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The lecture will be broadcasted via **ZOOM**. You will receive the login data by email.

Collective Phenomena in Mixed Ionic & Electronic Conductors

William Chueh

Associate Professor of Materials Science and Engineering and Senior Fellow at the Precourt Institute for Energy
Stanford University

Mixed ionic and electronic conductors underpin many energy storage and conversion mechanisms. The coexistence of ionic and electronic charge carriers gives rise to critical functionalities and mechanisms that do not exist in pure ionic and pure electronic conductors, such as ion insertion (intercalation). Fundamentally, mixed transport of ions and electrons involves collective phenomena, similar to many-body effects in condensed matter physics. At the atomic scale, mobile ions and electrons interact as they migrate in the solid-state, affecting both the equilibrium configuration and the kinetic pathway. At the mesoscale scale, a large ensemble of "wired" particles interact in non-trivial ways.

Historically, the electrochemistry community has largely taken a mean-field approach towards these collective phenomena, which is reflected in widely used reaction-transport models. In the solid-state ionics community, mobile ions and electrons are often dissociated under typical experimental conditions (i.e., higher temperatures). As such, the standard approach is to consider bulk ion-electron interaction through local and equilibrium charge neutrality.

In this talk, I will overview two bodies work at Stanford on collective phenomena in mixed conductors that goes beyond the mean-field and local charge neutrality approach. First, at the atomistic level, I will deconstruct the coupling between mobile ions and localized electrons (polarons) and show how the local chemistry is determined by such couplings. I will use two model solids, $Li_{2-X}MnO_3$ and $Na_{2-X}MnO_7$ as examples. Second, at the mesoscale, I will show that reaction-diffusion and phase separation occurring in an ensemble of wired particles give rise are vastly different behavior than their bulk, single crystal counterpart. I will use two additional model solids, $LiXCoO_2$ and $LiFePO_4$ to showcase these unusual collective phenomena occurring at the mesoscale. To conclude my talk, I will describe the ten-year vision to advance the understanding of ionic and electronic transport by embracing emergent experimental and theoretical tool that tackle transport at the intrinsic time and length scales.

Contact: Michael Eppard (1470) ● Email: M.Eppard@fkf.mpg.de