

ment which will ensure that the British pressure vessel industry remains economically viable and competitive in the world scene.

RAMAN SPECTROSCOPY

Separating Molecular Spectra

A REFINEMENT of the technique of Raman scattering, which promises to have wide applications for studying the rotational and kinetic properties of molecules, has been organized by R. Callender and P. S. Pershan (*Phys. Rev. Lett.*, **23**, 947; 1969). They have analysed the contributions of high orders to the polarizability of an isolated molecule with a certain number of Raman-active modes of vibration, and have found that the terms usually discarded in deriving the expression for rotational Raman scattering contain the makings of a technique for studying the motion of isolated molecules. The most important feature of this theoretical study is that the frequency of the scattered light associated with the terms of higher order is markedly different from that of the incident light, separated from it by as much as 1,000 cm^{-1} or 2,000 cm^{-1} . This is much greater than the small difference usually found in rotational Raman scattering.

Light scattering spectroscopy has been much invigorated by the introduction of lasers. Rotational Raman scattering has been used for studying the rotational motion of anisotropic molecules, but one obstacle in the use of the technique is that it cannot be applied to a system containing different types of molecules because of the difficulty of separating the light from the different species. Callender and Pershan have shown that the scattering attributable to the higher order terms in the polarization differs from the rotational Raman contribution by a frequency-dependent exponential factor, which is usually different for each molecule. Indeed, they claim that it should be possible to study molecules with high frequency eigenmodes that couple only weakly to the excitations of the surrounding medium. These circumstances apply to molecules in many organic and inorganic substances, in both solid and liquid form, and directly to impurity molecules inside a host medium.

Callender and Pershan have tested the technique on two types of molecular impurity in potassium bromide. By cooling a specimen containing NO_2 radicals to about 15 K, they found a peak in the scattering spectrum with a width they interpreted as a direct measure of the correlation time for the rotational motion of the impurity. Similar tests on CN^- impurity molecules showed that at 70 K the motion of the impurity molecule was severely inhibited by the cubic (as distinct from isotropic) symmetry of the halide lattice. Infrared and other techniques have been used to investigate these impurity modes in the past, but Callender and Pershan point out that their experiments confirm the power of the new technique as a general tool for investigating loosely coupled modes.

The correlation functions that feature in the light scattering formalism are quite similar to those in nuclear magnetic resonance spectroscopy, and Callender and Pershan suggest that light scattering may be useful for systems that do not have characteristic magnetic resonance signals. In particular, light scattering is sensitive to time scales of 10^{-12} seconds, many orders outside the NMR scale, and should provide

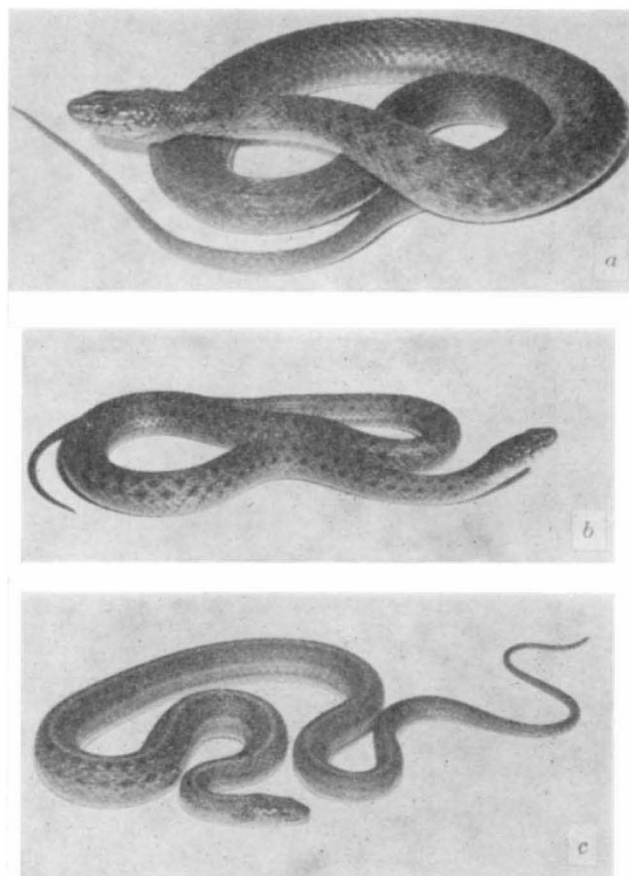
a valuable probe for vibrations in this range. They also point out that in large molecules there is often a ligand such as CH_3 with characteristic frequencies only weakly affected by the binding to the rest of the molecule, and the technique could be used to pick out the modes of this ligand. A potentially exciting application, they say, lies in the investigation of the regular arrays of organic molecules that make up liquid crystal systems. They indicate that their preliminary light scattering experiments on nematic liquid crystal *p*-azoxyanisole produced sharp spectral features which should prove important for studying the solid, mesomorphic and liquid phases of the system.

WATER SNAKES

Complex Distribution in Mexico

from a Correspondent

ROGER CONANT's recent review of the water snakes of the genus *Natrix* in Mexico (*Bull. Amer. Mus. Nat. Hist.*, **142**, 1; 1969) illustrates well the enthusiasm and endurance required if systematic zoology is to satisfy modern standards of attention to geographical variation. Only three species of *Natrix* are known in Mexico, but to survey the various subspecies and races Conant spent a year in the field, examined 1,373 specimens from forty-seven collections, pored over maps old and new, combed the records of museums,



Some water snakes of the *Natrix valida* complex from western mainland, Mexico. (a) *N. v. valida*, 771 mm long; (b) member of an intergrading population of *N. v. valida* \times *isabelleae* \times *thamnophisoides*, 544 mm long; (c) *N. v. thamnophisoides*, 523 mm long. There are four races in all, and several cases of intergradation.