

## Collision Broadening of Rotational Spectrum

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### Abstract:

The problem studied is the rotational absorption spectrum of linear molecules of moment inertia  $I$  in a simple nonpolar buffer gas. The focus is on the behavior of the spectrum as the buffer gas pressure and the associated collision frequency  $\nu$  is increased. Four regions are distinguished. (1)  $\nu \ll \hbar/I$ , there are sharp lines with a van Vleck-Weisskopf line shape; (2)  $\nu \approx \hbar/I$ , the contributions from overlapping lines are summed analytically. The ratio of minimum to maximum absorption in the weakly oscillatory spectrum is computed. (3)  $\hbar/I < \nu < (2kT/I)^{1/2}$ , This is the classical inertial region where there is a single maximum in the absorption per cycle. We compute its position as it moves from an angular frequency  $(2kT/I)^{1/2}$  to lower frequencies with increasing collision frequency. (4)  $\nu > (2kT/I)^{1/2}$ , this is the region where the Debye frequency profile is valid, with the peak of absorption at an angular frequency  $(1/\nu)(2kT/I)$ . The calculations are based on a kinetic equation for the density matrix with a single relaxation time, no position change, collision model. We also compute the time dependent correlation functions needed in the theory of the rotational Raman effect of linear molecules