Second Geometric Models of Nuclear Matters Conference

Christoph Adam: Recent Results and Future Prospects of the Skyrme Model

Stefano Bolognesi: Theta dependence and neutron electric dipole moment in Skyrme model and holographic QCD

Effects of the θ parameter are studied in Skyrme model and Witten-Sakai-Sugimoto (WSS) model of holographic QCD, where θ is the coefficient of the CP-breaking topological term. First, it is shown that, consistently, when massless quarks are present, any θ-dependence disappears from the model. We then turn on (small) quark masses and compute the ground state energy density and the topological susceptibility of the theory. We then move to compute one of the most relevant CP-breaking observables in the model, which is the Neutron Electric Dipole Moment (NEDM). Within the validity limits of our approximations, the NEDM is precisely determined in terms of the parameters of the model.

Alexis Diaz-Torres: Role of Nuclear Molecular Structures in Stellar Carbon Burning

Christian Aa. Diget: Experiment and theory in light nuclei (part I) - structure and dynamics in 12C

Katarzyna Dziedzic-Kocurek: Geometry in Biology

David Foster: Skyrmion knots

Guido Franchetti: Flow of geometrical structures from Eguchi-Hanson to Taub-NUT space

A hyperbolic version of Taub-NUT space has a one-parameter family of rescalings making it into an Einstein metric. For special values of the parameter one obtains the Eguchi-Hanson, Fubini-Study and Taub-NUT metrics. In this talk I will present some preliminary results about the flow of geometric structures, in particular harmonic forms and Dirac spinors, under this family of rescaling.

Ruchi Garg: Experiment and theory in light nuclei (part II) – deformations in 12C and 36Ar

Sven Bjarke Gudnason: Skyrmions with low binding energies and supersymmetric Skyrmions

I will discuss lowering the binding energies in the Skyrme-like class of models and in particular some new potentials that give quite low binding energies (albeit larger than those given by experimental data), even though (that particular) the model is not based on a deformation of a BPS theory. The second part of my talk is devoted to supersymmetrizing the Skyrme model and the desciption of some soliton solutions in the supersymmetric Skyrme model.

Mareike Haberichter: Roper Resonances and Skyrmion Vibration Modes

We study radial vibrations of spherically symmetric skyrmions in the Skyrme model and its variants. Concretely, we numerically solve the linearised field equations for small fluctuations in a skyrmion background, both for linearly stable oscillations and for (unstable) resonances. This is complemented by numerical solutions of the full nonlinear system, which confirm all the results of the linear analysis. In all cases, the resulting fundamental excitation provides a rather accurate value for the Roper resonance, supporting the hypothesis that the Skyrme model already gives a reasonable approximate description of this resonance. Part of the talk will be based on the following eprint:

`https://arxiv.org/pdf/1607.04286v1.pdf`

Chris Halcrow: Vibrational quantisation of Skyrmions

The zero mode quantisation of Skyrmions leads to a model of overly-tightly bound nuclei with a rigid structure and some jarring contradictions with experimental energy spectra; the most notably erroneous spectrum being that of Lithium-7. In this talk, I will sketch how vibrational quantisation could solve these problems without altering the standard Skyrme model. In addition, I will try to show which results from rigid body quantisation can be trusted and when one should proceed with caution.

Derek Harland: The Skyrme model and Chiral Perturbation Theory

The Skyrme model and Chiral Perturbation Theory are usually seen as alternative models of nuclear physics. In this talk I will derive some of the terms in the chiral effective Lagrangian, including the leading pion-nucleon couplings, as an approximate description of the Skyrme model. In this way I hope to clarify to what extent the two models are expected to agree.

Theodora Ioannidou: T-dependent BPS Skyrmions

An extended version of the Bogomolny-Prasad-Sommerfeld (BPS) Skyrme model that admits time-dependent solutions is discussed. Initially, by introducing a power law at the original potential term of the BPS Skyrme model, the existence, stability, and structure of the corresponding solutions are investigated. Then, the frequency and half-lifes of the radial oscillations of the constructed time-dependent solutions are determined.

Chris King: A dynamical alpha-cluster model of Oxygen-16

Kei-Ichi Kondo: Connecting Non-Abelian magnetic monopole and vortex in Yang-Mills and Yang-Mills-Higgs theories

Nick Manton: Four-dimensional Geometry and Atoms

In this talk I will present the latest version of the Geometry of Matter proposal initiated by Sir Michael Atiyah. New formulae for proton and neutron numbers have been found that allow a large class of algebraic surfaces (complex 4-manifolds) to be considered as models for neutral atoms.

Calum Ross: Solutions of the Perturbed Freund Equations

The Freund equations are a variant of the Seiberg-Witten equations with a sign change in the nonlinear equation. Solutions to the perturbed Freund equations on R^4 can be constructed using dimensional reduction to R^3. These solutions exhibit interesting links to 2D equations. This process also carries over to construction of solutions to the perturbed Freund equations on $R^{2,2}$. Here dimensional reduction is carried out by imposing translational invariance in one of the "time" directions. Again the solutions constructed can be related to 2D equations. I will outline the construction in both cases and the link to two dimensions

Bernd Schroers: Spectral properties of gravitational instantons

The spectrum of the Dirac and Laplace operators on ALF gravitational instantons twisted by a line bundle naturally associated to the geometry, plays a role in several distinct parts of mathematical physics - ranging from moduli space quantisation of monopoles to Hawking radiation. In this talk I discuss the common and special features of these operators for the Taub-NUT space, the Atiyah-Hitchin manifold and the Euclidean Schwarzschild space, and comment on their interpretation in the context of geometric models of matter.

Yasha Shnir: Boundary scattering in the ϕ^4 model

Robin Smith: Hoyle be back: The recurring problem of carbon-12s structure

The 0^+ excited state of ^{12}C at 7.65 MeV is named after Fred Hoyle, who proposed its existence in order to account for high stellar abundances of carbon [1,2].

Aside from this astrophysical significance, it is thought to possess a curious cluster structure. This is dominated by the relative motion of three alpha particles, rather than individual nucleons. Since its discovery in 1953 [3] the Hoyle state has been a major focus of experimental activity where measurements of its excitations and radius provide indirect insights into the structure of this famous state [4]. It has also become a foundation for tests of state-of-the-art nuclear theory, though such theories rarely agree on a single description of this state. This talk will examine our current understanding of the structure of the Hoyle-state and the rest of the ^{12}C spectrum. A review of recent and future experimental studies by the Birmingham nuclear physics group are presented and their connections with state-of-the-art nuclear models are made.

[1] E. Öpik, Proc. R. Ir. Acad. A 54 (1951) 49.

[2] E.E. Salpeter, Astrophys. J. 115 (1952) 326.

[3] D.N.F. Dunbar, R.E. Pixley, et. al., Phys. Rev. 92 (1953) 649.

[4] M. Freer, H.O.U. Fynbo, Prog. Part. Nucl. Phys. 78 (2014) 1-23.

Martin Speight: Point particle models of lightly bound skyrmions

Paul Sutcliffe: Phases of Kinky Holographic Nuclear Matter

Holographic QCD at finite baryon number density and zero temperature is studied using a new approximation that models a smeared crystal of solitonic baryons by assuming spatial homogeneity to obtain an effective kink theory in the holographic direction. The kink theory correctly reproduces a first order phase transition to lightly bound nuclear matter and captures previously suggested phases including dyonic salt, baryonic popcorn and soliton bags.

Floris ter Braak: Some aspects of the modified regularized long wave equation

In this talk we will discuss the modified regularized long wave (mRLW) equation introduced by J. D. Gibbon, J. C. Eilbeck and R. K. Dodd (1976). We will investigate the Hirota integrability and kinematic integrability of this system. We will argue that even though the system is not Hirota integrable, it does admit a zero curvature equation. Furthermore, we will mention that there are numerical indications that an exact three-soliton solution exists despite the fact that only an analytical one- and two-soliton solution are known (which are obtained using Hirota's method).

Andrzej Wereszczynski: The volume of solitons and the (baryon) chemical potential

Tom Winyard: Anisotropic Multi-component Superconductors

Wojtek Zakrzewski: Quasi-integrability and some interesting aspects of some Toda field theories