Compact Two-Dimensional Spectrometer Optics

This unit would feature coarse and fine resolution along two orthogonal axes.

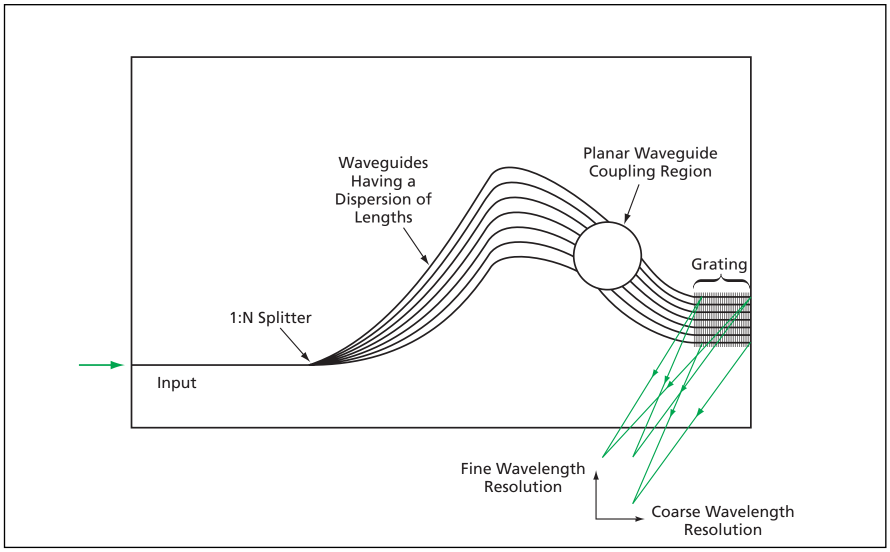
NASA's Jet Propulsion Laboratory, Pasadena, California

The figure is a simplified depiction of a proposed spectrometer optical unit that would be suitable for incorporation into a remote-sensing instrumentation system. Relative to prior spectrometer optical assemblies, this unit would be compact and simple, largely by virtue of its predominantly two-dimensional character.

The proposed unit would be a combination of two optical components. One component would be an arrayed-waveguide grating (AWG) — an integrated-optics device, developed for use in wavelength multiplexing in telecommunications. The other component would be a diffraction grating superimposed on part of the AWG.

The function of an AWG is conceptually simple. Input light propagates along a single-mode optical waveguide to a point where it is split to propagate along some number (N) of side-by-side waveguides. The lengths of the optical paths along these waveguides differ such that, considering the paths in a sequence proceeding across the array of waveguides, the path length increases linearly. These waveguides launch quasi-free-space waves into a planar waveguide-coupling region. The waves propagate through this region to interfere onto an array of output waveguides. Through proper choice of key design parameters (waveguide lengths, size and shape of the waveguide coupling region, and lateral distances between waveguides), one can cause the input light to be channeled into wavelength bins nominally corresponding to the output waveguides.

Notwithstanding the conceptual simplicity as described thus far, the function is complicated by the fact that the response of each output waveguide is characterized by a spectral periodicity with multiple frequency components spaced at multiples of the free spectral range appearing in each frequency bin. Hence, in the absence of a corrective measure, each output waveguide would carry multiple wavelength components, resulting in an ambiguous output.



A **Diffraction Grating Would Be Superimposed** on the output portion of an arrayed-waveguide grating in this integrated optical device. The diffraction grating would both (1) impose coarse spectral resolution to break spectral degeneracy and (2) contribute to coupling of light into modes propagating through free space (out of the page).

In the proposed device, the degeneracy would be broken by means of the diffraction grating, which would be lithographically formed on the surface in the output waveguide region. The grating lines would cross the output waveguides, establishing orthogonal coordinate axes. One axis would represent coarse spectral resolution; the other, fine spectral resolution. The net result of superimposing the grating on the output waveguides would be to divert some of the light from waveguide modes to free-space-propagating modes. Because the output diffraction angle of each mode would depend on its wavelength, the output waves propagating in free space would be sorted with coarse spectral resolution along one coordinate axis and fine spectral resolution along the other axis. The proposed unit could be designed, in conjunction with a planar photodetector array, to obtain an optimal match between the array pixel pattern and the wavelength-dispersion pattern.

This work was done by John Hong of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-42431