Mathematical Physics

# On the determinant formula in the inverse scattering procedure with a partially known steplike potential

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We are concerned with the inverse scattering problem for the full line Schr\"odinger operator $-\partial_x^2+q(x)$ with a steplike potential $q$ a priori known on $\Reals_+=(0,\infty)$. Assuming $q|_{\Reals_+}$ is known and short range, we show that the unknown part $q|_{\Reals_-}$ of $q$ can be recovered by {equation*} q|_{\Reals_-}(x)=-2\partial_x^2\log\det(1+(1+\mathbb{M}_x^+)^{-1}\mathbb{G}_x), {equation*} where $\mathbb{M}_x^+$ is the classical Marchenko operator associated to $q|_{\Reals_+}$ and $\mathbb{G}_x$ is a trace class integral Hankel operator. The kernel of $\mathbb{G}_x$ is explicitly constructed in term of the difference of two suitably defined reflection coefficients. Since $q|_{\Reals_-}$ is not assumed to have any pattern of behavior at $-\infty$, defining and analyzing scattering quantities becomes a serious issue. Our analysis is based upon some subtle properties of the Titchmarsh-Weyl $m$-function associated with $\Reals_-$.

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