Title:	Concept of effective Hamiltonians for transitions in multi-level systems
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Abstract:	Employing the concept of effective Hamiltonians, an analytical theory is introduced to describe transitions in a multi-level system in nuclear magnetic resonance (NMR) spectroscopy. Specifically, the discussion is centered towards the treatment of selective and non-selective excitations in static quadrupolar spin (I > 1/2) systems. To this end, effective radiofrequency (RF) Hamiltonians based on the spherical tensor formalism are proposed for describing transitions in both integral (I = 1, 2 and 3) and half-integral (I = 3/2, 5/2 and 7/2) quadrupolar spins. The optimum conditions desired for selective excitation in a multi-level system are derived pedagogically from first principles and presented through analytical expressions. Employing suitable model systems, the derived optimum conditions are substantiated through rigorous numerical simulations based on the spherical tensor formalism. The theory presented provides a framework for describing selective and non-selective RF pulses and could improve our understanding of multiple-pulse experiments involving quadrupolar nuclei.
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