An accurate quantum expression for radiative transitions between the Stark levels of nearby Rydberg states

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Abstract
The paper presents a new alternative exact quantum expression of the x-component of the dipole matrix element between the Stark states of a hydrogen atom in terms of the Jacobi polynomials by transforming the hypergeometric functions appearing in the standard quantum formula. The new quantum formula readily leads to analytic study and numerical computation for such large values of the parabolic quantum numbers for which difficulties had earlier been encountered. The paper goes on to derive an approximate but simple quantum formula of the dipole matrix element in terms of the ordinary Bessel functions and demonstrates its remarkable accuracy for transitions ranging from that between the Stark levels of the lowest lying states to that between the Stark levels of nearby Rydberg states. The formula enables accurate numerical computation to be performed over an extended range of large parabolic quantum numbers that had earlier defied evaluation. The expressions given in this paper in essence solve the problem of determination of analytic behaviour and numerical computation of the dipole matrix element for transitions between the Stark levels of nearby Rydberg states. The paper also presents, for the first time, a derivation of the formula of the correspondence principle method from the quantum expression without appealing to any classical or semiclassical argument, and clarifies the conditions of its applicability.

1. Introduction
Radiative dipole transitions between high Rydberg states (i.e., states of large principal quantum numbers n and n') are of interest in several disciplines which include interpretation

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