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Representations of affine Lie algebras and soliton equations

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A few years ago the 'hidden symmetries' of the soliton equations had been identified as affine Lie groups, also known as loop groups. The first extensive use of the representation theory of affine Lie algebras for the soliton equations have been developed in a series of works by mathematicians of the Kyoto school. We will review some of their results and develop them further on the basis of the representation theory. Thus an orbit of the simplest affine Lie group $SL(2, \mathbb{C})^\wedge$ in the fundamental representation V will provide the solutions of the Korteweg–de Vries equation, and similarly the solutions of the sine–Gordon equation will come from an orbit of the group $(SL(2, \mathbb{C}) \times SL(2, \mathbb{C}))^\wedge$ in $V \times V^*$. The affine analogue of the classical invariant theory will provide an explicit description of these equations in bilinear form. Another application of the representation theory will allow us to pass to nonlinear matrix equations, which for $SL(2, \mathbb{C})^\wedge$ yield the familiar form of Korteweg–deVries and sine–Gordon equations.

Note. The abstract only is given here because, unfortunately, Professor Frenkel's paper did not become available after the meeting.