information from fusion of complex images acquired by different sensors such as SAR, visible, and infrared [3].

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N93-28790 160736

p. 1

A UNIQUE PHOTON BOMBARDMENT SYSTEM FOR SPACE APPLICATIONS.

E. J. Klein, KET Canada Inc./Sol-RF Energy Systems Inc., Box 2550, Winnipeg, Canada, R3C 4B3.

The innovative (patents pending) Electromagnetic Radiation Collection and Concentration System (EMRCCS) described here is the foundation for the development of a multiplicity of space and terrestrial system formats. The system capability allows its use in the visual, infrared, and ultraviolet ranges of the spectrum for EM collection, concentration, source/receptor tracking, and targeting.

The nonimaging modular optical system uses a physically static position aperture for EM radiation collection. Folded optics provide the concentration of the radiation and source autotracking. The collected and concentrated electromagnetic radiation is utilized in many applications, e.g., solar spectrum in thermal and associative photon bombardment applications for hazardous waste management, water purification, metal hardening, hydrogen generation, photovoltaics, etc., in both space and terrestrial segment utilization. Additionally, at the high end of the concentration capability range, i.e., 60,000+, a solar-pulsed laser system is possible.

The system outputs the concentrated flux, orthogonal (normally incident) to the input plane of an output port. The orthogonality remains constant regardless of the radiation input angle to the collection aperture, allowing simplification of radiation receptor design and highly efficient utilization of the concentrated radiation. The system configuration is arrayed for extremely high levels of flux concentration in windowing and targeting applications. Other system design formats provide power generation and thermal processes for heating and absorption cooling.

Fixed portable and mobile (space and terrestrial) applications include designs that incorporate a phased RF and/or the system array for purposes of radiation source acquisition/tracking and data derivation. The data is utilized in source acquisition (array capture angle of ±75° in the orthogonal E and H planes), source autotracking in the same angular intervals, and, subsequent to source and receptor acquisition, control of direction and magnitude of the output concentrated radiation at a given target range. In addition, the phased array can provide EM channel voice or data capability.

N93-28791 160737

p. 1

DETECTION OF OTHER PLANETARY SYSTEMS USING PHOTOMETRY.

D. Koch[1], W. Borucki[1], and H. Reitsema[2], [1]Mail Stop 245-6, NASA Ames Research Center, Moffett Field CA 94035, USA, [2]Ball Aerospace Systems Group, P.O. Box 1062, Boulder CO 80306, USA.

Detection of extrasolar short-period planets, particularly if they are in the liquid-water zone, would be one of the most exciting discoveries of our lifetime. A well-planned space mission has the capability of making this discovery using the photometric method. An Earth-sized planet transiting a Sun-like star will cause a decrease in the apparent luminosity of the star by one part in 10,000 with a duration of about 12 hours and a period of about one year. Given a random orientation of orbital plane alignments with the line-of-sight to a star, and assuming our solar system to be typical, one would expect 1% of the stars monitored to exhibit planetary transits. A null result would also be significant and indicate that Earth-sized planets are rare.

For the mission to be successful one needs a sensor system that can simultaneously monitor many thousands of stars (F, G, and K dwarfs) with a photometric precision of one part in 30,000 per hour of integration. The stellar magnitude, integration time, and desired photometric precision determine the aperture size. The field of view and limiting stellar magnitude determine the number of stars that can be monitored. A 1.5-m telescope is required to attain the photometric precision for 12.5 mag stars. An 8° field of view will yield many thousands of stars and several transit detections per month. Confirmation of a detection will involve detection of a second transit that will yield a period and predict the time for a third and subsequent transits.

The technology issues that need to be addressed are twofold: One is for an appropriate optical design; the other is for a detector system with the necessary photometric precision. Two candidates for the detector system are silicon diodes and CCDs. It has been demonstrated that discrete silicon diodes have the required precision. However, the technology for building them into arrays with readouts needs development. The other approach is to use silicon CCDs. These already exist as arrays. However, the required photometric precision technology has yet to be demonstrated. Data processing complexity can be reduced by using the local-area-readout technique to obtain the flux for a few hundred stars per CCD.

N93-28792 160738 p 2

AN INTEGRATED XRF/XRD INSTRUMENT FOR MARS EXOBIOLOGY AND GEOLOGY EXPERIMENTS.

L. N. Koppel[1], E. D. Franco[1], J. A. Kerner[1], M. L. Fonda[2], D. E. Schwartz[2], and J. R. Marshall[2], [1]ARACOR, 425 Lakeside Drive, Sunnyvale CA 94086-4701, USA, [2]Mail Stop 239-12, NASA Ames Research Center, Moffett Field CA 94035-1000, USA.

By employing an integrated X-ray instrument on a future Mars mission, data obtained will greatly augment those returned by Viking; details characterizing the past and present environment on Mars and those relevant to the possibility of the origin and evolution of life will be acquired. A combined XRF/XRD instrument has been breadboarded and demonstrated to accommodate important exobiology and geology experiment objectives outlined for MESUR and future Mars missions. Among others, primary objectives for the exploration of Mars include the intense study of local areas on Mars to "establish the chemical, mineralogical, and petrological character of different components of the surface material; to determine the distribution, abundance, and sources and sinks of volatile materials, including an assessment of the biologic potential, now and during past epoches; and to establish the global chemical and physical characteristics of the martian surface" [1].

The XRF/XRD breadboard instrument identifies and quantifies soil surface elemental, mineralogical, and petrological characteristics and acquires data necessary to address questions on volatile abundance and distribution. Additionally, the breadboard is able to 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.

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S29-91 N93-28793 ABS. ONLY 160739

p.1

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.

S30 N93-28794 160740

p.1

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.

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p. 2

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

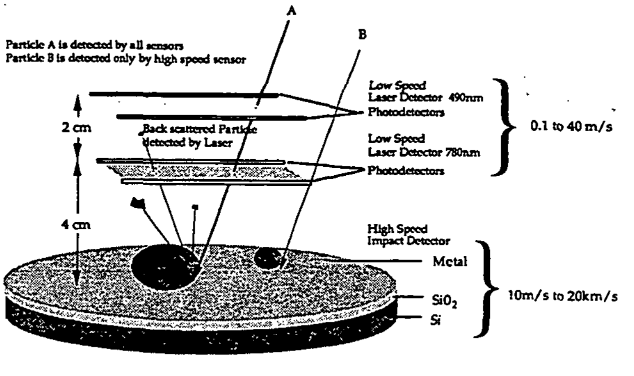

Fig 1. UPDE sensor.