

中央大學物理學系

Department of Physics, National Central University



Colloquium

Polarization Charge Effects in Microwave Heating

Dr. Li-Chung Liu

Postdoctoral Research Fellow
Department of Physics, NTU

Date: 2026/02/24 (Tue)

Venue: S4-625

Time: 14:00

Abstract :

Polarization charges play a crucial yet often overlooked role in microwave heating. In this talk, we elucidate the fundamental impact of polarization-charge effects through two representative and practically relevant examples.

First, we show that non-uniform heating does not arise solely from exposure to non-uniform electromagnetic fields. Even under a perfectly uniform incident electric field, polarization charges induced within a dielectric object partially shield the field, leading to a reduced and spatially non-uniform internal electric field. This shielding effect is highly sensitive to the object's shape and orientation, resulting in large and sometimes unexpected temperature variations. The implications of this mechanism for microwave-assisted chemical synthesis are discussed.

Second, we examine the interaction between two closely spaced dielectric spheres. When separated by a narrow gap, polarization charges on opposing surfaces strongly enhance the local electric field, which can become sufficiently intense to ignite air sparks. This mechanism provides a physical explanation for the long-standing and widely observed phenomenon of sparking between paired grapes in household microwave ovens.

Finally, we discuss the interplay between polarization-charge shielding and internal electromagnetic resonances in microwave heating. Simulations show that sample geometry critically influences field distribution and penetration. In particular, spherical samples exhibit superior temperature uniformity due to rotational symmetry, highlighting important limitations of commonly used non-spherical vessels.