**B1)** M. Cadoni, R. De Leo and S. Demelio, Soliton propagation in homogeneous and inhomogeneous models for DNA torsion dynamics, J. Nonlin. Math. Phys. 18, suppl. 2, 287-319, 2011

The existence of solitonic excitations is a generic feature of a broad class of homogeneous models for nonlinear DNA internal torsional dynamics, but many properties of solitonic propagation depend on the actual model one is considering. In this paper we perform a detailed and comparative numerical investigation of the profiles and time evolution of solitons for two different models, the Yakushevich one and the more recent "composite" model of [1], and for two different choices of the potential describing the pairing interaction between bases (harmonic and Morse potential). We consider not only homogeneous DNA chains but also inhomogeneous ones (with sequence of bases corresponding to a real organism, the Human Adenovirus 2). We show that twist solitons can propagate in inhomogeneous chains over biologically significant distances. It is also shown that stable soliton propagation is possible for inhomogeneous chains when dissipation and an external force are present. On a more general level, our results indicate that solitonic propagation can take place in highly inhomogeneous nonlinear media.

**B2)** M. Cadoni, R. De Leo, S. Demelio and G. Gaeta, Propagation of twist solitons in fully inhomogeneous dna chains, J. Nonlin. Math. Phys. 17, 567-569, 2010

In the framework of a recently introduced model of DNA torsional dynamics, we argued on the basis of perturbative considerations that an inhomogeneous DNA chain could support long-lived soliton-type excitations due to the peculiar geometric structure of DNA and the effect of this on nonlinear torsional dynamics. Here we consider an inhomogeneous version of this model of DNA torsional dynamics, and investigate numerically the propagation of solitons in a DNA chain with a real base sequence (corresponding to the Human Adenovirus 2); this implies inhomogeneities of up to 50interactions. We find that twist solitons propagate for considerable distances (210

times their diameters) before stopping due to phonon emission. Our results show that twist solitons may exist in realistic DNA chain models, and on a more general level that solitonic propagation can take place in highly inhomogeneous media. The most relevant feature for general nonlinear dynamics is that we identify the physical mechanisms allowing this behavior and thus the class of models candidate to support long-lived soliton-type excitations in the presence of significant inhomogeneities.

**B3)** M. Cadoni, R. De Leo, S. Demelio and G. Gaeta, Twist solitons in complex macromolecules: From DNA to polyethylene, Int. J. Nonlin. Mech. 43, 1094-1107, 2008

DNA torsion dynamics is essential in the transcription process; simple models for it have been proposed by several authors, in particular Yakushevich (Y model). These are strongly related to models of DNA separation dynamics such as the one first proposed by Peyrard and Bishop (and developed by Dauxois, Barbi, Cocco and Monasson among others), but support topological solitons. We recently developed a "composite" version of the Y model, in which the sugar-phosphate group and the base are described by separate degrees of freedom. This at the same time fits experimental data better than the simple Y model, and shows dynamical phenomena, which are of interest beyond DNA dynamics. Of particular relevance are the mechanism for selecting the speed of solitons by tuning the physical parameters of the non-linear medium and the hierarchal separation of the relevant degrees of freedom in "master" and "slave". These mechanisms apply not only do DNA, but also to more general macromolecules, as we show concretely by considering polyethylene.

**B4)** M. CADONI M, DE LEO R, GAETA G (2007). Solitons in a double pendulums chain model, and DNA roto-torsional dynamics. JOURNAL OF NONLINEAR MATHEMATICAL PHYSICS, vol. 14, p. 128-146.

It was first suggested by Englander et al to model the nonlinear dynamics of DNA relevant to the transcription process in terms of a chain of coupled pendulums. In a related paper [4] we argued for the advantages of an extension of this approach based on considering a chain of double pendulums with certain characteristics. Here we study a simplified model of this kind, focusing on its general features and nonlinear travelling wave excitations; in particular, we show that some of the degrees of freedom are actually slaved to others, allowing for an effective reduction of the relevant equations.

**B5)** M. Cadoni, R. De Leo and G. Gaeta, Sine-Gordon solitons, auxiliary fields and singular limit of a double pendulums chain, J. Phys. A 40, 12917-12929, 2007

We consider the continuum version of an elastic chain supporting topological and non-topological degrees of freedom; this generalizes a model for the dynamics of DNA recently proposed and investigated by ourselves. In a certain limit, the non-topological degrees of freedom are frozen, and the model reduces to the sine-Gordon equations and thus supports well-known topological soliton solutions. We consider a (singular) perturbative expansion around this limit and study in particular how the non-topological field assumes the role of an auxiliary field. This provides a more general framework for the slaving of this degree of freedom on the topological one, already observed elsewhere in the context of the mentioned DNA model; in this framework one expects such a phenomenon to arise in a quite large class of field-theoretical models.

**B6)** CADONI M, DE LEO R, GAETA G (2007). A Symmetry breaking mechanism for selecting the speed of relativistic solitons. JOURNAL OF PHYSICS. A, MATHEMATICAL AND THEORETICAL, vol. A40, p. 8517-8534.

We propose a mechanism for fixing the velocity of relativistic solitons based on the breaking of the Lorentz symmetry of the sine-Gordon (SG) model. The proposal is first elaborated for a molecular chain model as the simple pendulum limit of a double pendulums chain. It is then generalized to a full class of two-dimensional field theories of the sine-Gordon type. From a phenomenological point of view, the mechanism allows one to select the speed of a SG soliton just by tuning elastic couplings constants and kinematical parameters. From a fundamental, field-theoretical point of view we show that the characterizing features of relativistic SG solitons (existence of conserved topological charges and stability) may be still preserved even if the Lorentz symmetry is broken and a soliton of a given speed is selected.

**B7)** M. Cadoni, R. De Leo and G. Gaeta, Composite model for DNA torsion dynamics, Phys. Rev. E 75 (2007), 021919

DNA torsion dynamics is essential in the transcription process; a simple model for it, in reasonable agreement with experimental observations, has been proposed by Yakushevich (Y) and developed by several authors; in this, the nucleotides (the DNA subunits made of a sugar-phosphate group

and the attached nitrogen base) are described by a single degree of freedom. In this paper we propose and investigate, both analytically and numerically, a "composite" version of the Y model, in which the sugar-phosphate group and the base are described by separate degrees of freedom. The model proposed here contains as a particular case the Y model and shares with it many features and results, but represents an improvement from both the conceptual and the phenomenological point of view. It provides a more realistic description of DNA and possibly a justification for the use of models which consider the DNA chain as uniform. It shows that the existence of solitons is a generic feature of the underlying nonlinear dynamics and is to a large extent independent of the detailed modeling of DNA. The model we consider supports solitonic solutions, qualitatively and quantitatively very similar to the Y solitons, in a fully realistic range of all the physical parameters characterizing the DNA.

**B8)** Cadoni M (1998). 2D extremal black holes as solitons. PHYSICAL REVIEW D 58, 1040011-1040017

We discuss the relationship between two-dimensional (2D) dilaton gravity models and sine-Gordon-like field theories. We show that there is a one-to-one correspondence between the solutions of 2D dilaton gravity and the solutions of a (two fields) generalization of the sine-Gordon model. In particular, we find a connection between the soliton solutions of the generalized sine-Gordon model and extremal black hole solutions of 2D dilaton gravity. As a by-product of our calculations we find an easy way to generate cosmological solutions of 2D dilaton gravity.

**B9)** Cadoni M, Mignemi S, Serra M (2012). Black brane solutions and their solitonic extremal limit in Einstein-scalar gravity. PHYSICAL REVIEW D, PARTICLES, FIELDS, GRAVITATION, AND COSMOLOGY 85, 086001

We investigate static, planar solutions of Einstein-scalar gravity admitting an anti-de-Sitter (AdS) vacuum. When the squared mass of the scalar field is positive and the scalar potential can be derived from a superpotential, minimum energy theorems indicate the existence of a scalar soliton. On the other hand, for these models, no-hair theorems forbid the existence of hairy black brane solutions with AdS asymptotics. By considering a specific example (an exact integrable model which has the form of a Toda molecule) and by deriving explicit exact solution, we show that these models allow for

hairy black brane solutions with non-AdS domain wall asymptotics, whose extremal limit is a scalar soliton. The soliton smoothly interpolates between a non-AdS domain wall solution at $r = \delta$ and an AdS solution near $r = 0$.

**B10)** Cadoni M, Mignemi S, Serra M (2011). Exact solutions with AdS asymptotics of Einstein and Einstein-Maxwell gravity minimally coupled to a scalar field. PHYSICAL REVIEW D, PARTICLES, FIELDS, GRAVITATION, AND COSMOLOGY 84, 084046

We propose a general method for solving exactly the static field equations of Einstein and Einstein-Maxwell gravity minimally coupled to a scalar field. Our method starts from an ansatz for the scalar field profile, and determines, together with the metric functions, the corresponding form of the scalar self-interaction potential. Using this method we prove a new no-hair theorem about the existence of hairy black-hole and black-brane solutions and derive broad classes of static solutions with radial symmetry of the theory, which may play an important role in applications of the AdS/CFT correspondence to condensed matter and strongly coupled QFTs. These solutions include: (1) four- or generic (d+2)-dimensional solutions with planar, spherical or hyperbolic horizon topology; (2)solutions with anti-deSitter, domain wall and Lifshitz asymptotics; (3)solutions interpolating between an anti-deSitter spacetime in the asymptotic region and a domain wall or conformal Lifshitz spacetime in the near-horizon region.