On non-linearity of p-brane dynamics

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Abstract

Relativistic membranes and p-branes in higher dimensional space-time are fundamental objects of string theory, and their macroscopic physics is explained by effective elastic forces, like QCD tubes in string theory. However, quantization of branes is blocked up by non-linearity of their equations. Solution of this problem implies investigation of relativistic elastic forces generated by membranes and p-branes.

The behavior of the forces, encoded in non-linear equations of p-branes, is studied here considering a class of closed p-branes in $D = 2p+1$-dimensional Minkowski space. A new $U(1)\times U(1)\times \ldots U(1)$ invariant anzats for the solution of p-brane equations is construced. In particular, this class includes membranes ($p = 2$) in $D = 5$ and 5-branes ($p = 5$) in $D = 11$ spaces. As a result, the p-brane dynamics is reduced to the non-linear equations of p-dimensional anharmonic oscillator with their solutions expressed in terms of (hyper)elliptic finctions. The density of elastic energy is found to be equal to $(\frac{T}{\sqrt{2C}})^2(q_1q_2...q_p)^2$, where $q_r, (r = 1, 2, ..., p)$ are the elastic displacements and T is tension.