## [pex27] Depletion interaction potential between spherical colloids

Consider a colloidal dispersion with monodisperse, spherical colloids of radius a. If the dispersion medium also contains globules of radius  $L \ll a$ , they produce an attractive depletion interaction between the colloids. It is of osmotic origin and can be written in the form

$$\Phi_{dep}(r) = -p_{osm}V_{ex}, \quad p_{osm} = n_g k_B T,$$

where the second equation with volume density  $n_g$  of globules is van 't Hoff's approximation for the osmotic pressure. It is adequate for low globule concentration. The volume  $V_{ex}$  from which globules are excluded when the distance r between two colloids is smaller than 2(a + L) is that of the lense-shaped region shown.

(a) Use the results of [pex21] to show that

$$V_{ex} = \frac{4\pi}{3}(a+L)^3 \left[1 - \frac{3r}{4(a+L)} + \frac{r^3}{16(a+L)^3}\right].$$

(b) Plot  $\Phi_{dep}(r)/p_{osm}V_0$  versus scaled distance r/2(a+L), where  $V_0 = (4\pi/3)(a+L)^3$ .

[adapted from [Jones 2002]



Solution: