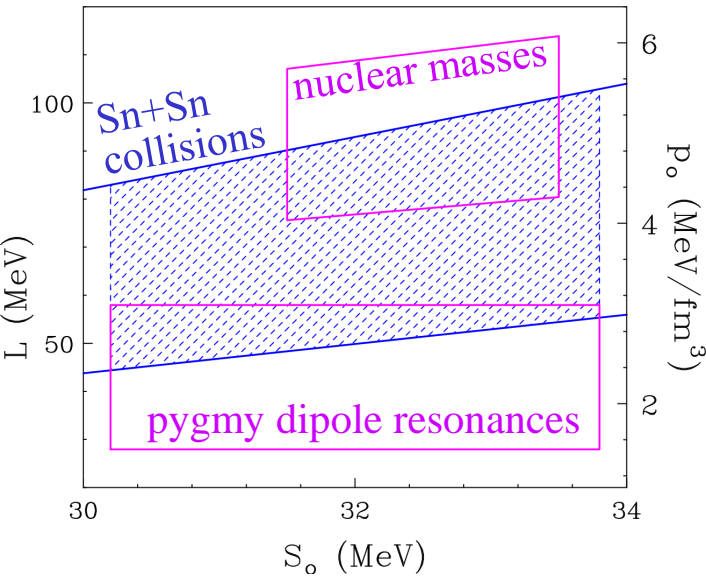
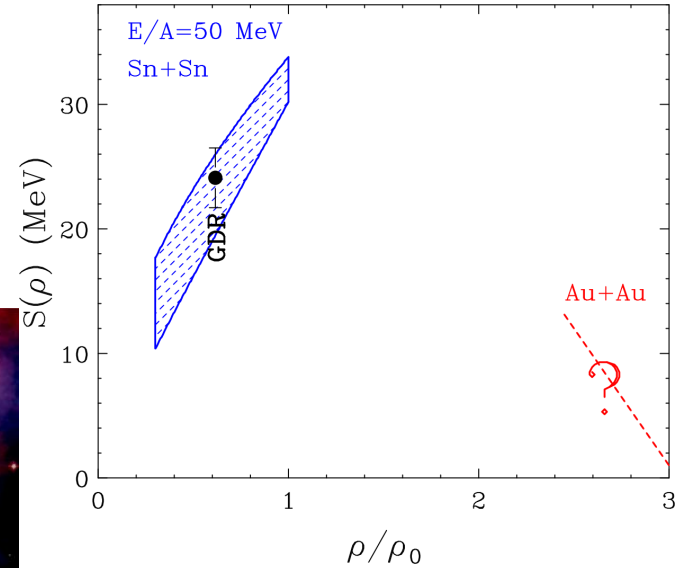
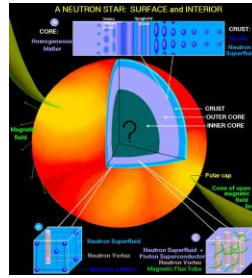


Density dependence of the symmetry energy



Nuclear Equation of State

$$E/A(\rho, \delta) = E/A(\rho, 0) + \delta^2 \cdot S(\rho)$$



$$S = S_0 + \frac{L}{3} \left(\frac{\rho_B - \rho_0}{\rho_0} \right) + \frac{K_{sym}}{18} \left(\frac{\rho_B - \rho_0}{\rho_0} \right)^2 + \dots$$

$$L = 3\rho_0 \left. \frac{\partial S}{\partial \rho_B} \right|_{\rho_B = \rho_0} = \frac{3}{\rho_0} P_0$$

Current constraints at subnormal density from heavy ion collisions, nuclear masses and nuclear collective motion in subnormal density.

Current status of the density dependence of symmetry energy

- $\rho / \rho_0 < 1$: improved constraints at NSCL, TAM, GANIL, INFN-Catania
- $\rho / \rho_0 \approx 1-2$: establish constraints at NSCL, RIKEN, FRIB
- $\rho / \rho_0 > 2$: verify and establish constraints at GSI

Require international collaborations

M.B. Tsang (曾敏兒), Yingxun Zhang (张英逊), P. Danielewicz, M. Famiano, Zhuxia Li (李祝霞), W.G. Lynch (連致標), A. W. Steiner, PRL (in press) (2009).