PRECISE LABORATORY MEASUREMENTS OF LINE FREQUENCIES USEFUL TO STUDIES OF STAR AND PLANET FORMATION

CARL A. GOTTLIEB, PHILIP C. MYERS, and PATRICK THADDEUS, *Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138.*

In the millimeter-wave band the uncertainty in most laboratory frequency measurements is $\sim$ 30 kHz. Precision such as this is quite adequate for the identification of new molecules, but it generally does not allow radial velocities to be measured accurately enough to study the motions and abundances in dense cores forming sunlike stars and in the outer parts of circumstellar disks forming planets. The technique used by radio astronomers is to measure lines of selected molecular species with high signal-to-noise ratio and to quantitatively compare the profiles of optically thick and optically thin lines. At least ten molecules relevant to studies of star and planet formation were identified in a critical review of the spectroscopic literature as needing improvement in their line frequencies. These include CS, c-C_3H_2, H_2CS, SO, SiO, CN, CCH, HCO^+, N_2H^+, and HCS^+. For most of these molecules the uncertainties in the line frequencies in the millimeter-wave band are roughly ten times too large. To support molecular studies of star formation we have undertaken a program in laboratory spectroscopy to determine accurate line frequencies. In this talk, recent laboratory measurements will be presented and examples of how the kinematic interpretation by astronomers depends crucially on the line frequencies will be discussed.