

COMPUTERIZATION OF AN INFRARED DIODE LASER SPECTROMETER

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The diode laser has become a useful source of tunable infrared coherent radiation between 3-20 μm . Unfortunately, its small continuous frequency tuning range of typically less than 1cm^{-1} and its tendency to produce nonlinear frequency scans limit its usefulness in spectroscopy. A method for producing diode laser scans several wavenumbers long, linear in frequency, and accurately calibrated from reference spectra has been devised. Such scans are especially useful in pattern recognition during the analysis of spectra.

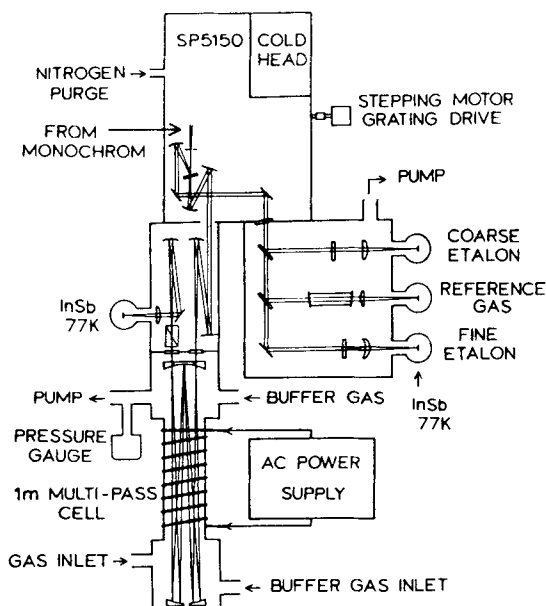


Fig. 1. Experimental set-up. The optical arrangement allows data to be collected from the experiment as well as the three diagnostic channels in a single scan.

The infrared diode spectrometer consists of a Spectra Physics diode laser source (SP-5150), an LS1-11 minicomputer, a one meter multi-pass White cell, and diagnostic instrumentation as shown in Fig. 1. The laser output beam is split by a ZnSe beamsplitter which directs 70% into the multipass cell. The remaining 30% is divided among three diagnostic channels which consist of a fine and a coarse etalon with free spectral ranges of 500MHz and 3GHz and a reference gas absorption cell.

A particular frequency scan consists of consecutive current scans between each of which the diode temperature is adjusted. At the end of each current scan (usually about 10GHz) the computer automatically halts the scan and enters a 'ramp mode' in which the current is rapidly ramped over the region just scanned. By viewing the coarse marker cavity features on an oscilloscope, the temperature is adjusted such that the last peak on the high current side of the display is moved to the edge of the low current side. In this manner the next region to be scanned exhibits an overlap in frequency with the previous region. The user then signals the computer to continue the scan. The monochromator is adjusted during the 'ramp mode' by a stepping motor also under computer control.

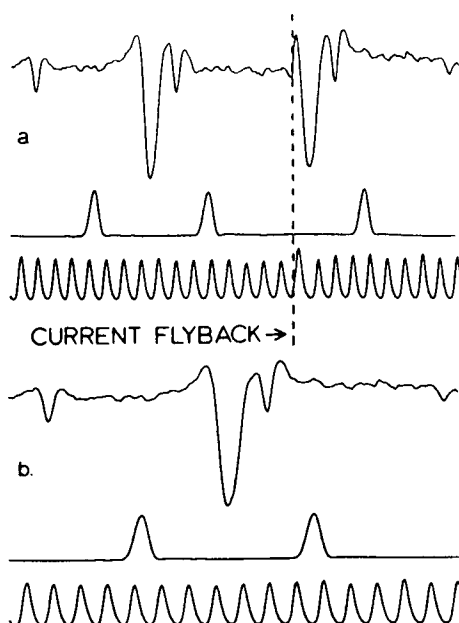


Fig. 2. A sample of the overlapping procedure. The traces from top to bottom are data from the the experiment, coarse etalon, and fine etalon. (a) Raw data. (b) After linearization and overlap. It is not always the case that there is an overlapping feature on the reference gas or experimental channels.

The resulting data set must be linearized and the overlaps removed so the adjacent current scans can be accurately joined. In order to linearize the data of a given current ramp segment, a fourth order fit to the positions of the fine markers is calculated. The marker spacings are then normalized to the maximum observed spacing and parallel corrections are made to all channels. Once linearized the overlapping segments are joined by identifying a spectral feature occurring on each side of the flyback and superimposing the centroid line centers. The spectrum can now be calibrated as one continuous scan by another set of calibration programs. Scans made in this manner are typically $3\text{-}4\text{cm}^{-1}$ in length although scans as long as 7cm^{-1} have been collected.

This system for producing multi-wavenumber, frequency linear, readily calibrated scans will simplify the assignment and analysis of diode laser gas phase spectra. New advances in diode fabrication technology¹ hold promise for diode lasers capable of longer range current scans. Such diodes combined with the overlapping methods presented here will significantly enhance infrared diode laser spectroscopy.

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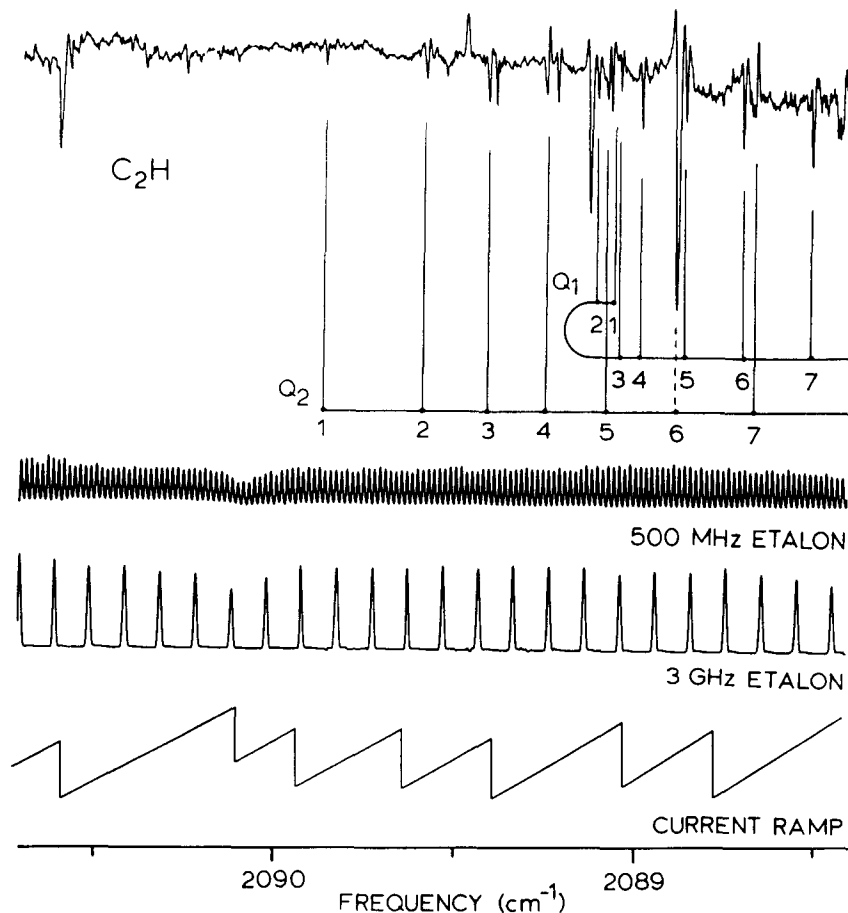


Fig. 3. A portion of a 3.5cm^{-1} continuous scan of an electrical discharge through argon over a coating of polyacetylene. A recently reported² C_2H band is observed using the magnetic rotation technique.

1. Y. Shani, A. Katzir, K. H. Bachem, P. Norton, M. Tacke, H. M. Preier, *Appl. Phys. Lett.* **48**, 1178 (1986).
2. E. Hirota, personal communication.