Status of the search for a critical point in the nuclear matter phase diagram

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Nuclear matter, like water, has a phase diagram which summarizes the physical states of the matter versus the temperature and other parameters. Unlike water, we have a solid experimental understanding of only the very edges of the nuclear matter phase diagram - most of the inside is just a good guess. The RHIC accelerator in New York, USA, is capable of providing beams of 197-Au nuclei with fine control of the beam energy, allowing the STAR experiment to search systematically through the phase diagram for hints of a key landmark in any phase diagram - a critical point. It may not exist. If it does, it is assumed to contribute increased positive fluctuations and correlations that are localized in beam energy. In this presentation, I will try to carefully define what are "fluctuations" and "correlations" in heavy-ion collisions. The terms represent closely related concepts, and each concept represents a type of offline analysis strategy that can directly access possible critical point signals. The most sensitive such analyses require the widest acceptance for the final state particles, which makes the STAR experiment at RHIC extremely attractive. I will summarize the latest results from STAR on the search for the nuclear matter critical point in the data collected during the Beam Energy Scan from 2010-2014. Some preliminary results from the much larger BES-II (2019-2021) datasets collected by STAR, before which STAR received three major upgrades all benefitting these analyses, will also be presented.