

## Shear viscosity of neutron-rich nucleonic matter near liquid-gas phase transition

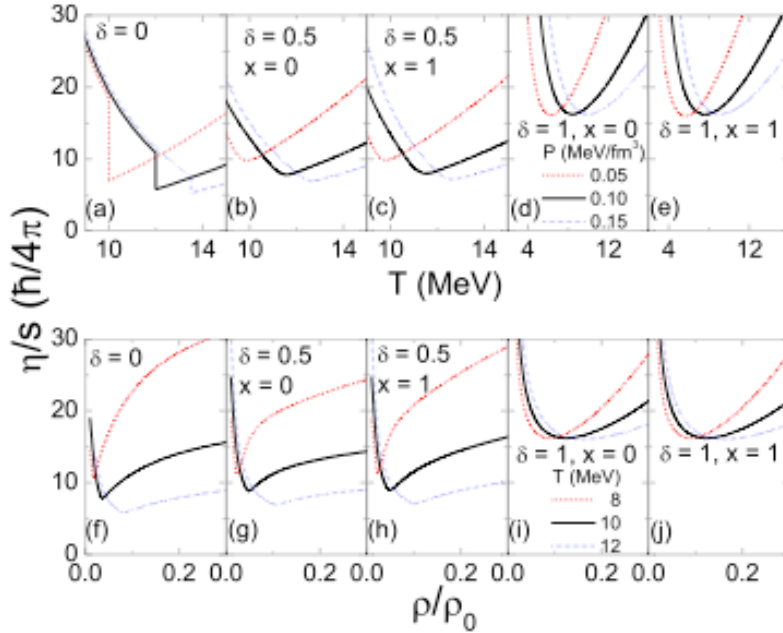
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Within a relaxation time approach using free nucleon–nucleon cross sections modified by the in-medium nucleon masses that are determined from an isospin- and momentum-dependent effective nucleon– nucleon interaction [1,2], we have investigated the specific shear viscosity ( $\eta/s$ ) of neutron-rich nucleonic matter near its liquid–gas phase transition [3]. We have found that as the nucleonic matter is heated at fixed pressure or compressed at fixed temperature, its specific shear viscosity shows a valley shape in the temperature or density dependence, with the minimum located at the boundary of the phase transition as shown in Fig. 1. Moreover, the value of  $\eta/s$  drops suddenly at the first-order liquid–gas phase transition temperature, reaching as low as 4–5 times the KSS bound [4]. However, it varies smoothly for the second-order liquid–gas phase transition. We have further found that the density dependence of the symmetry energy affects the value of the specific shear viscosity of nucleonic matter in the mixed phase region, although it has little effects on the location of its minimum. Our results are expected to be useful for investigating the nature and signatures of the liquid–gas phase transition in neutron-rich matter using intermediate-energy heavy-ion collisions induced by rare isotopes.



**FIG. 1.** Temperature (upper panels) and density (lower panels) dependence of the specific shear viscosity at different fixed pressures and temperatures, respectively, in isospin symmetric matter ( $\delta = 0$ ), neutron-rich matter ( $\delta = 0.5$ ), and pure neutron matter ( $\delta = 1$ ) for both a stiffer ( $x=0$ ) and a softer ( $x=1$ ) symmetry energy.

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