Working Group 1 (WG1)

Progress Report (PR1)

CA17139

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The Working Goup 1 (WG1) is the general theoretical component of the COST action. The task of WG1 is to adress “theory of topological entanglement” with applications in particular to polymers and fibres.

At the end of this first reporting period, the total number of participants who are included in the mailing list of WG1 is 29. A request was sent to all these colleaques, to report how progress has been made during first reporting period, since the inaugural event in Trento 5-8 february 2019.

The number of articles that are to be credited primarily for WG1 can not be determined at the moment; the present reporting of articles only credit the entire COST project, without specifically crediting a Working Group. This makes sense, since there are several participants who are listed in more than one WG. However, a number of articles fall clearly within the WG1 area of theoretical foundations, and the report is based on these articles.

A notable contribution was reported by Ferrari, Paturej, Pia̧tek and Zhao in Nuclear Physics B945, 114673 (2019). They developed a field theory approach to the statistical mechanics of a system of mutually linked polymer rings, and found connections to soliton supporting integrable equations. The authors also investigated potential applications to topological quantum computing and high-temperature superconductivity.

Along the same lines of topologically stable soliton structures, Rybakov, Garaud and Babaev reported on findings of stable Hopf-Skyrme topological excitations in the superconducting state published in Physical Review B 100 (9), 094515 (2019). An extension of this work towards synthetic nuclear Skyrme matter in imbalanced Fermi superfluid mixtures is being finalized.

Dai reported together with Peng, Niemi and Wilczek on a breakthrough in understanding Hamiltonian structure of time crystals. The finding have potential application to entangled molecular chains. Physical Review A 99, 023425 (2019)

Ilieva, in collaboration with Hou, Peng and Niemi, and separately Dai and Niemi in collaboration with Liu and Peng, have developed novel 3D visualization approaches for structural analysis of proteins. As applications they have considered the characterization of the myoglobin ligand gateway and the reconstruction of protein side-chain structure based on knowledge of the backbone geometry. The results have been published e.g. in Journal of Mathematical Chemistry 57, 1586 (2019), The Journal of chemical physics 150, 225103 (2019) and in AIP Conference Proceedings.

Niemi reports on progress in understanding the phae structure of proteins as a function of temperature and acidity. For this, together with Begun and Molochkov, he has develpoed techniques to study thermodynamical properties of entangled structures. The findings were reported in Scientific reports 9 (1), 10819 (2019). Niemi also reported on development of novel topological indices, to characterize polyconal chains with applications to proteins, in Scientific reports 9 (1), 14641 (2019).

Miller has reported on forth-coming publication on Energy landscapes of folding and knotting protein-like chains, which is collaboration with Ivan Coluzza and Giacometti.

Fajstrup reports on success in development of new approaches to amorphous structures using topological data analysis,

Chernodub reports progress in constructing knotted structures in parity-odd superconductors, that emerge as stable soliton structures in self-linked magnetic field. An article is under preparation.

In addition, Ilieva reports that Bulgarian National Science Fund has provided national COST actions Co-funding under project title Topological Aspects of Biomolecular Dynamics  
KP-06-COST-9/06.08.2019 (Bulgarian National Science Fund; August 2019 – July 2021)

This first reporting period/process has also brought up a number of proposal, to ensure uniformity between WG for the enamation of results from the project. In particular, it would be advisable that the poublications acknowledging the project would be posted in the homepage grouped according to Working Groups. For this, the leaders of each group should become participants in the posting process. Also, uniform template for reporting results from each working groups would be good to introduce, for the second reporting period.