# Shaping the chameleon

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In conversation with C. Burrage

**Contents**



## I. INTRODUCTION

$$\phi = \begin{cases} \phi_{\rm c} & 0<r<S, \\ \frac{\rho r^2}{6m} + \frac{c}{r} + d & S<r<R, \\ \frac{\alpha}{r} + \phi_\infty & R<r \end{cases} \tag{1.1a}$$

Matching value and derivative at $r = S$:

$$\phi_{\rm c} = \frac{\rho S^2}{6m} + \frac{c}{S} + d, \qquad 0 = \frac{\rho S}{3m} - \frac{c}{S^2} \tag{1.2}$$

Matching value and derivative at $r = R$:

$$\frac{\rho R^2}{6m} + \frac{c}{R} + d = \frac{\alpha}{R} + \phi_\infty, \qquad \frac{\rho R}{3m} - \frac{c}{R^2} = -\frac{\alpha}{R^2}. \tag{1.3}$$

We thus combine to obtain

$$c = \frac{\rho S^3}{3m}, \qquad \alpha = \frac{\rho}{3m}\left(S^3 - R^3\right), \qquad d = \phi_{\rm c} - \frac{\rho S^2}{2m}. \tag{1.4}$$

Now, let all quantities aquire an angular perturbation,

$$X \to X_0 + \varepsilon X_1(\theta). \tag{1.5}$$

Collecting like powers of $\varepsilon$ yields

$$\frac{\alpha_1}{\alpha_0} = \frac{\rho_1}{\rho_0} + \frac{3}{1-\left(S_0/R_0\right)^3}\left[\frac{R_1}{R_0} - \left(\frac{S_0}{R_0}\right)^2\frac{S_1}{R_0}\right]. \tag{1.6}$$

Note that $\alpha$ will be the magnitude of the radial component of the chameleon force outside the source. Note that if $S_0 \approx R_0$ then the denominator above will become very small, meaning that $\alpha_1/\alpha_0$ could become rather large.

The volume of the thin shell is

$$\mathcal{V} = \frac{4}{3}\pi\left(R^3 - S^3\right). \tag{1.7}$$

Hence,

$$\mathcal{V} = \mathcal{V}_0 + 4\pi R_0^3\left[\frac{R_1}{R_0} - \left(\frac{S_0}{R_0}\right)^2\frac{S_1}{R_0}\right] \tag{1.8}$$

`Does this make sense? volume is an integrated quantity, and here we have angular-dependent terms on the RHS`

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