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 -> 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 +... 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 \Psi 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 +..., 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 + >...

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