ON THE ASSIGNMENT OF OPTICALLY PUMPED FAR-INFRARED LASER EMISSION FROM CH_3OH

R. M. LEES, *Department of Physics, University of New Brunswick, Fredericton, N.B., Canada E3B 5A3*; LI-HONG XU, *Department of Physical Sciences, University of New Brunswick, Saint John, N.B., Canada E2L 4L5*.

Since 1970, observations of optically pumped FIR laser lines have provided windows into the complexities of the torsion-rotation structure of excited vibrational states of methanol, principally for the CO-stretching mode but also for the CH_3-rocking, OH-bending and CH_3-deformation modes. However, the richness and variety of the FIR laser emission presented a significant spectroscopic challenge to identify the IR-pump/FIR-laser energy level and transition schemes. With the advent of tunable diode lasers and high-resolution Fourier transform instruments capable of full rotational resolution of the infrared bands, this task became more feasible, and a valuable synergy has developed between IR spectroscopy and FIR laser studies in initially pointing towards and then confirming possible assignments.

In this talk, recent progress in the assignment and confirmation of FIR laser transition systems for CH_3OH will be presented. Earlier proposals by Henningsen of pumping from ν_t=2 torsionally excited ground state levels up to the CH_3-deformation mode are now supported by spectroscopic evidence, and in turn have provided important signposts to spectral assignments involving a variety of torsional states of the CH_3-deformation, OH-bending, CH_3-rocking and CO-stretching modes. The FIR laser system pumped by the 9P(22) CO_2 laser line is particularly interesting both torsionally and vibrationally. The IR pump transition has been reassigned as arising from a K=0 A, ν_t=2 ground-state level, but the identity of the upper state is not clear. Two of the FIR laser lines go to K=1 A, ν_t=0 OH-bending levels, while another pair is deduced to connect, following the logic of Sherlock Holmes, to the elusive out-of-plane CH_3-rocking mode.