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Generalized susceptibilities and the critical point of a van der Waals hadron resonance gas

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The study of hadronic matter at high temperatures and baryon densities plays a central role in exploring the QCD phase diagram and the possible existence of a critical point. Generalized susceptibilities, which are related to cumulants experimentally accessible in heavy-ion collisions, are particularly sensitive to critical behavior and therefore valuable tools in this search. In this work, we use the hadron resonance gas (HRG) model with quantum van der Waals interactions, which contains a genuine critical point, and compare it with the ideal HRG using Thermal-FIST. We extract the chemical freeze-out line from STAR hadron yields and characterize the critical region: the critical point lies at T_c ≈ 19.5 MeV and μ_B ≈ 914 MeV. We then study the baryon, electric-charge and strangeness susceptibility ratios along the freeze-out line. We show how the critical signal depends on the distance between the freeze-out line and the critical point, and how it is affected when the baryon number is replaced by measurable proxies such as protons. Finally, we present a proposal for measuring strangeness-related susceptibility ratios in the MPD-NICA experiment.

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