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Rogue waves and unbounded solutions of the NLSE

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Since the pioneering work of Zakharov has been generally admitted that rogue waves can be studied in the framework of the Nonlinear Schrödinger Equation (NLSE). Many researchers, Akhmediev, Peregrine, Matveev among others gave different solutions to this equation that, in some way, could be linked to rogue waves and also to its more important characteristic: its unexpectedness.
Janssen (2003, 2004), Onorato (2004, 2006) and Waseda (2006) linked the coefficient of the nonlinear term of the Schrödinger equation with the Benjamin-Feir index (BFI) that, we know, is a measure of the modulational instability of the waves. From this point of view the value of this coefficient of the NLSE could be known from statistics. Thus the relationship between sea states and the mechanism of generation of rogue waves could be found out.
Following the well-known Lie group theory researchers have been studying the Lie point symmetries of the NLSE: the scaling transformations, Galilean transformations and phase transformations. Basically these transformations turn the NLSE into a nonlinear ordinary differential equation called Duffing equation (also called eikonal equation). There are different ways to do this, but in most of them the independent variable that could be seen as a space variable is a kind of moving frame with the time incorporated in this way. The main aim of this work is to classify solutions of the Duffing equation (periodic and nonperiodic waves and also bounded and unbounded waves) bearing in mind that the coefficient of the nonlinear term in the NLSE is left unaltered in the process of the transformation.