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Remote Sensing of the Coastal Zone
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Exercise 5: Remote oil film thickness measurement at the water surface by means of water Raman signal attenuation

Introduction

Active remote sensing has been successfully applied to the detection of marine pollution linked to ecological disasters, like a tanker sinking. In this exercise we will apply a laser-based system to the thickness measurement of an oil film over a water surface. This will be achieved by the observation of the attenuation of the Raman signal originated from water. In particular, if the observed water column is thin enough, the oil thickness is given by the relation

$$d = -k^{-1} \ln(R/R_w) \quad (1)$$

where

$$k = k_L + k_R$$

and k_L is the oil extinction coefficient at the laser wavelength, k_R is the oil extinction coefficient at the Raman-shifted wavelength, R is the time-integrated Raman signal, R_w is the time-integrated Raman signal of pure water.

Experiments

The transmitter is based on a frequency-tripled Q-switched Nd:YAG laser (355 nm). The receiver is composed by a collecting lens, an optical fibre and an optical multichannel analyzer (OMA) observing both the Raman scattering by water and the fluorescence emission by oil.

At first we will observe the Raman and fluorescence signal of pure water (measuring R_w). Then we will drop on the water surface a controlled amount of oil (measuring R). We will continue to add oil on the surface while measuring R . In this way, at the end of the experiment we will have a set of points (A_i , R_i).

Data interpretation

Amount and thickness of oil are proportional. Consequently, we will check that the points [A_i , $\ln(R_i/R_w)$] are along a straight line, according to equation (1). Once performed this test, we will obtain the thicknesses associated to the different oil amounts according to equation (1) and using the extinction coefficient given in the literature for the oil under investigation.

Further Reading

1. MEASURES, R. M. 1992. *Laser Remote Sensing*. Krieger Publishing Company, 510 pp.
2. FANTONI, R., BARBINI, R., COLAO, F., PALUCCI, A. & RIBEZZO, S. 1994. "Applications of excimer laser based remote sensing systems to problems related to water pollution" in *Excimer Lasers*, LAUDE L. D., ed. Kluwer Academic Publisher, pp. 289-305.

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