characterize the biogenic element constituents of soil samples providing information on the biologic potential of the Mars environment. For example, experimental results employing the breadboard indicate that accurate and precise data including the detection, identification, and quantification of elements to trace levels (ppm) from carbon to zirconium ($6 < Z < 40$), as well as relative abundance of amorphous vs. crystalline minerals in Mars soil surface samples, can be obtained. The breadboard has been designed and built with regard to expected Mars environmental operating conditions, mission constraints, and technical requirements that include general instrument design considerations.

Preliminary XRF/XRD breadboard experiments have confirmed the fundamental instrument design approach and measurement performance. Experimental accomplishments and results include the following: XRD observation of the principal diffraction lines of montmorillonite; XRF measurement of aluminum, silicon, calcium, titanium, and iron abundances in palagonite powder samples commensurate with expectations; and calibration of a carbon-detecting XRF channel with detectability limits in the order of 0.01 wt%.

The breadboard experiments provided valuable confirmation of models used to simulate and optimize the instrument's performance and indicated practical improvements in its design.

References: [1] *COMPLEX* (1978) National Academy of Sciences, Washington, DC, 97 pp.

N93-28793

REMOTE MEASUREMENT OF PLANETARY MAGNETIC FIELDS BY THE HANLE EFFECT. C. K. Kumar[1,2], L. Klein[1,2], and M. Giraud[3], [1]Department of Physics and Astronomy, Howard University, Washington DC 20059, USA, [2]Center for the Study of Terrestrial and Extra-Terrestrial Atmospheres, Howard University, Washington DC 20059, USA, [3]Departement de Physique, Université de Provence/St. Jerome, Marseilles, France.

Resonance fluorescence lines in the spectra of planetary atmospheres are polarized. They will be depolarized by magnetic fields in the scattering medium (Hanle effect). The amount of depolarization has been calculated for some atomic (FeI, CaI) lines and some molecular lines (NO γ bands) seen in the Earth's dayglow spectra. The results are presented and the potential advantages of LIDAR measurements for obtaining atmospheric magnetic fields are discussed. The depolarization of Na and Ca lines are suitable for measuring magnetic fields in and near Io.

N93-28794

RESOLUTION-ENHANCED MAPPING SPECTROMETER. J. B. Kumer, J. N. Aubrun, W. J. Rosenberg, and A. E. Roche, Lockheed Palo Alto Research Laboratory, Palo Alto CA 94304, USA.

A familiar mapping spectrometer implementation utilizes two-dimensional detector arrays with spectral dispersion along one direction and spatial along the other. Spectral images are formed by spatially scanning across the scene (i.e., push-broom scanning). For imaging grating and prism spectrometers the slit is perpendicular to the spatial scan direction. For spectrometers utilizing linearly variable focal-plane-mounted filters the spatial scan direction is perpendicular to the direction of spectral variation. These spectrometers share the common limitation that the number of spectral resolution elements is given by the number of pixels along the spectral (or dispersive) direction. In this presentation we discuss resolution enhancement by first passing the light input to the spectrometer through a scanned etalon or Michelson. Thus, while a detector element is scanned through a spatial resolution element of the scene, it is also temporally sampled. For example, to enhance resolution by a factor of 4 in a given spectral element, one would design the etalon to have finesse 4 in that spectral region, scan the etalon through a free spectral range as the detector is spatially scanned through spatial resolution element, and take eight samples in the process. To plug numbers in a specific example, suppose the mapping spectrometer pixel at 1 µm had unenhanced resolution of 60 cm^{-1}, but 15 cm^{-1} resolution is desired. Further assume that 2 s is required to scan across a spatial element. An etalon with gap 83.33 µm would give it the required free spectral range of 60 cm^{-1}, reflectivity 46.5% would give it the required finesse ≈ 4, and a sample rate of eight per second while scanning the gap through 1/2 wavelength (i.e., 0.5 µm in this example, in order to scan through the 60 cm^{-1} free spectral range) in eight steps of 0.5 µm/8 would provide a spectrum of resolution of 15 cm^{-1} resolution within the order sorting 60 cm^{-1} provided by the unenhanced spectrometer. Our presentation will address the analysis for all the pixels in the dispersive direction. We will discuss several specific examples. We will also discuss the alternate use of a Michelson for the same enhancement purpose. Suitable for weight constrained deep space missions, we have developed hardware systems including actuators, sensors, and electronics such that low-resolution etalons with performance required for implementation (performance requirement typified by the example above) would weigh less than one pound.

N93-28795

PROPOSAL FOR A UNIVERSAL PARTICLE DETECTOR EXPERIMENT. J. C. Lesho, R. P. Cain, and O. M. Uy, APL, Building 13-5377, Johns Hopkins University, Laurel MD 20723, USA.

The Universal Particle Detector Experiment (UPDE), which consists of parallel planes of two diode laser beams of different wavelengths and a large surface metal oxide semiconductor (MOS) impact detector, is proposed. It will be used to perform real-time monitoring of contamination particles and meteoroids impacting the spacecraft surface with high resolution of time, position, direction, and velocity. The UPDE will discriminate between contaminants

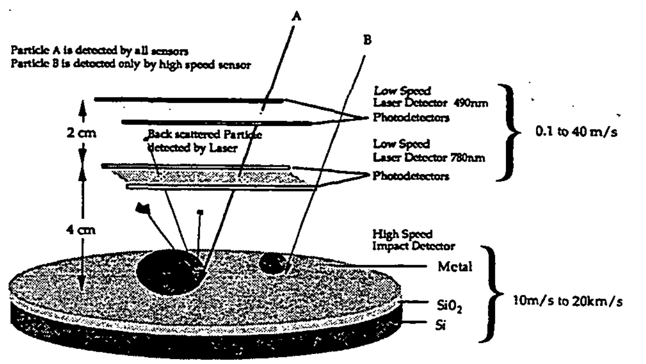

Fig 1. UPDE sensor.

and meteoroids, and will determine their velocity and size distributions around the spacecraft environment. With two different color diode lasers, the contaminant and meteoroid composition will also be determined based on laboratory calibration with different materials. Secondary particles dislodged from the top aluminum surface of the MOS detector will also be measured to determine the kinetic energy losses during energetic meteoroid impacts. The velocity range of this instrument is 0.1 m/s to more than 14 km/s, while its size sensitivity is from 0.2 μm to millimeter-sized particles.

The particulate measurements in space of the kind proposed here will be the first simultaneous multipurpose particulate experiment that includes velocities from very slow to hypervelocities, sizes from submicrometer- to pellet-sized diameters, chemical analysis of the particulate composition, and measurements of the kinetic energy losses after energetic impacts of meteoroids.

This experiment will provide contamination particles and orbital debris data that are critically needed for our present understanding of the space environment. The data will also be used to validate contamination and orbital debris models for predicting optimal configurations of future space sensors and for understanding their effects on sensitive surfaces such as mirrors, lenses, paints and thermal blankets.

N93-28796 160742

OPTIMISM EXPERIMENT AND DEVELOPMENT OF SPACE-QUALIFIED SEISMOMETERS IN FRANCE.
P. Lognonné[1], J. F. Karczewski[2], and DT/INSU-CRG Garchy Team[2], [1]IPGP, 4 Place Jussieu, 75252 Paris Cedex 05, France, [2]INSU, 4 Avenue de Neptune, 94107 Saint Maur des Fosses Cedex, France.

The OPTIMISM experiment will put two magnetometers and two seismometers on the martian floor in 1995, within the framework of the Mars '94 mission. The seismometers are put within the two small surface stations.

The seismometer sensitivity will be better than 10^{-9} g at 1 Hz, 2 orders of magnitude higher than the Viking seismometer sensitivity. *A priori* waveform modeling for seismic signals on Mars [1] shows that it will be sufficient to detect quakes with a seismic moment greater than 10^{15} Nm everywhere on Mars. Such events, according to the hypothesis of a thermoelastic cooling of the martian lithosphere, are expected to occur at a rate close to one per week [2] and may therefore be observed within the 1-year lifetime of the experiment.

Due to severe constraints on the available power, mass budget, *g* load, and size of the small stations, it was necessary to completely redesign the seismometer sensors and electronic. The sensor has been developed in order to support a high *g* load of 200 *g*/10 ms without reducing its sensitivity. It consists of a new leaf-spring vertical seismometer, with a free period close to 0.5 s and an inertial mass of 50 *g*. The seismometer has two modes, working either with a velocity transducer, for high-frequency seismic measurements, or with a displacement transducer, for long-period seismic measurements. The seismometer's mass is 340 *g*, and its size is 9 cm^3.

Along the same lines, a low-power, hybrid technology has been used for the electronic. The velocity transducer and displacement transducer need a power of a few milliwatts, with a sensitivity of 10^{-10} for the displacement transducer.

This seismometer will be the first space-qualified or automatic very-broad-band seismometer to be developed in France. The next generation will consist of a triaxial seismometer, with performances at least 1 order of magnitude better than the OPTIMISM seismometer.

References: [1] Lognonné and Mosser (1992). [2] Solomon et al. (1991).

N93-28797 160743

FILTERING INTERPOLATORS FOR IMAGE COMPARISON ALGORITHMS.
R. L. Lucke[1] and A. D. Stocker[2], [1]Code 7604, Naval Research Laboratory, Washington DC 20375-5352, USA, [2]Space Computer Corporation, Suite 104, 2800 Olympic Boulevard, Santa Monica CA 90404-4119, USA.

Comparing two or more images, either by differencing or ratioing, is important to many remote sensing problems. Because the pixel sample points for the images are (almost) always separated by some nonzero shift, a resampling, or interpolation, process must be performed if one image is to be accurately compared to another. Considered in Fourier space, an interpolator acts as a filter that attenuates some frequencies (usually high) of the image. Thus, when the shifted and unshifted images are compared, the former has been filtered, while the latter has not; the effect of this difference is called interpolation error. The key idea of this paper is to apply a filter to the unshifted image that matches the filtering effect of applying the interpolator to the shifted image, thereby drastically reducing interpolation error. The resulting interpolators, called filtering interpolators, are derived and discussed in detail elsewhere [1]. Basic results will be given in this presentation.

The cost of reducing interpolation error is some loss of high-frequency information. This paper presents parameterized families of local convolutional interpolators (polynomial and trigonometric) that can be adjusted to the desired trade-off between interpolation error reduction and high-frequency information retention. These interpolators allow as many images as desired, all with different shifts, to be compared on an equal footing.

The method is derived for images with the same pixel spacing and purely translational shifts. Performance suffers if these conditions are not met, but is still better than ordinary interpolation. Four-point interpolators are probably the most useful because they give good interpolation performance with reasonable computational efficiency. One-dimensional formulas are given; for two dimensions, the interpolators are applied to each dimension separately. In tests on simulated imagery, the filtering interpolators reduced interpolation error to below the level of sensor noise for 13-bit data (LSB = rms noise) on highly structured scenes.

References: [1] Lucke R. L. and Stocker A. D. (1993) *IEEE Trans. Signal Processing*, in press.

N93-28798 160744

MASS SPECTROMETRIC MEASUREMENT OF MARTIAN KRYPTON AND XENON ISOTOPIC ABUNDANCE.
P. Mahaffy[1] and K. Mauersberger[2], [1]Laboratory for Atmospheres, NASA/Goddard Space Flight Center, Greenbelt MD 20771, USA, [2]University of Minnesota, School of Astronomy and Physics, Minneapolis MN 55455, USA.

The Viking gas chromatograph mass spectrometer experiment provided significant data on the atmospheric composition at the surface of Mars, including measurements of several isotope ratios. However, the limited dynamic range of this mass spectrometer resulted in marginal measurements for the important Kr and Xe