October 1973 B73-10359

NASA TECH BRIEF

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Dye Laser Remote Sensing of Marine Plankton

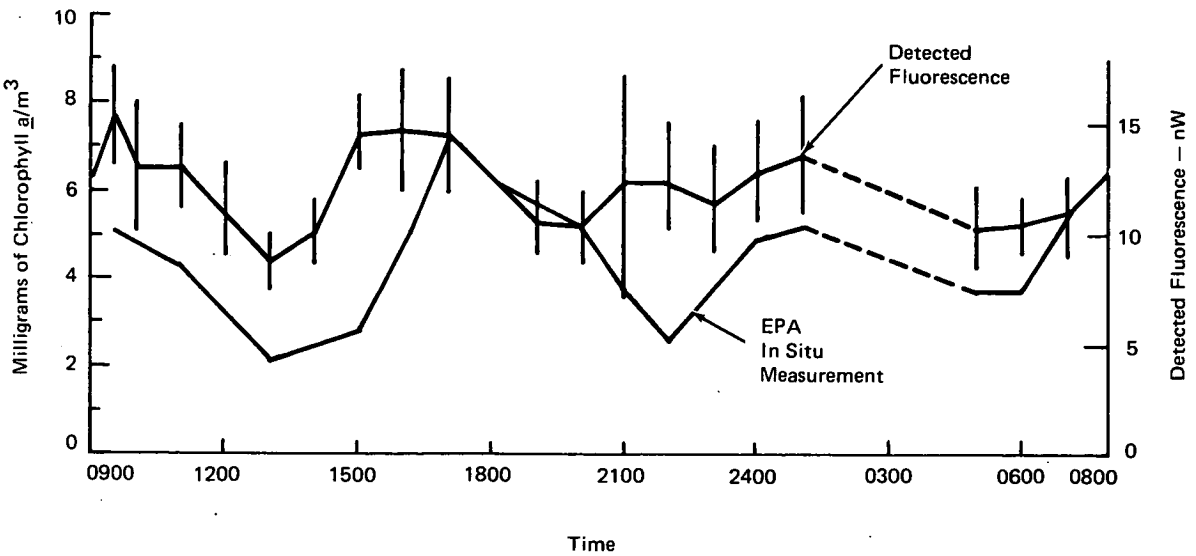
A dye laser, emitting four wavelengths sequentially in time, has been incorporated into a helicopter-borne lidar flight package, for performing studies of laser-induced fluorescence of chlorophyll a in algae.

A mathematical model has been developed incorporating the fluorescence data gathered, allowing the contribution of each color group to the total chlorophyll a fluorescence to be determined, thus giving a quantitative measure of the chlorophyll a density of each color group.

Data obtained by the multicolor lidar technique can provide water-resource management with rapid-access wide-area coverage of the impact of various environmental factors for any body of water.

Using a single-wavelength dye laser in an earlier prototype instrument, field-test fluorescence measurements were made over a 24-hour period. Water samples were simultaneously collected from the surface waters (approximately 1 m deep) for laboratory analysis. The illustration shows both fluorescence detected and chlorophyll a concentration (as determined by wet chemical analysis) over the measurement period. Since only one color group of algae was present (dominant) in the water, a single laser-excitation wavelength was sufficient. The multiwavelength laser now in use in the advanced system enables one to efficiently excite the chlorophyll a fluorescence in all algae color groups regardless of the mixture. Multiwavelength excitation is essential, due to the extreme differences in excitation spectra of different color groups.

The flight package uses the multielliptical-cavity laser head in which a single linear flashlamp is used to pump four separate dye cells. These four dye-cell systems are cloverleaf arranged, and each has a flow



Detected Fluorescence and Chlorophyll a Concentration Determined by Wet Chemical Analysis

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system and a cavity mirror. Each dye laser system can be altered independently and dyes chosen to cover the entire visible spectrum. In this instance, the need was for sequential excitation at the four different laser wavelengths.

The laser pulse widths are 0.5 microseconds (FWHM) with pulse energies of 20 to 50 millijoules. The receiver is a 25-cm-diameter Dall-Kirkham telescope with an interference filter (685 nm) and an integrated photodetection assembly. The instrument package, along with its data acquisition-and-control unit, mounts easily inside a Bell 204B helicopter and requires approximately 1.2 kW of electrical power.

This system could also be used for detecting and mapping fluorescent tracer dyes in bodies of water. Detection of less than 0.1 ppb of rhodamine WT should be possible.

Note:

Requests for further information, including the laser head used for simultaneous optical pumping of several dye lasers, may be directed to:

Technology Utilization Officer
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Reference: B73-10359

Patent status:

Inquiries concerning rights for the commercial use of this invention should be addressed to:

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