. Compression ratios of $10^7$ or higher for N are achieved with very small pumping systems. It is expected that with continued development toward a ruggidized flight pump a mass of less than 1 kg for a system with a pumping speed of 10 to 30 liters/s can readily be achieved. The pump capacity is only limited by power constraints and eventual failure of the bearings after several thousand hours of operation. With reference to the payload described by the MESUR Science Definition Team, a mass spectrometer experiment incorporating such a pump together with a recently developed thermal analyzer [1] could provide information on the volatile composition of martian near-surface solid-phase material in addition to carrying out the isotope measurements described.

**References:** Mauersberger K. et al. (1992) *LPI Tech. Rpt. 92-07.*

N93-28799 160745

**VISIBLE IMAGING ON THE PLUTO FAST FLYBY MISSION.** M. C. Malin, Malin Space Science Systems, 3535 General Atomics Court, Suite 250, San Diego CA 92121, USA.

Objectives for visible imaging of the Pluto-Charon system, as prescribed by the Outer Planets Science Working Group, are to acquire (1) global observations (FOV of ~5000 IFOVs) at 1 km/line-pair for the purpose of characterizing surface morphology and geology, (2) global observations in 3–5 broadband colors at 5–10 km/line-pair for studies of surface properties and composition as it relates to morphology, and (3) selected observations at higher spatial resolution for study of surface processes.

Several factors of the Pluto Fast Flyby mission make these difficult objectives to achieve: At Pluto's distance from the Sun, there is nearly 1/1000 the amount of light as at the Earth, the flyby velocity is high (~15 km/s), and the science requirements dictate a large data volume (1 km/line-pair implies between 20 and 50 MBytes for the panchromatic global image, and a comparable amount for the multispectral dataset).

The low light levels can be addressed through a large aperture, image intensification, long exposures with precision pointing and image motion compensation (scan mirror or spacecraft movement), or time-delay integration. The high flyby velocities require short exposures, image motion compensation, or observations from considerable distance (e.g., longer focal lengths and larger apertures). Large data volume requires a large spacecraft data buffer, an internal instrument data buffer, or real-time data compression. The difficulty facing the successful Pluto Fast Flyby imaging investigation will be overcoming these technical challenges within the extremely limited mass (~2 kg) and power (~2 W) available.

N93-28800 160746

**A DTA/GC FOR THE *IN SITU* IDENTIFICATION OF THE MARTIAN SURFACE MATERIAL.** R. L. Mancinelli[1], M. R. White[1], and J. B. Orenberg[2], [1]NASA Ames Research Center, Moffett Field CA 94035, USA, [2]Department of Chemistry and Biochemistry, San Francisco State University, San Francisco CA 94132, USA.

The composition and mineralogy of the martian surface material remain largely unknown. To determine its composition and mineralogy several techniques are being considered for *in situ* analyses of the martian surface material during missions to Mars. These techniques include X-ray fluorescence, X-ray diffraction, α-proton backscattering, γ ray spectrometry, mass spectrometry, differential thermal analysis (DTA), differential scanning calorimetry (DSC), and pyrolysis gas chromatography. Results of a comparative study of several of these techniques applicable to remote analysis during MESUR-class missions indicate that DTA/GC would provide the most revealing and comprehensive information regarding the mineralogy and composition of the martian surface material [1].

We have successfully developed, constructed, and tested a laboratory DTA/GC. The DTA is a Dupont model 1600 high-temperature DTA coupled with a GC equipped with a MID detector. The system is operated by a Sun Sparc II workstation. When gas evolves during a thermal chemical event, it is shunted into the GC and the temperature is recorded in association with the specific thermal event. We have used this laboratory instrument to define experimental criteria necessary for determining the composition and mineralogy of the martian surface *in situ* (e.g., heating of sample to 1100°C to distinguish clays). Our studies indicate that DTA/GC will provide a broad spectrum of mineralogical and evolved gas data pertinent to exobiology, geochemistry, and geology. Some of the important molecules we have detected include organics (hydrocarbons, amides, amines, etc.), $CO_3^{2-}$, $NO_3^-$, $NO_2^-$, $NH_4^+$, $SO_4^{2-}$, $H_2O$, and $CO_2$. The technique can also discern the mineral character of the sample (i.e., clay vs. silicates vs. glasses; degrees of hydration, etc.) [2]. It is thought that the surface of Mars consists primarily of an amorphous juvenile silicate material similar to palagonite with not more than 15 wt% clay [3]. This type of mixture is easily determined by DTA/GC using the high-temperature (1100°C) capability of the DTA [1,2]. This is important to the definition of mission analytical techniques, which must be able to analyze samples ranging from those containing no clay or evaporites to samples composed of significant amounts of highly structured clay and evaporites within a predominately amorphous matrix.

**References:** [1] Schwartz D. E. et al. (1993) *Adv. Space Res.*, *13*, in press. [2] Mancinelli R. L. et al. (1992) *LPSC XXIII*, 831–832. [3] Orenberg J. B. and Handy J. (1992) *Icarus, 96*, 219–225.

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p. 1

**ONBOARD SIGNAL PROCESSING: WAVE OF THE FUTURE FOR PLANETARY RADIO SCIENCE?** E. A. Marouf, Department of Electrical Engineering, San Jose State University, San Jose CA 95192-0084, USA.

Future spacecraft-based radio observations of planetary surfaces, rings, and atmospheres could significantly benefit from recent technological advances in real-time digital signal processing (DSP) hardware. Traditionally, the radio observations have been carried out in a "downlink" configuration in which about 20-W spacecraft-transmitted RF power illuminates the target of interest and the perturbed signal is collected at an Earth receiving station. The downlink configuration was dictated by the large throughput of received data, corresponding to a relatively large recording band width (about 50 kHz) needed to capture the coherent and scattered signal components in the presence of trajectory, ephemeris, and measurement uncertainties. An alternative "uplink" configuration in which powerful Earth-based radio transmitters (20–200 kW) are used to illuminate the target and data are recorded onboard a spacecraft could enhance the measurements' signal-to-noise ratio by a factor of about 1000, allowing a quantum leap in scientific capabilities. The recorded data must be preprocessed to reduce its volume while preserving its salient information content. The latter include time-history of estimates of the amplitude and phase of the coherent signal and dynamic power spectra of the scattered signal, computed at adaptable resolutions. The "compressed" data is later relayed to the Earth for further detailed processing and analysis. Onboard data compression can readily be accomplished either by a DSP processor that is a part of an Uplink Radio Science Instrument, or by a configurable spacecraft "DSP subsystem" that serves as a preprocessing engine for multiple spacecraft instruments. In either case, the hardware architecture must be sufficiently flexible to allow implementation of a broad class of preprocessing algorithms, adaptable to a given observation geometry and corresponding signal dynamics. Specific signal compression needs and expected scientific gain are illustrated for potential future uplink observation of planetary ring systems. A similar argument can be made for radio observations of the tenuous atmosphere of Pluto and for radio imaging of the martian surface, two potential targets for the Pluto FFM and the Mars MESUR missions.

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**SPACEBORNE PASSIVE RADIATIVE COOLER.** S. Mathias, Arthur D. Little, Inc., Cambridge MA 02140, USA.

Radiative coolers are passive refrigeration devices for satellites and space probes that provide refrigeration for an infrared or other type of detector that operates at cryogenic temperatures. Typically a cooler can supply 20 mW of cooling at about 85 K, and over 500 mW of cooling at about 165 K. The exact cooler temperatures and heat loads are dependent upon the clear field of view of the cooler to space.

Some features of the Arthur D. Little passive radiative cooler are (1) the cooler has no moving parts leading to very long life and high reliability; (2) the cooler weight is approximately 3 lb; (3) the detector may be easily replaced without disassembling the cooler; (4) the alignment of the detector is insensitive to induced launch vibration and thermal cycling; (5) a movable field lens provides a simple method of adjusting the system focus during testing at operating temperatures; (6) the optical axis is referenced to the room-temperature mounting flange interface, eliminating the need for iterative optical adjustments in thermal vacuum chambers at the system level; (7) heater and temperature sensors provide precise detector temperature control; (8) the design offers protection against overheating of the sensitive detector element during nonoperational spacecraft attitude acquisition; (9) a modular "bolt-on" concept provides simple integration and interface definition of the cooler with an optical system; and (10) there is maximum protection of the low-temperature optical elements from contamination.

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p. 2

**SYSTEMATIC PROCESSING OF CLEMENTINE DATA FOR SCIENTIFIC ANALYSES.** A. S. McEwen, U.S. Geological Survey, Flagstaff AZ 86001, USA.

If fully successful, the Clementine mission will return about 3,000,000 lunar images and more than 5000 images of Geographos. Effective scientific analyses of such large datasets require systematic processing efforts. Described below are concepts for two such efforts.

**Global Multispectral Imaging of the Moon:** The lunar orbit has been designed to enable global coverage with the UV/VIS and near-IR cameras. Global coverage will require 120 frames per orbit × 300 orbits × 16 frames (6 near-IR filters and double coverage in 5 UV/VIS filters to improve S:N), for a total of 576,000 image frames. Lunar scientists cannot analyze half a million small images. We will need a single global 11-wavelength image cube with full geometric and radiometric calibrations and photometric normalizations. Processing steps could include (1) decompressing the data, (2) radiometric calibration, (3) removal of camera distortions, (4) co-registration of each set of 16 images to 0.2 pixel, (5) replacing bad or missing data, (6) merging UV/VIS double coverage, (7) identifying three control points per orbit, (8) along-track frame matching (geometry and brightness), (9) reprojecting images, (10) photometric function normalization, (11) mosaicking into single-orbit strips, (12) brightness matching of orbit strips, and (13) mosaicking orbit strips into map quadrangles. The final global dataset at a scale of 100 m/pixel will require a set of 70 CD-ROMS (650 Mbytes/CD) for archiving and distribution. Once systematic processing is completed, a series of global maps can be derived that show the distribution and abundances of pyroxenes, olivine, anorthosite, shocked anorthosite, norite, troctolite, glassy materials, and titanium.

**Videos of Geographos:** Clementine is expected to acquire continuous imaging throughout the closest approach sequence at Geographos with frame rates of 4.5 or 9 frames/s. (For comparison, the highest frame rate on Galileo is 0.4 frame/s, and there was no imaging near closest approach to Gaspra.) The high frame rates and continuous imaging are ideal for production of computer "movies" of the flyby, which can be recorded onto video tapes. These movies