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# A machine learning study to identify spinodal clumping in high energy nuclear collisions

*Wednesday 6 November 2019 08:40 (20 minutes)*

In this talk I will discuss possible observables of baryon number clustering due to the instabilities occurring at a first order QCD phase transition.
The dynamical formation of baryon clusters at a QCD phase transition can be described by numerical fluid dynamics, augmented with a gradient term and an equation of state with a mechanically unstable phase [1]. I will show that
the dynamical description of this phase transition, in nuclear collisions, will lead to the formation of dense baryon clusters at the phase boundary [2]. Using state-of-the-art machine learning methods I will show that the coordinate space clumping leaves characteristic imprints on the spatial net density distribution in almost every event. On the other hand the momentum distributions do not show any clear event-by-event features. In fact only a few events can be systematically differentiated when only the momentum space information is available. In such a scenario conventional observables, like the baryon number cumulants seem to be the best hope at finding signals for the phase transition. Indeed it is shown that the third order cumulant, the skewness, shows a peak at the beam energy where the system, created in the heavy ion collision, reaches the deconfinement phase transition. Most of this talk will be based on [3].

[1] J. Steinheimer and J. Randrup,
Phys. Rev. Lett. 109, 212301 (2012).
[2] J. Steinheimer and V. Koch,
Phys. Rev. C 96, no. 3, 034907 (2017)
[3] J. Steinheimer, LongGang Pang, Kai Zhou, Volker Koch, Jorgen Randrup and Horst Stoecker,
arXiv:1906.06562 [nucl-th].

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