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ANALYSIS OF ADIABATIC PROCESSES IN MULTILEVEL N-POD QUANTUM SYSTEMS FROM THE PERSPECTIVE OF RIEMANNIAN GEOMETRY

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Abstract. Population transfer between quantum levels in atomic and molecular systems with slowly (adiabatically) changing parameters (internuclear distances, intensities of external control fields, etc.) is traditionally described within the formalism of adiabatic or so-called dressed states. In this formalism, the quantum dynamics of a system is determined by the nonadiabatic coupling operator and critically depends on the structural features of the adiabatic energy diagram. In contrast to the case of an avoided crossing where population transfer is localized in Landau-Zener points, the dynamics of mixing permanently degenerate adiabatic states requires studying the entire time interval of the process, thus significantly complicating the theoretical methods used.

Focusing on a tripod excitation scheme, we demonstrate that adiabatic evolution of an N-pod system for a given sequence of laser excitation pulses $\Omega_j(t)$ can be interpreted as Riemannian parallel transport [1] of the state-vector along the surface of a (N-1)-dimensional Bloch sphere. This approach presents a convenient tool for analysis of adiabatic quantum processes.

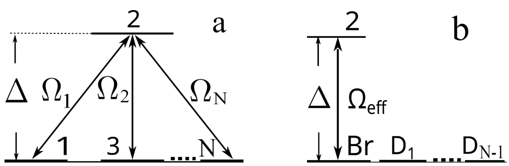

Figure 1: (a) Energy level diagram of a N-pod system and (b) the relevant set of (N-1) degenerate adiabatic D-states.

References

[1] Arnold V. I. 1978, *Mathematical Methods of Classical Mechanics*, Springer New York.