

Symmetries and Conservation Laws of a System of Timoshenko Type Beam Equations

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ABSTRACT

In 2004, Yoon, Ru and Mioduchowski [1] studied a model describing the Timoshenko-beam effects on transverse wave propagation in multi-wall carbon nanotubes regarded as a system of separate nested tubes. In the present study, we investigate the group properties of the system of equations, which describes a generalised case of a double-wall carbon nanotube, namely the respective coefficients are supposed to depend on the spatial variable. The van der Waal force between the tubes is expressed linearly by introducing a new coefficient. The linear model could be complicated additionally by involving some kind of non-linearity, for instance, in the term accounting for the aforementioned van der Waal force. The full group, consisting of the local point one-parameter smooth automorphisms admitted by the regarded system, [2] will be obtained. Next, the subgroup of those automorphisms preserving the functional, whose Gateaux gradient (Euler-Lagrange equations) is exactly our system of equations, will be discussed. Finally, all conservation laws bijective to the set of the divergence symmetries will be established. We intend to use the obtained results in the analysis of the dynamic behaviour of the considered system of nested carbon nanotubes.

References

- [1] Yoon, J., Ru, C.Q., Mioduchowski, A.: Timoshenko-beam effects on transverse wave propagation in carbon nanotubes. *Composites Part B: Engineering* 35.2, 87-93 (2004)
- [2] Olver, P.: *Applications of Lie Groups to Differential Equations*, 2nd ed. (Springer-Verlag, New York, 1993)