The pressure equation at the surface of the droplet (to first order) is [2]

$$\left.\frac{\partial \phi}{\partial t}\right|_{r=a} = U(R) + \frac{p(R)}{\rho} + F(t), \tag{6}$$

where $F(t)$ is an arbitrary function of t only and ϕ is the velocity potential [2]

$$\phi(r, \theta) = -\frac{r^l}{la^{l-1}}\omega\epsilon P_l(\cos\theta)\cos\omega t. \tag{7}$$

The pressure difference across the surface resulting from the surface tension is [2]

$$p(R) = T\left(\frac{2}{a} + \frac{\zeta(l-1)(l+2)}{a^2}\right). \tag{8}$$

The magnetogravitational potential U at the surface of the drop is (to first order)

$$U(R(\theta, t)) = U(a) - \Gamma_r(a, \theta)(R - a) \tag{9a}$$

$$= U(a) - \epsilon\Gamma_r(a, \theta)P_l(\cos\theta)\sin(\omega t), \tag{9b}$$

where $\Gamma_r(a, \theta) = -c_0'(a)$ for a spherically symmetric well (see Eqn. 4). Inserting Eqns. 9b, 8 and 7 into Eqn. 6, we obtain

$$\omega^2 = \sigma_T^2 + \sigma_0^2, \tag{10}$$

where

$$\sigma_0^2 = \frac{c_0'(a)l}{a} \tag{11}$$

is the oscillation frequency (squared) of a hypothetical drop with $T = 0$, held together by the magnetogravitational trap alone. The fact that the square of the *measured* frequency ω^2 is a simple sum of the square of the Rayleigh frequency σ_T^2 and σ_0^2 is due to the fact that l remains a good eigennumber for oscillations in a *spherically-symmetric* potential well. In Sec. V, we will consider the effect of a non-spherical magnetogravitational well. In a non-spherical well, l is not a good eigennumber in general, but for small deviations from spherical, we can use perturbation theory to obtain corrections to Eqn. 10.

We can obtain an experimental measurement of c_0' by examining the difference between the measured frequencies ω of any two of the modes $l, n \geq 2$:

$$h_l\sigma_{0,n}^2 - h_n\sigma_{0,l}^2 = h_l\omega_n^2 - h_n\omega_l^2, \tag{12}$$

where $h_l = l(l-1)(l+2)$. Dividing by $(nh_l - lh_n)/a$, we obtain an experimental measurement of $c_0'(r)$ from the oscillations of a drop that has radius $a = r$ at rest:

$$c_0'(r) = r\frac{h_l\omega_n^2 - h_n\omega_l^2}{nh_l - lh_n}. \tag{13}$$