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Light-Controlled Topological Charge in a Nematic Liquid Crystal

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Creating, imaging, and transforming the topological charge in a superconductor, a superfluid, a system of cold atoms, or a soft ferromagnet is a difficult—if not impossible—task, because of the hortness of the length-scales and lack of control. The length scale and softness of defects in liquid crystals allow for the easy observation of charges, but it is difficult to control charge creation. Recently, we demonstrated [1,2] full control over the creation, manipulation and analysis of topological charges that are pinned to a microfibre in a nematic liquid crystal. Oppositely charged pairs are created via the Kibble-Zurek mechanism by applying a laser-induced local temperature quench in the presence of symmetry-breaking boundaries. The pairs are long-lived, oppositely charged rings or points that either attract and annihilate, or form a long-lived, charge-neutral loop made of two segments with a fractional topological charge. This indicates the sensitivity of the Kibble-Zurek mechanism and the coarsening dynamics of entangled defects at late times to the connectedness of space and symmetry-breaking boundary conditions which might have implications also on the cosmological level. Furthermore, we show that any even number of topological charges could be deliberately created on topologically simple objects, which opens new routes to the design and assembly of topologically complex colloidal structures.

[1] M. Nikkhou, M. Škarabot, S. Čopar, M. Ravnik, S. Žumer and I. Muševič, Nature Physics 11, 183 (2015), doi:10.1038/nphys3194.
[2] M. Nikkhou, M. Škarabot, and I. Muševič, Eur. Phys. J. E 38: 23 (2015), doi:10.1140/epje/i2015-15023-6.

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