Péter Kovács: Anomalous U(1)A couplings, the Columbia plot, and CP violation

When quark masses are lighter than those in QCD, conventional wisdom holds that the chiral phase transition for three light flavors should be of first order. However, recent lattice simulations indicate that the transition may instead be second order in the chiral limit. In this work, we investigate this possibility using an extended linear sigma model within the mean-field approximation. We focus on the role of terms that explicitly break the anomalous U(1)A symmetry, and how their presence can lead to a second-order chiral transition even for three massless quark flavors. In addition, we explore an unphysical region of the Columbia phase diagram, where the strange quark mass is light and negative, and find that an eta condensation appears there, signaling a CP broken phase in this regime.