J Astrophys Aerospace Technol 2018, Volume 6
DOI: 10.4172/2329-6542-C3-024

Liquid drop model of nuclei with account of viscosity

Azamat Khokonov
Kabardino-Balkarian State University, Russia

In present the interest to nuclear matter hydrodynamics increases. Liquid drop model (LDM) successfully being used for semi-empirical formulation of surface and Coulomb terms in Bethe-Weizsacker mass formula. In this study in the frame of nuclear liquid drop model an analytical solution for the frequency of capillary oscillations is obtained with taking into account the damping due to viscosity and surrounding medium motion and polarizability. The normal coordinates for the drop capillary oscillations are coefficients a_l in expansion for drop surface radius over the Legendre polynomials

$$R(\mu) = \sum_{l=0}^{\infty} a_l P_l(\mu),$$

where $\mu=cos\theta$, θ is the polar angle shown in Fig.

The result for square of capillary oscillation frequency looking is as follows

$$\omega_l^2 = \frac{l}{a^3}\left(\frac{(l-1)(l+1)(l+2)\sigma}{\rho_1(l+1)+\rho_2 l} - \frac{3Z^2e^2}{4\pi a^3}\frac{(l+1)(l\varepsilon_1 + (l-2)\varepsilon_2)}{(\rho_1(l+1)+\rho_2 l)(l\varepsilon_1 + (l+1)\varepsilon_2)}\right) - \gamma_n^2$$

$$\gamma_n = \frac{(2l+1)\left((l-1)(l+1)\eta_1 + l(l+2)\eta_2\right)}{a^2\left((l+1)\rho_1 + l\rho_2\right)}$$

where a is nucleus radius, ρ_1, η_1 are the nuclear core matter density and viscosity, ρ_2, η_2 are the density and viscosity of surrounding area, ε_1 and ε_2 electrical permittivities of the inner and outer core medium, respectively. Comparison of octupole and quadrupole vibrations for empty exterior gives

$$\eta = \rho a^2 \sqrt{\frac{15\omega_3^2 - 4\omega_2^2 + \frac{60E_c}{7Ma^2}}{734}},$$

where $E_c = \frac{3}{5}\frac{Z^2e^2}{a}$.

The model with empty exterior has been applied for estimation of even-even spherical nuclei surface tension and viscosity. On the base of experimental data, it has been shown that energy shift of capillary oscillations of even-even spherical nuclei due to viscous dissipation gives viscosities in the interval 4.2–7.6 MeV fm−2 c−1 for nuclei from Pd–106 to Hg–198. For non-zero temperatures the ratio of shear viscosity η to entropy density s is estimated and compared with the limit $\frac{\eta}{s} > \frac{1}{4\pi}$ motivated by AdS/CFT for quark–gluon plasma.

azkh@mail.ru