A recent paper from IPM's Soft Matter and Biophysics group co-authored by Ali Naji and his colleagues appeared on the front page of some of major science news websites (on 30 April 2012), including Science Daily, PhysOrg, Springer Select, AlphaGalileo, Nanotechnology Now, Nanowerk, etc. It is also highlighted by the European Physical Journal (publisher) website, and featured as a Biophysics Highlight in Europhysics News 43 (4), 11 (2012).

Science Daily link: http://www.sciencedaily.com/releases/2012/04/120430105356.htm

Electric Charge Disorder: A Key to Biological Order?

ScienceDaily (Apr. 30, 2012) — Strong attraction that arises between biological objects with random patches of electric charge on an otherwise neutral surface may partly explain pattern recognition in biology.

Theoretical physicist Ali Naji from the IPM in Tehran and the University of Cambridge, UK, and his colleagues have shown how small random patches of disordered, frozen electric charges can make a difference when they are scattered on surfaces that are overall neutral. These charges induce a twisting force that is strong enough to be felt as far as nanometers or even micrometers away.

These results, about to be published in *EPJ E* [1], could help to understand phenomena that occur on surfaces such as those of large biological molecules.

To measure the strength of the twist that acts on a randomly charged surface, the authors used a sphere which was mounted like a spinning top next to a randomly charged flat substrate. Because small amounts of positive and negative charges were spread in a disordered mosaic throughout both surfaces, they induced transient attractive or repulsive twisting forces. This was regardless of the surfaces' overall electrical neutrality, thus making the sphere spin.

Using statistical averaging methods, the authors studied the fluctuations of these forces. The authors found that the twisting force, created by virtue of the disorder of surface charges, is expected to be much stronger and far-reaching than the remnant forces. The latter are always present, even in the absence of charge disorder, and are due to fluctuations at the atomic and molecular levels.

This could have implications for large randomly charged surfaces such as biological macromolecules, which may be exposed to strong electrostatic forces, inducing attraction and/or repulsion, even if they carry no overall net charge. For instance, this phenomenon could partly explain biological pattern recognition, such as lock and key phenomena. In that context, the twisting force could explain the attraction between biological macromolecules that lead to pre-alignment prior to their interaction.

Journal Reference:

[1] Ali Naji, Jalal Sarabadani, David S. Dean, Rudolf Podgornik. **Sample-to-sample torque fluctuations in a system of coaxial randomly charged surfaces**. *The European Physical Journal E*, 2012; 35 (3) DOI: 10.1140/epje/i2012-12024-y