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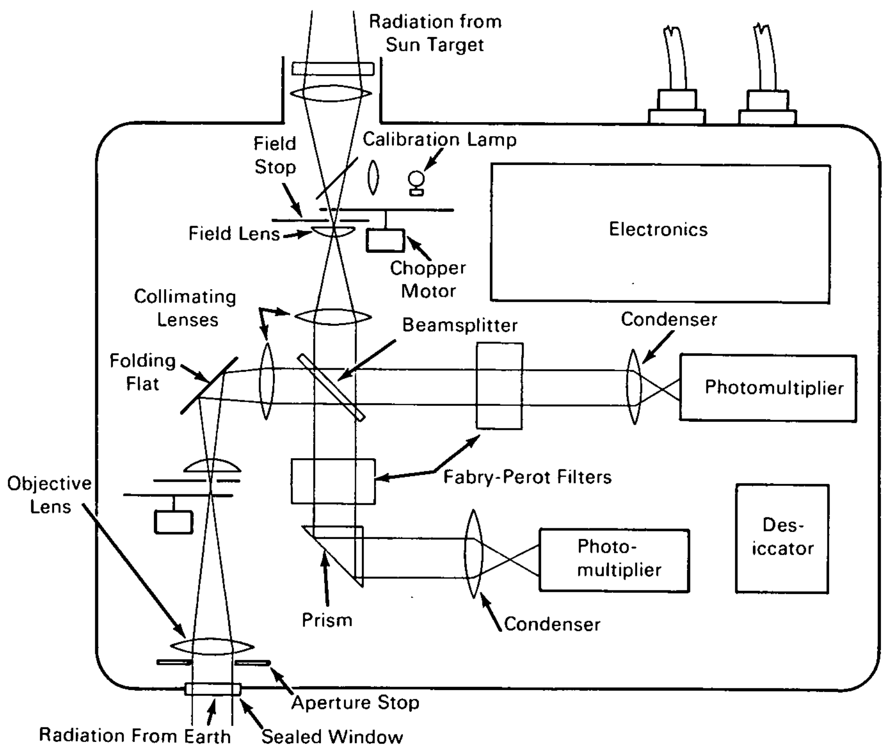
NASA TECH BRIEF

Airborne Fraunhofer Line Discriminator



Schematic of Optical Unit

Prospecting for fluorescent minerals, hydrography by use of fluorescent dyes, detection of water pollutants by fluorescence of detergents and oil slicks, fish finding by means of the oil slick associated with large schools of fish, and plant studies based on the natural fluorescence of chlorophyll are applications for the Airborne Fraunhofer Line Discriminator. Details of this instrument, which employs a new optical sensing technique, are found in the reference in Note 1.

Basis of the design of the optical unit shown in the schematic drawing is the coincidence of certain sharply defined absorption lines (Fraunhofer lines) in the solar spectrum occurring at the characteristic wavelengths of some fluorescent materials. Coincidence of the sodium D_2 line (5890Å) and the characteristic emission of the fluorescent dye Rhodamine B or Rhodamine WT are used.

A narrowband optical filter located on the center of this 0.7Å wide line at 5890Å and thus closely

(continued overleaf)

matching the bandwidth and wavelength of a strong Fraunhofer line makes the airborne measurement system practical. The use of a Fabry-Perot filter with a bandwidth of only 0.7Å, a peak transmittance greater than 60 percent, and a quartz spacer with sides polished flat to within 0.01 λ achieves the required spectral resolution. A variable temperature housing around the filter allows it to be tuned over a small spectral range. This filter is immune to any temporal or vibration-induced spectral changes.

The optical unit looks down at the ground and also at a small solar-illuminated target located just outside the aircraft fuselage. Four separate signals, which correspond to the energy received from the sun and earth in two narrowband spectral intervals, are continuously monitored, sent to an analogue computer, and converted into a recorded signal proportional to the amount of fluorescence.

Energy from both sources is modulated at two different frequencies by chopper wheels to provide signal source identification for the signal processing. A beamsplitter combines the two modulated energy beams and directs them through two solid Fabry-Perot filters centered at different wavelengths (one on the 0.7Å wide D_2 line of sodium and the other at 5892Å), then through two condensers, and finally, to two photomultiplier tubes. The outputs from the photomultipliers are demodulated and applied to a real time analogue computer, which solves the appropriate equation and indicates a normalized fluorescence value directly. A normalized value is desirable since it is characteristic of the target only and does not depend upon solar zenith angle or atmospheric conditions. Vibration induced photomultiplier noise is avoided by use of a very rugged phototube constructed to operate in a missile launch environment.

With the Fraunhofer line method, the detection of flourescence depends upon the comparison of two ratios. Since the ratios are obtained simultaneously and with the same photomultipliers, any change in photomultiplier gain affects both ratios and leaves the comparison unchanged. A small calibration lamp measures and compares the gains in each of the two filter channels.

Notes:

1. A detailed description of the Airborne Fraunhofer Line Discriminator is given in Accession Number N68-21919, "Fraunhofer Line Discriminator Final Report," by H. Ludwig, D. Markle, and G. Schlesinger (Perkin-Elmer Corp., Norwalk, Conn.), April 15, 1968, under NASA Contract NAS 9-7447, and is available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151; price: $3.00; microfiche $0.65.
2. No additional documentation is available. Specific questions, however, may be directed to:

   Technology Utilization Officer
   Manned Spacecraft Center
   Houston, Texas 77058
   Reference: B69-10594

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: D. A. Markle and F. C. Gabriel of
Perkin-Elmer Corporation
under contract to
Manned Spacecraft Center
(MSC-13146)