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Small-Signal Parameters of Quantum Dash Lasers with Multiple Coupled Energy States

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Abstract: The small-signal parameters of quantum dash (QDash) lasers with multiple coupled energy states have been derived using a rate equation model. Analytical expressions for the small-signal differential gain, resonance frequency, and recombination lifetime have been derived. The linewidth enhancement factor of QDash lasers with multiple coupled energy states is studied using our derived model. With the help of our model, we find that introducing p-type doping in the active region of the QDash layer does not enhance the small-signal resonant frequency, but reduces the small-signal recombination lifetime and the linewidth enhancement factor. Also, we find that increasing the n-type doping concentration decreases slightly the small-signal recombination lifetime and the resonant frequency, and increases slightly the linewidth enhancement factor. Our analysis reveals that an undoped QDash laser can be designed to operate at the second excited state energy and to yield high modulation bandwidth and low linewidth enhancement factor.