

**[mex54] Circular orbits of the Yukawa potential**

A particle of mass  $m$  moves in the Yukawa potential  $V(r) = -(k/r)e^{-r/\rho}$ . Circular orbits exist only if the angular momentum  $\ell$  does not exceed a certain value  $\ell_{max}$ . For any value  $\ell < \ell_{max}$ , there exist two circular orbits, one stable orbit at radius  $R_S(\ell)$  and one unstable orbit at radius  $R_U(\ell)$ . (a) Determine the value of  $\ell_{max}/\sqrt{mk\rho}$ . (b) Determine the value  $R_S(\ell_{max})/\rho = R_U(\ell_{max})/\rho$ . (c) Sketch the two functions  $R_S(\ell)$  and  $R_U(\ell)$  and label them clearly.

**Solution:**