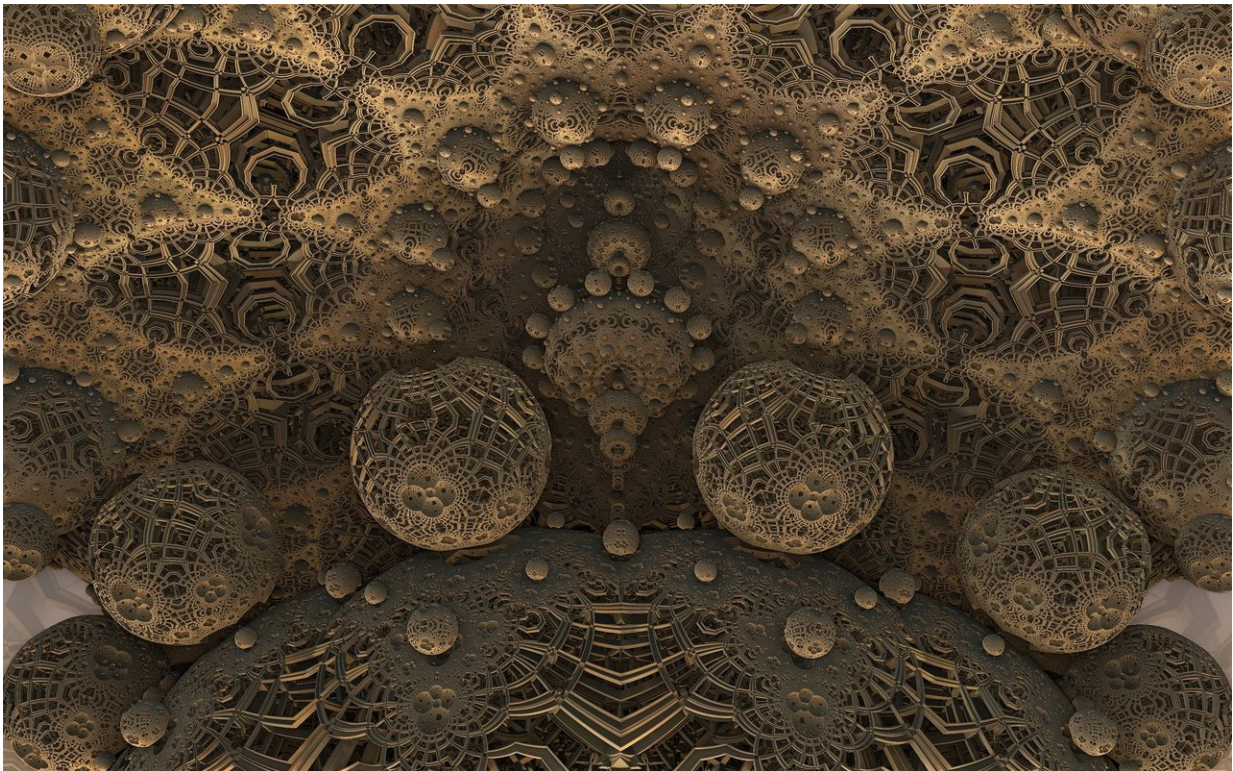


# Charge change: How electric forces vary in colloids

September 12 2019

---



Credit: CC0 Public Domain

When calculating electrokinetic force, the convention has been to assume that there is no relative velocity of the fluid compared to the surface, which holds true for hydrophilic surfaces. However, this needs to be reconsidered for hydrophobic surfaces. Prof Hiroyuki Ohshima

from Tokyo University of Science has conducted theoretical research on electrokinetic phenomena in colloidal particles for 50 years. Now, he has summarized some of the major findings in his field in a compelling review article.

Colloidal suspensions are heterogenous mixtures of particles with diameters of about 2-500 nanometers, which are permanently suspended in a second phase, usually a liquid. Owing to the small particle size of the suspended material, a colloid does not separate into its characteristic components even if allowed to remain undisturbed, nor can the suspended material be separated through filtration. Colloids are distinguished from other types of mixtures by several important distinctive properties, one of which is the electrokinetic force in colloidal suspensions, also known as the "zeta potential."

To explore zeta potential, we must first understand what a "slipping surface" is. A slipping surface is an "electrical double [layer](#)" that forms on the surface of any object when it is exposed to a fluid. This double layer consists of one layer of charges that adhere to the surface of the object as a result of chemical interactions, and a second layer of opposite charges that are attracted to the first layer. Due to the attraction between these two layers of opposite "ions" or charges, an [electric potential](#) is created, and this is the zeta potential. The zeta potential occurs in double layers on the surface of particles suspended in colloids as well.

Prof Hiroyuki Ohshima of Tokyo University of Science has been a lifelong theoretical researcher of electrokinetic phenomena such as the movement of [colloidal particles](#) in an electric field and electrostatic interactions between colloidal particles. He has recently summarized some of the major findings in his field in a review published in the journal *Advances in Colloid and Interface Science*. He asserts the importance of zeta potential in colloidal surface chemistry. According to him, "the dispersion stability of colloidal particles, which is one of the

most important issues in colloid surface chemistry, greatly depends on the zeta potential of the particles."

Zeta potential is calculated based on the electrophoretic mobility of the particles. Until now, the no-slip boundary condition of the fluid, which assumes that the fluid will have zero velocity relative to the boundary, has been applied when calculating the zeta potential. However, while this condition is applicable to particles with a hydrophilic ("water-loving") surface, it cannot be applied to particles with a hydrophobic ("water-shy") surface. In this case, the Navier boundary condition, which considers the relative velocity of the fluid, is applied.

In the Navier boundary condition, the effect of the hydrodynamic slip is characterized by the slipping length. When the surface is hydrophilic, the slipping length is considered to be zero, and it progressively increases with the increase in hydrophobicity of the surface, where the molecules of the particle surface weakly interact with the molecules in the surrounding phase so that liquid slip occurs. In accordance, an infinitely large slipping length theoretically corresponds with a completely hydrophobic surface. From this information, theoretical calculations show that electrophoretic mobility and sedimentation potential increase with increasing slipping length.

According to Prof Ohshima, what is more interesting is that if we accept the possibility of the presence of a slipping surface on a spherical solid colloidal particle, we can observe that the electrokinetic properties of this solid particle will be hydrodynamically similar to those of a liquid drop.

These findings highlight the importance of reconsidering how the electrokinetic properties of hydrophilic and hydrophobic surfaces vary and showcase how they affect the dynamics of [colloidal suspensions](#). Prof Ohshima concludes, "We have constructed a general theory

describing various electrokinetic phenomena of particles with a sliding surface. By applying this theory, we could expect a more accurate evaluation of zeta potential and colloidal particle dispersion stability in the future."

**More information:** Hiroyuki Ohshima, Electrokinetic phenomena in a dilute suspension of spherical solid colloidal particles with a hydrodynamically slipping surface in an aqueous electrolyte solution, *Advances in Colloid and Interface Science* (2019). [DOI: 10.1016/j.cis.2019.101996](https://doi.org/10.1016/j.cis.2019.101996)

Provided by Tokyo University of Science

Citation: Charge change: How electric forces vary in colloids (2019, September 12) retrieved 25 April 2024 from <https://phys.org/news/2019-09-electric-vary-colloids.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.