for $q \neq (2n+1)\pi$, so $E < V(q)_{max}$, and there are q turnining points given by $q = 2\pi n \pm \cos^{-1}(-E)$ ($\pm$ since cosine is an even function). For $E = -1$, there is no motion since the only root for q in the equation $-1 + \cos q = 0$ is $q = 2\pi n$ and then $p = 0$. Hence all librational motion has E in the range $-1 < E < 1$ as required. No motion for $E < -1$

$p^2 = 2(1 + a\sin q)(E + \cos q)$

$p^2 = (-p)^2$, so the phase curves are symmetrical under reflection in the q axis. There will be a 'shoulder' in the phase curves near the point at which $(1 + a\sin q)$ is minimum ie when $q = (2n - \frac{1}{2})\pi$ since $\sin(2n - \frac{1}{2})\pi = -1$, the extent ~~of~~ which will depend on the value of a, increasing with increasing a, but since $0 < a < 1$, the phase curves will not touch the q axis because of this shoulder.

When $q = (2n + \frac{1}{2})\pi$, $\sin q$ is max $(=1)$ and the maximum for $|p|$ is shifted right with greater values of a, from $2n\pi$, and the maximum for p is also shifted right with increasing E. The maximum for $|p|$ is shifted right with increasing a because of the phase difference of $\pi/2$ between cos and sin. This phase difference also explains the asymmetry in the graph of p around the p axis; cos and