

Mathematical Physics

\hbar -expansion of KP hierarchy: Recursive construction of solutions

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The \hbar -dependent KP hierarchy is a formulation of the KP hierarchy that depends on the Planck constant \hbar and reduces to the dispersionless KP hierarchy as $\hbar \rightarrow 0$. A recursive construction of its solutions on the basis of a Riemann-Hilbert problem for the pair (L, M) of Lax and Orlov-Schulman operators is presented. The Riemann-Hilbert problem is converted to a set of recursion relations for the coefficients X_n of an \hbar -expansion of the operator $X = X_0 + \hbar X_1 + \hbar^2 X_2 + \dots$ for which the dressing operator W is expressed in the exponential form $W = \exp(X/\hbar)$. Given the lowest order term X_0 , one can solve the recursion relations to obtain the higher order terms. The wave function Ψ associated with W turns out to have the WKB form $\Psi = \exp(S/\hbar)$, and the coefficients S_n of the \hbar -expansion $S = S_0 + \hbar S_1 + \hbar^2 S_2 + \dots$, too, are determined by a set of recursion relations. This WKB form is used to show that the associated tau function has an \hbar -expansion of the form $\log \tau = \hbar^{-2} F_0 + \hbar^{-1} F_1 + F_2 + \dots$

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