HYPERFINE STRUCTURE IN THE SPECTRA OF DIATOMIC MOLECULES WITH TWO NUCLEAR SPINS

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The presence of a nuclear spin in a molecule splits the rotational levels and microwave lines into hyperfine components. A second nuclear spin (such as exists, for example, in the molecule DCN) further splits these into hyperhyperfine components. Three types of coupling between the two nuclear spins I_1, I_2 and the molecular angular momentum J can be imagined:

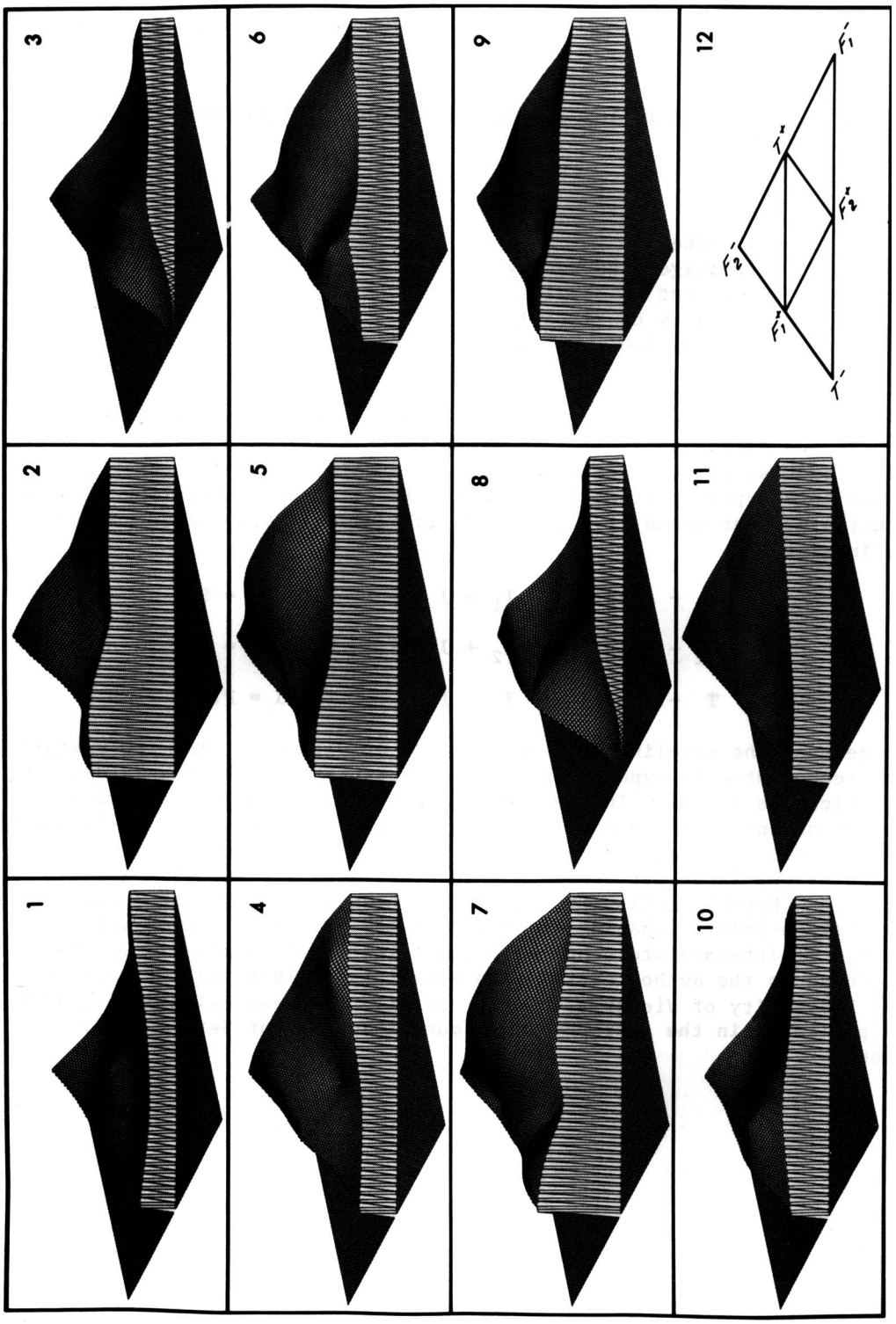
F_1 - coupling: $I_1 + J + F_1$; $F_1 + I_2 = F$

F_2 - coupling: $I_2 + J = F_2$; $F_2 + I_1 = F$

T - coupling: $I_1 + I_2 = T$; $T + J = F$.

In general the coupling is a combination of all three, and the energies are represented by hyperhyperfine energy surfaces in a ternary diagram, in which the position inside the triangle corresponds to a particular degree of intermediate coupling. An example of these surfaces is shown in Figure 1 for the case, $JI_1I_2 = 2\ \frac{3}{2}\ 1$, being an extension of calculations first performed in 1948 by Bardeen and Townes. A movie entitled "Hyperhyperfine Structure" has been prepared which shows how the "fingerprint" (spacing and intensities) of a line varies with degree of intermediate coupling. Enquiries about this movie may be directed to the author or to Audio-Visual and Television Services of the University of Victoria. Fuller details of these calculations will be published in the Astrophysical Journal Supplement Series early in 1986.

M. S. Vardya and S. P. Tarafdar (eds.), Astrochemistry, 107–108.



https://doi.org/10.1017/S0074180900153896 Published online by Cambridge University Press