Instruments for Imaging From Far to Near

These instruments could also perform some spectral imaging functions at close range.

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The acronym "CHAMP" (signifying "camera, hand lens, and microscope") denotes any of several proposed optoelectronic instruments that would be capable of color imaging at working distances that could be varied continuously through a range from infinity down to several millimeters. As in any optical instrument, the magnification, depth of field, and spatial resolution would vary with the working distance. For example, in one CHAMP version, at a working distance of 2.5 m, the instrument would function as an electronic camera with a magnification of 1/100, whereas at a working distance of 7 mm, the instrument would function as a microscope/electronic camera with a magnification of 4.4. Moreover, as described below, when operating at or near the shortest-working-distance/highest-magnification combination, a CHAMP could be made to perform one or more spectral imaging functions.

CHAMPs were originally intended to be used in robotic geological exploration of the Moon and Mars. The CHAMP concept also has potential for diverse terrestrial applications that could include remotely controlled or robotic geological exploration, prospecting, field microbiology, environmental surveying, and assembly-line inspection.

A CHAMP (see figure) would include two lens cells: (1) a distal cell corresponding to the objective lens assembly of a conventional telescope or microscope and (2) a proximal cell that would contain the focusing camera lens assembly and the camera electronic image-detector chip, which would be of the active-pixel-sensor (APS) type. The distal lens cell would face outward from a housing, while the proximal lens cell would lie in a clean environment inside the housing. The proximal lens cell would contain a beam splitter that would enable simultaneous use of the imaging optics (that is, proximal and distal lens assemblies) for imaging and illumination of the field of view. The APS chip would be mounted on a focal plane on a side face of the beam splitter, while light for illuminating the field of view would enter the imaging optics via the end face of the beam splitter.

The proximal lens cell would be mounted on a sled that could be translated along the optical axis for focus adjustment. The position of the CHAMP would initially be chosen at the desired working distance of the distal lens from (corresponding to an approximate desired magnification of) an object to be examined. During subsequent operation, the working distance would ordinarily remain fixed at the chosen value and the position of the proximal lens cell within the instrument would be adjusted for focus as needed.

A CHAMP could be equipped with one or more illumination subsystem(s), one of which could be a laser probe that could be used during microscope operation. Laser light would be delivered via an optical fiber to the focal plane on the end face of the beam splitter. The laser light would pass through the beam splitter into the imaging optics, which would focus the laser light to a small spot (typically no wider than about 10 μm) on the object under examination. The output end of the optical fiber could be moved in the beam-splitter-end-face focal plane to scan the laser spot across the object in order to interrogate microscopic features anywhere in the field of view. Depending on the specific application and specific instrument design, the laser light could be used as simple illumination for ordinary imaging or as excitation for one or more of several spectroscopic techniques that could include Raman spectroscopy, micro-laser-induced breakdown spectroscopy, and ultraviolet fluorescence spectroscopy.

This work was done by Greg Mungas, John Boynton, and Cesar Sepulveda of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

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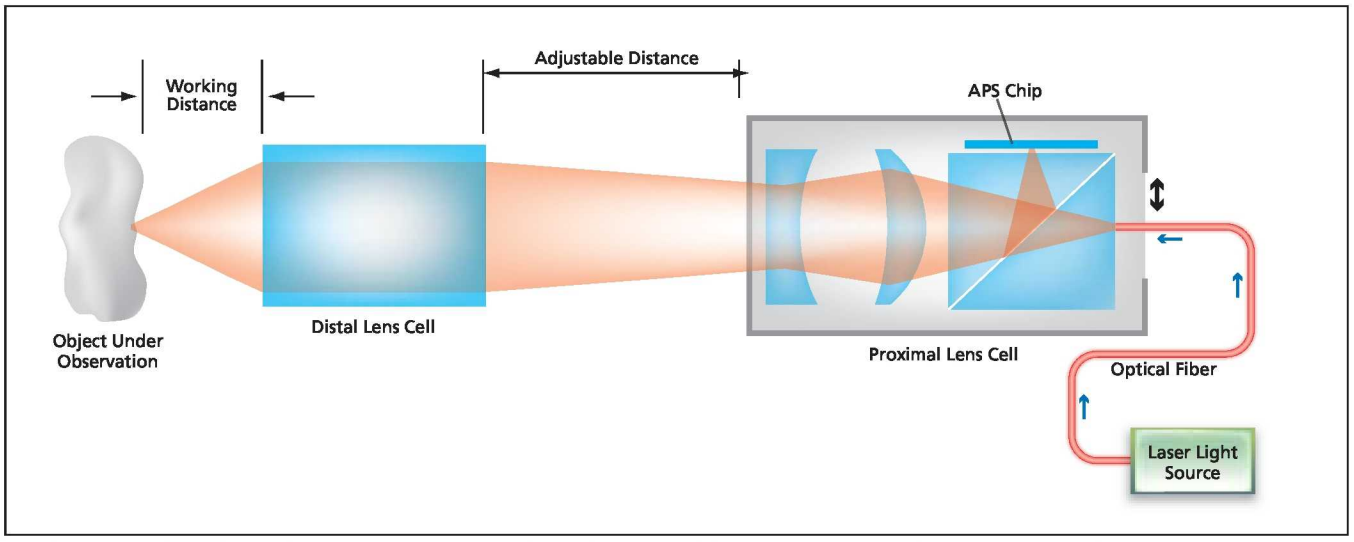

The Optical Layout of a CHAMP is shown here greatly simplified and not to scale. It serves mainly to illustrate the focus adjustment and the use of the optics for both illumination and imaging.