Nanoscopic static electricity generates chiral patterns

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In the tiny world of amino acids and proteins and in the helical shape of DNA, a biological phenomenon abounds.

These objects are all chiral — they cannot exactly superimpose their mirror image by translation or rotation. A common example of this is human hands — a right hand cannot superimpose itself into its mirror image, a left hand. This description of a molecule's symmetry (or lack thereof) is important in determining the molecule's properties in chemistry.

But while scientists and engineers know that at the sub-atomic level weak forces are chiral, how these electrostatic forces can generate a chiral world is still a mystery.

Researchers at Northwestern University in the group of Monica Olvera de la Cruz, professor of materials science and engineering and chemical and biological engineering at the McCormick School of Engineering and Applied Science, have recently shown how electrostatic interactions — commonly known as static electricity — alone can give rise to helical shapes. The group has constructed a mathematical model that can capture all possible regular shapes chiral objects could have, and they computed the preferred arrangements induced by electrostatic interactions.

Their work will be published as the cover story in the journal *Soft Matter* and is published online.

"In this way we are simply letting nature tell us how it would like to be, and we generalize it to many different systems," Olvera de la Cruz says." She and her colleagues report that chirality can only spontaneously arise as a consequence of electrostatic interactions and does not require the presence of other more complicated interactions, like dipolar or short-range van der Waals interactions.

Their model also describes arrangement of DNA mixed with carbon nanotubes. DNA has been shown to form helices around nanotubes, thereby separating the different types of carbon nanotubes into families.

The research findings concur with previous research using microscopy.

"From our predicted helical shapes of DNA wrapped around carbon nanotubes, we found amazing correspondence to those that were recently measured by atomic force microscopy," Olvera de le Cruz says.

The work shows that electrostatics is a pathway for understanding how nature generates helical symmetries. Researchers hope that future work can show how to use simple interactions to generate other symmetries that drive complex phenomena.

Source: Northwestern University