Controlling defects in engineered liquid crystals

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Sitting with a joystick in the comfort of their chairs, scientists can play "rodeo" on a screen magnifying what is happening under their microscope. They rely on optical tweezers to manipulate an intangible ring created out of liquid crystal defects capable of attaching a microsphere to a long thin fibre. Maryam Nikkhou and colleagues from the Jožef Stefan Institute, in Ljubljana, Slovenia, recently published in *EPJ E* the results of work performed under the supervision of Igor Muševič. They believe that their findings could ultimately open the door to controlling the flow of light using light of a specific frequency in the Gigahertz range in liquid crystal photonic microdevices.

Liquid crystals are familiar to us from their application in LCD screens. What makes them so interesting is that they are rich in defects. Thanks to advances in manipulation tools such as optical tweezers, the authors were able to create an arbitrary number of defect pairs on a long thin fibre plunged into a nematic liquid crystal - an ordered fluid with long organic molecules all pointing in the same direction like sardines in a tin.

Nikkhou and colleagues use very strong laser tweezers to locally melt the liquid crystal into a phase where the molecules are oriented in all directions, encircling one part of the fibre. They subsequently switch-off the laser light, resulting in the locally molten liquid crystal rapidly cooling down. Its molecules then revert back from being oriented in all directions to being parallel to each other, creating several pairs of defects - akin to localised disruptions of the crystal's ordering field - forming a ring. Because liquid crystals are made of soft materials, their defects can be moved and modified easily. The defect ring is used as a non-material "rope" to entangle and strongly bind a microsphere and long fibre of micrometric diameter. Because these defects are typically preserved when subjected to stretching and bending, they offer an ideal physical model of an abstract field of mathematics called topology.

More information: "Topological binding and elastic interactions of microspheres and fibres in a nematic liquid crystal." M. Nikkhou, M. Škarabot, and I. Muševič (2015), *Eur. Phys. J.* E 38: 23, DOI: 10.1140/epje/i2015-15023-6

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