

Exact Solutions to the Sine-Gordon Equation

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A systematic method is presented to provide various equivalent solution formulas for exact solutions to the sine-Gordon equation. Such solutions are analytic in the spatial variable x and the temporal variable t , and they are exponentially asymptotic to integer multiples of 2π as $x \rightarrow \pm\infty$. The solution formulas are expressed explicitly in terms of a real triplet of constant matrices. The method presented is generalizable to other integrable evolution equations where the inverse scattering transform is applied via the use of a Marchenko integral equation. By expressing the kernel of that Marchenko equation as a matrix exponential in terms of the matrix triplet and by exploiting the separability of that kernel, an exact solution formula to the Marchenko equation is derived, yielding various equivalent exact solution formulas for the sine-Gordon equation.

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