RUHR-UNIVERSITÄT BOCHUM
FAKULTÄT FÜR PHYSIK UND ASTRONOMIE

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Bound states of vortices: from Kelvin theory of luminiferous aether and Skyrme theory to unconventional superconducting states

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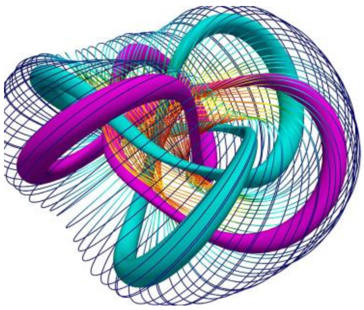

The failed "vortex-atoms" theory of matter by Kelvin and Tait had a profound impact on mathematics and physics. Building on the understanding of vorticity by Helmholtz, and observing stability of smoke rings, they hypothesised that elementary particles (at that time atoms) are indestructible knotted vortices in luminiferous aether: the hypothetical ideal fluid filling the universe. The vortex-atoms theory identified chemical elements as topologically different vortex knots, and matter was interpreted as bound states of these knotted vortices. This work initiated the field of knot theory in mathematics. It also influenced modern physics, with most notable attempt to develop similar ideas being the Skyrme theory of nucleons. An incomplete analogy also exists with the theory of superfluidity, which started with Onsager's and Feynman's introduction of the concept of quantum vortices. Indeed many macroscopic properties of superconductors and superfluids are determined by vortex lines forming different "aggregate states", such as vortex crystals and liquids. Yet
these states are still in many respects simpler that the states hypothesized by Kelvin since in the usual superfluids and superconductor vortices do not form bound states. I will discuss unconventional superconducting states, one of them is “type-1.5” superconducting state were vortices have long-range attractive short range repulsive interaction forming bound states with many physical consequences. In the second part of the talk I will discuss that near certain critical points, the hydro-magnetostatics of superconducting states changes completely leading to formation of stables vortex knots characterized by Hopf invariants which behave similarly to those envisaged in Kelvin and Tait's theory of vortex-atoms in luminiferous aether.

Einführung: Prof. Dr. I. Eremin

Die Fakultät lädt alle Interessierten herzlich ein.