Collision-induced Raman scattering from a pair of dissimilar particles: An intriguing mathematical model predicting the suppression of the odd-numbered partial waves

Titre	Collision-induced Raman scattering from a pair of dissimilar particles: An intriguing mathematical model predicting the suppression of the odd-numbered partial waves
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Résumé en anglais	Relying on a simple analytic two-atom model in which the anisotropy of the interaction dipole polarizability obeys an inverse power law as a function of separation, we offer mathematical and numerical evidence that, in a monoatomic gas, the free-free Raman spectrum for a collisional pair of two different isotopes,a–a′, may vastly differ from that for a–a. This result is obtained even if a and a′ are assumed to have the same mass and zero nuclear spin and even if a–a and a–a′ are subject to the same interaction polarizability and potential. The mechanism responsible for this effect is inherent in the parity of the partial-wave rotational quantum number J: given that the contribution of each partial wave to the Raman cross section is controlled by a polarizability-transition matrix-element and that each of those matrix-elements has a radial component with a magnitude slightly smaller than that of the preceding partial wave, a deficit which disfavors the odd-numbered waves is accumulated upon summing over J. In the far high-frequency wing, this deficit tends to generate spectral intensities for a–a′ about half as great as the a–a ones, a tendency which becomes all the more effective as temperature is decreased. We show for instance that, for the spectral branch ΔJ = 2, the fractional difference between the free-free differential cross sections for a–a and a–a′ is 12(1−x2)31+3x412(1−x2)31+3x4, with x=E/E′−−−−−√x=E/E′ (E (E′) being the initial (final) state energy of the pair and E′ − E = hcν (ν > 0)). Remarkably, this quantity is zero at ν ≈ 0 but goes to 1212 for ν □ 0. For ΔJ = 0, analogous conclusions may be drawn from the expression (1+ln(1+x1−x)2arctanx)−1(1+ln(1+x1−x)2arctanx)−1.
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[1] http://okina.univ-angers.fr/michel.chrysos/publications
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