

## “Spontaneous chiral symmetry breaking in polar fluid – heliconical ferroelectric nematic materials”

### Popular-science summary

The idea of polar ordering of molecules in liquids has accompanied mesomorphic materials basically since the beginning of their discovery. In 1916, Max Born, inspired by the works of P. Weiss, developed a hypothesis of the polar ordering of polar molecules in a nematic liquid, but this hypothesis was not experimentally confirmed. The next wave of optimism related to the search for ferroelectric liquid crystals occurred in the 1970s, when McMillan proposed a model of a polar tilted smectic phase (SmC), which was eventually replaced by Meyer's theory, which is generally considered to be the beginning of experimentally confirmed ferroelectricity in liquid crystal materials. Returning to the least organized LC phase - the nematic phase, the idea of ferroelectricity has been present in the sphere of theoretical considerations for many years, which found experimental confirmation relatively recently in 2017, when two groups independently demonstrated the existence of the ferroelectric nematic NF phase. In 2024, our team made another discovery that, in addition to ferroelectric properties, added another effect - spontaneous symmetry breaking (SSB), manifested in the spontaneous formation of a chiral superstructure - a heliconical screw structure, which is exhibited by the achiral compound with newly discovered NTBF phase. The coupling of both these effects - the generation of polarity-ferroelectricity and chirality - for achiral, relatively simple molecules exhibiting a nematic phase, is a phenomenon that has not been seen before and is still poorly understood from the molecular point of view. This project is part of research on the search for new nematic compounds exhibiting the twist-bend nematic ferroelectric phase NTBF and physicochemical research on its structure and properties. The correlation between the chemical structure of the newly developed materials and the structural and physicochemical properties will shed new light on the molecular mechanism of spontaneous formation of the heliconyl polar structure of the nematic NTBF phase. Understanding the molecular mechanism of creating the heliconical NTBF phase will allow for the purposeful design of compounds and their mixtures for applications. At the current stage, it is difficult to predict the applications of these materials, but preliminary results of the high sensitivity of the electric field to the periodicity of the heliconical structure and fluid properties indicate this area of potential applications.