

Fridolin Melong: q -Deformed Topological Recursion: Quantum Curves and Non-perturbative Analysis

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This work investigates the q -deformation of (r, s) -Airy structures and their realization via symmetric q -difference operators, providing a bridge between quantum spectral curves and integrable systems. We construct an all-order q -WKB solution for the matrix systems associated with the q -quantized curve $E_q(x, y) = 0$. We demonstrate that the resulting non-perturbative connected q -amplitudes satisfy a set of shifted q -loop equations, which can be interpreted as the Ward identities of a q -deformed $\mathcal{W}(\mathfrak{gl}_r)$ algebra. Our main result provides a rigorous classification of admissible (r, s) pairs and q -Casimir configurations that satisfy the q -topological type property. This ensures that the semi-classical expansion is uniquely governed by the q -topological recursion, offering new insights into the q -quantization of mirror curves and their underlying algebraic structures.