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Correlation of fluctuation with parametric slow mode: a signature of the QCD critical point?

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The structure factor ($\mathcal{S}_{nn}(k,\omega)$) of dynamical density fluctuation is studied in the presence of the out-of-equilibrium modes (ϕ) within the scope of relativistic viscous hydrodynamics. The $\mathcal{S}_{nn}(k,\omega)$ without the ϕ modes shows three peaks of Lorentzian types, identified as one Rayleigh peak and two Brillouin peaks, symmetrically situated about the Rayleigh peak with even magnitudes. In the presence of the critical point, Brillouin peaks merge with the Rayleigh peak, enhancing the magnitude of the Rayleigh peak. Whereas, the structure factor with the slow mode variable shows four peaks, which are identified as one Rayleigh peak, two Brillouin peaks, and one peak due to the coupling of hydrodynamic modes with the slow mode. The extra peak due to coupling only arises in the second-order theory of hydrodynamics. Contrary to the $\mathcal{S}_{nn}(k,\omega)$ without ϕ mode, the Brillouin peaks are situated asymmetrically about the Rayleigh peak with uneven magnitudes. In the presence of the critical point, the Brillouin peaks get merged with the Rayleigh peak, and the $\mathcal{S}_{nn}(k,\omega)$ shows only the Rayleigh peak and the peak due to coupling of the hydrodynamic modes and the slow mode.

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