Abstract for GR-TR Conference on Statistical Mechanics and Dynamical Systems

Topic: Soft Matter Preference: Oral

Nonlinear DNA dynamics: nonlinearity versus dispersion

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We study the impact of dispersion and nonlinearity on DNA dynamics. Nonlinear dynamics of DNA can be viewed as an interplay between nonlinearity and dispersion [1]. This means that nonlinearity increases wave amplitude and decreases its width, while the impact of dispersion on the wave is opposite, which we demonstrate.

We rely on the helicoidal Peyrard-Bishop (HPB) model [2]. All important details and derivations regarding this model can be found in a review paper [3]. A basic equation, describing DNA dynamics, is nonlinear Schrödinger equation (NLSE), which includes a dispersion parameter P and a nonlinear parameter Q. Both of them depend on five internal parameters, describing DNA geometry and chemical interactions between nucleotides. According to the interplay between nonlinearity and dispersion we should expect that the wave amplitude is an increasing function of Q and a decreasing function of P, while the impact of dispersion and nonlinearity on the wave width Λ is opposite. However, according to the HPB model, the corresponding relations are: $A \propto (PQ)^{-1/2}$ and $\Lambda \propto P$. This absurd can be solved assuming that P and Q are mutually dependent. We show how functions $Q(P)$ and $P(Q)$ can be obtained. Also, we show how this can be used to find a possible interval for the most intriguing internal parameter, describing helicoidal structure of DNA. This result is compared with the one obtained earlier using different methods [4].

As NLSE appears in several branches of physics and determination of the parameters is always important but difficult problem we believe that our procedure can be widely used.

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