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Equation of State for QCD with a Critical Point: Imposing Thermodynamic Stability Using Neural Networks DEBORA MROCZEK, Univ of Houston, MORTEN HJORTH-JENSEN, Michigan State Univ, CLAUDIA RATTI, Univ of Houston, PAOLO PAROTTO, Univ of Wuppertal, JACQUELYN NORONHA-HOSTLER, Univ of Illinois Urbana-Champaign — A few microseconds after the Big Bang, a state of matter known as the quark-gluon plasma (QGP) filled the universe. Currently, droplets of QGP can be created in heavy-ion collisions at the Relativistic Heavy Ion Collider (RHIC). Quantum chromodynamics (QCD) calculations and experimental results indicate that the transition from nuclear matter to the QGP is a crossover if the system has a net baryon density of zero. If QCD exhibits a first-order phase transition at large baryon densities, a critical point (CP) would mark the end of the crossover and the beginning of the first order line. In order to study the implications of the presence of a CP, we constructed a family of equations of state based on Lattice QCD results but also containing a CP from the 3D Ising model universality class. The mapping of the Ising CP onto the QCD phase diagram gives rise to free parameters, which need to be optimized to reflect consistent thermodynamic behavior. In this work, we use a Feed-Forward Neural Network to identify choices of free parameters that result in inconsistent thermodynamics. In future studies, this approach will be used to rule out pathological parameter choices at a low computational cost, eliminating possible locations of the QCDCP and guiding experimental searches at RHIC.

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