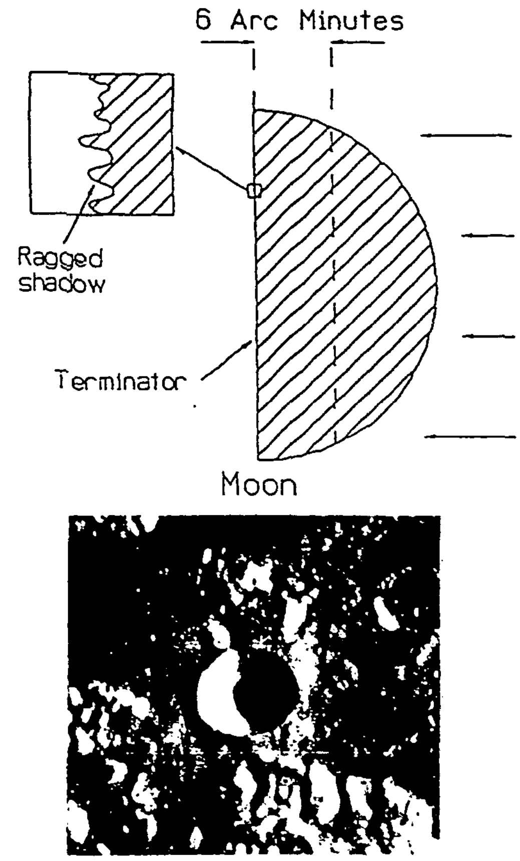

Fig. 3. The ragged edges at the lunar terminator provide suitable references for stabilizing the image. Using the configuration shown in Fig. 2 permits diffraction-limited imaging at IR wavelengths of a strip adjacent to the terminator several arcminutes wide.

tracking these abrupt intensity changes using two edges that are roughly at right angles to one another, image stabilization can be obtained to diffraction-limited accuracy. Suitable edges are found on the lunar terminator and at obliquely illuminated crater and basin edges (Fig. 3). Because the edges must lie within the isoplanatic angle of the region being imaged, it is only possible to image a strip a few arcminutes wide. Over the course of the lunar day (two weeks), however, a complete image of the lunar surface can be compiled using successive strips. With an infrared spectrometer mounted to this system, accurate compositional data will also be obtained.

The objective of this project is to conduct a lunar resource survey using image stabilization hardware of the sort shown in Fig. 2, in combination with a suitable edge-tracking algorithm. When the arrangement is used with existing 4–5-m class telescopes, 0.1-arcsec resolution (150 m) is expected at 2.2 μm. However, if the new 8-m (NOAO) telescopes are built to appropriate optical standards, diffraction-limited images should be obtained routinely at 1 μm. At this wavelength, 0.03-arcsec resolution is expected that, on the lunar surface, will result in imaging and spectroscopy being possible down to a 50-m spatial resolution element. With these resolutions, accurate geological and compositional maps may be constructed of the resource-rich regional pyroclastic deposits at a resolution currently not obtainable from Earth-based systems.

References: [1] President Bush, July 20, 1989. [2] Hawke B. R. et al. (1989) *Proc. LPSC 20th*, 249–258. [3] Mendell W. W., ed. (1985) *Lunar Bases and Space Activities of the 21st Century*, LPI, 866 pp. [4] Coombs C. R. (1988) Ph.D. dissertation, Univ. of Hawaii, 256 pp. [5] Blacic J. D. (1985) In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), 487–495. [6] T. S. McKechnie (1991) *J. Opt. Soc. Am.*, 8, 346–365. [7] T. S. McKechnie (1991) *Proc. SPIE*, 1408, 119–135. [8] C. E. Coulman et al. (1982) *Appl. Optics*, 27, 155–160.

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A REMOTE LASER MASS SPECTROMETER FOR LUNAR RESOURCE ASSESSMENT. R. J. De Young and M. D. Williams, NASA Langley Research Center, Hampton VA 23665-5225, USA.

The use of lasers as a source of excitation for surface mass spectroscopy has been investigated for some time [1]. Since the laser can be focused to a small spot with high intensity, it can vaporize and accelerate atoms of material. Using this phenomenon with a time-of-flight mass spectrometer allows a surface elemental mass analysis of a small region with each laser pulse. While the technique has been well developed for Earth applications, space applications are less developed. The Soviet Union attempted to use a pulsed Nd:YAG laser to analyze the surface of the Mars moon, Phobos, using an instrument called "LIMA-D" [2]. Laser-induced ions would have returned to spacecraft hovering 50 m above the Phobos surface. Unfortunately, the mission was unsuccessful for reasons unrelated to the instrument.

NASA Langley recently began a research program to investigate the use of a laser to create ions from the lunar surface and to analyze the ions at an orbiting spacecraft. A multijoule, Q-switched Nd:YAG laser would be focused to a small spot on the lunar surface, creating a dense plasma. This plasma would eject high-energy ions, as well as neutrals, electrons, and photons, as shown in Fig. 1. Such a system is shown in schematic form in Fig. 2. Here the spacecraft is 10 km above the lunar surface, and for the parameters shown, would detect 10^7 ions per laser shot. The travel time and velocity of the elemental ions created is shown in Fig. 3, assuming a 10-eV equilibrium plasma. Detection of ions at large distance requires that the flight path be a larger than the collision mean-free path as shown in Fig. 4 where the mean-free path (km) is shown for various regions of space. The lunar environment provides very long collision mean-free paths for the detection of laser-produced ions.

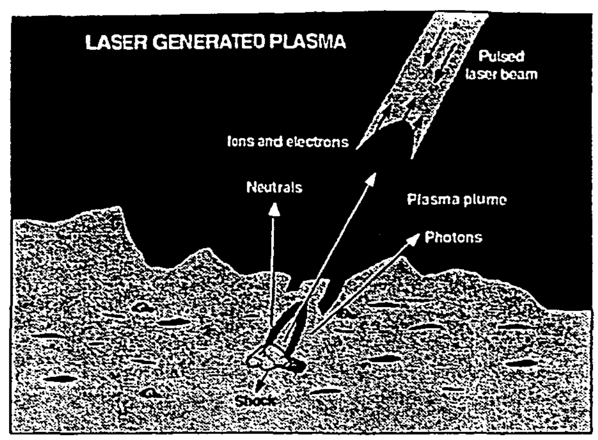

Fig. 1.

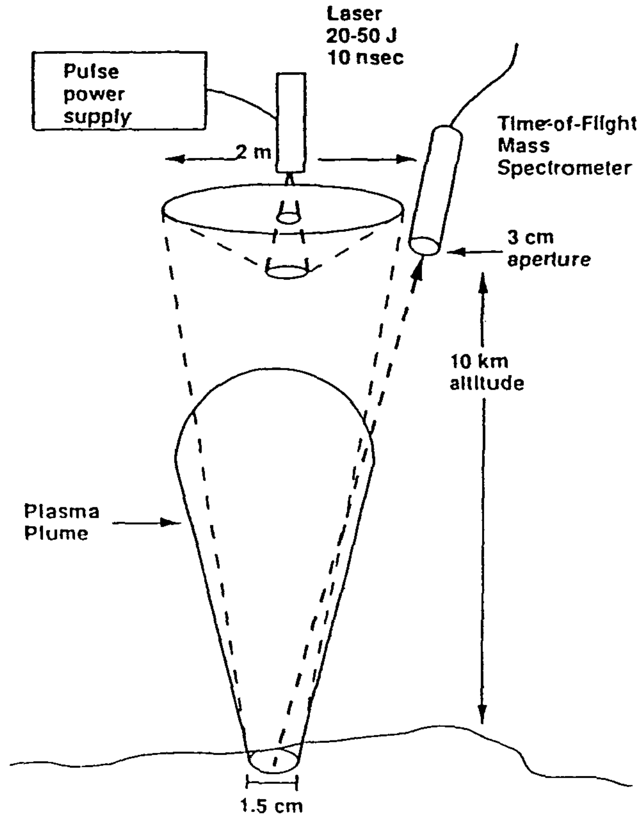

Fig. 2.

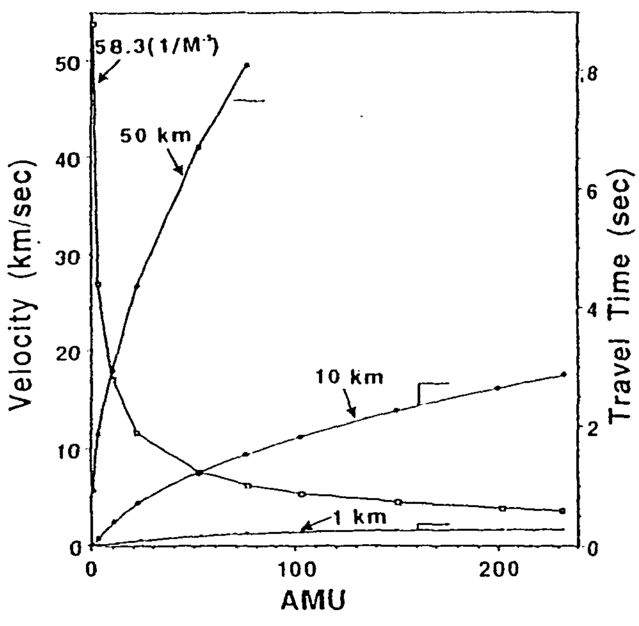

Fig. 3.

An experiment is now being set up (Fig. 5) to determine the characteristics of such a laser mass spectrometer at long flight distances. This experiment will determine the character of a future flight instrument for lunar resource assessment. Such an instrument could determine the surface composition on a centimeter-scale in one laser shot. Regions of high interest could be analyzed with fine spatial resolution. Since the plasma also generates photons and neutral particles, these could also be analyzed, providing additional information. The laser-produced plasma will have sufficient energy to create a shock wave in the lunar surface, which could derive information on the lunar subsurface.

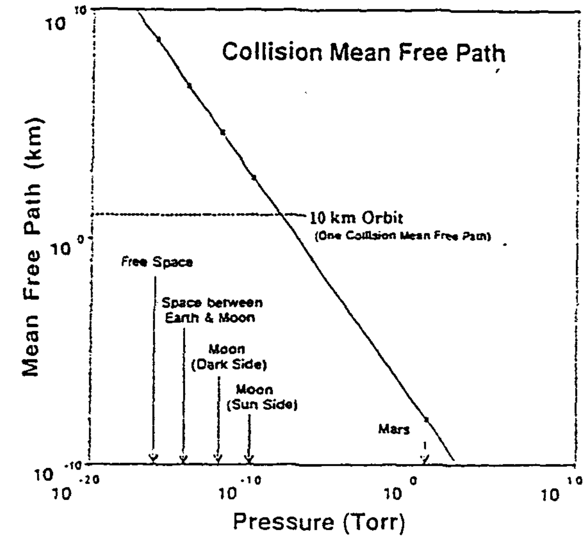

Fig. 4.

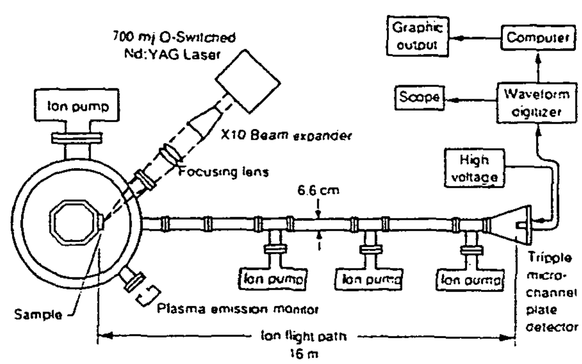

Fig. 5.

This instrument could provide substantial benefits to planetary surface analysis, allowing smaller spatial resolution and faster analysis than other remote methods.

References: [1] Lubman D. M. (1990) *Lasers and Mass Spectroscopy*, Oxford Univ., New York. [2] Head J. W. (1988) *NASA Mars Conf. Proc., Vol. 71*, Am. Astron. Soc., 215–240.

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AN α-p-x ANALYTICAL INSTRUMENT FOR LUNAR RESOURCE INVESTIGATIONS. T. E. Economou and A. L. Turkevich, Enrico Fermi Institute, University of Chicago, Chicago IL 60637, USA.

An instrument using alpha backscattering, alpha-proton nuclear reactions, and X-ray production by alpha particles and other auxiliary sources can be used on lunar landers to provide detailed