FRIB-TA Summer School: Speed of Sound

Consider the nonrelativistic speed of sound at zero temperature:

$$c_s^2 = \frac{1}{m}\,\frac{\mathrm{d}P}{\mathrm{d}\rho}\,.$$

A) When the r.h.s. above is negative, the uniform matter is said to be unstable. Why is it so?

B) Take the primitive EOS for symmetric nuclear matter,

$$\frac{E_0}{A} = -16\,\mathrm{MeV} + 16\,\mathrm{MeV}\left(\frac{\rho-\rho_0}{\rho_0}\right)^2,$$

and calculate c_s^2.

C) At what ρ/ρ_0 does the uniform matter become unstable? The answer should be close to what one finds for sophisticated EOS.

D) If the EOS above were used for high densities, at what ρ/ρ_0 would the matter become supraluminal?

E) What is the nuclear incompressibility,

$$K = 9\rho_0^2\,\frac{\mathrm{d}^2\,E_0/A}{\mathrm{d}\,\rho^2}\Big|_{\rho_0},$$

for the primitive EOS? The answer should not be overly far from what is believed to be true experimentally.