High Precision Tunable Diode Laser Control: Application to the Study of Dicke Narrowing

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To stabilize the frequency, otherwise very unstable, of a T.D.L., its beam is sent through a Michelson interferometer controlled by a stabilized He-Ne laser. The T.D.L. is actively forced to maintain its emission at a wavelength value λ_d corresponding to an interference fringe of fixed order k_d. When D, the path difference of the interferometer, is changing, an optical device makes the vibration plane of the polarized He-Ne beam to rotate. When the azimuth plane is kept constant, D is also maintained constant, the fluctuation of k_d is reduced by nearly two orders of magnitude (*i.e:* 10^{-3} to 10^{-5} in the wavenumber units). Conversely, changing this azimuth by steps changes the value of D by increments ΔD. A change of λ_d is then induced in order to preserve the relation $D = k_d\lambda_d$. In addition, the usual intensity fluctuations are completely removed by a convenient double beam set-up. Finally, the signal-to-noise ratio obtained is better than 2000, allowing the measurement of gas traces.

Application:

At low pressure, the line profile narrowing resulting from the confinement of CO molecules by buffer gases (He, Ne, Ar, Xe and N_2) is studied to check the usual different collision models. The β^0 coefficient associated to this Dicke narrowing is compared to the dynamic friction coefficient β^0_{diff} deduced from the diffusion constant, as a test for the validity of these different models.

When the pressure broadening becomes preponderant, the line profile must be determined carefully, taking into account the absorber speed dependent effect, in order to preserve the signification of the β^0 parameter–mainly when the perturber mass is greater than the active molecule one. A line asymmetry has been observed for the CO–Xe mixture, its magnitude beeing in agreement with the measured pressure shift.