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Suppressed flow harmonics: A signature of the QCD critical point?

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The fate of a perturbation (disturbance) imparted in the QGP fluid governed by the second-order Israel-Stewart viscous hydrodynamics has been studied when it passed through the Critical End Point (CEP). The effects of CEP have been incorporated in the system through the Equation of State (EoS). The dispersion relation for the perturbation in frequency (ω) wave vector (k) space has been derived. An expression for the threshold wavelength (λ_{th}) has been derived such that waves with wavelength, $\lambda > \lambda_{th}$ can propagate in the QGP but waves with lower λ will dissipate. Most interestingly, it is found that the value of λ_{th} at the CEP diverges, blocking waves of all wavelength irrespective of the value of transport coefficients. Near the CEP the correlation length (ξ) diverges, violating the hydrodynamic limit, $\xi << \lambda$ and the development of sound wave is prevented. The forbiddance of sound wave will lead to the vanishing of Mach cone (Mach angle, $\alpha = Sin^{-1}(c_s/v)$, v is the fluid velocity). Therefore, the vanishing of Mach angle will indicate the presence of the critical point. Also the presence of critical point makes the viscous horizon scale, $R_v \sim 1/k_{th} \sim \lambda_{th}$ to diverge and since the highest order of surviving harmonic vary as, $n_v \sim 2\pi R/R_v$. Therefore, ideally, the vanishing harmonics will indicate the presence of critical point.

However, the experimentally measure quantities are superposition of different temperatures and densities from the formation to the freeze-out stage, therefore, even if the system hits the critical point in the $T-\mu$ plane, the harmonics may not vanish, but will be suppressed. Hence we propose the suppressed flow harmonics to be a signature of the CEP.

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