I want to expand:

$$\Sigma(\vec{k}|L,\gamma,r_0,\epsilon,\phi_0) = \frac{L}{\{1+k^2\gamma^2 r_0^2[1-\epsilon\cos(2(\phi-\phi_0))]\}^{1+\nu}}. \tag{1}$$

Instead of fitting for r_0, Spergel suggests fitting for

$$\Delta = 1 - \left(\frac{r_0}{r_1}\right)^2, \tag{2}$$

where r_1 is the size of the nearest precomputed profile. Expand:

$$\begin{aligned}
\Sigma(\vec{k}) &= \frac{L}{\{1+k^2\gamma^2 r_1^2(1-\Delta)[1-\epsilon\cos(2(\phi-\phi_0))]\}^{1+\nu}} \\
&= \frac{L}{\{1+k^2\gamma^2 r_1^2 - k^2\gamma^2 r_1^2[\Delta+(1-\Delta)\epsilon\cos(2(\phi-\phi_0))]\}^{1+\nu}} \\
&= \frac{L(1+k^2\gamma^2 r_1^2)^{-1-\nu}}{\{1-\frac{k^2\gamma^2 r_1^2}{1+k^2\gamma^2 r_1^2}[\Delta+(1-\Delta)\epsilon\cos(2(\phi-\phi_0))]\}^{1+\nu}} \\
&= \frac{L}{(1+k^2\gamma^2 r_1^2)^{1+\nu}} \sum_{j=0}^{\infty} \binom{\nu+j}{j} \left(\frac{k^2\gamma^2 r_1^2}{1+k^2\gamma^2 r_1^2}\right)^j [\Delta+(1-\Delta)\epsilon\cos(2(\phi-\phi_0))]^j \\
&= \sum_{j=0}^{\infty} \frac{L(k\gamma r_1)^{2j}}{(1+k^2\gamma^2 r_1^2)^{1+\nu+j}} \binom{\nu+j}{j} [\Delta+(1-\Delta)\epsilon\cos(2(\phi-\phi_0))]^j \\
&= \sum_{j=0}^{\infty}\sum_{m=0}^{j} \frac{L(k\gamma r_1)^{2j}}{(1+k^2\gamma^2 r_1^2)^{1+\nu+j}} \binom{\nu+j}{j}\binom{j}{m} \Delta^{j-m}(1-\Delta)^m\epsilon^m\cos^m(2(\phi-\phi_0))
\end{aligned} \tag{3}$$

This is where the mistake is. We need to separate the ϕ and the ϕ_0 in order for the galaxy model parameters to separate from the $\vec{k}$ basis functions.

$$\begin{aligned}
\cos^m(x) &= \frac{1}{2^m}\left(e^{ix}+e^{-ix}\right)^m \\
&= \frac{1}{2^m}\sum_{n=0}^{m}\binom{m}{n}(e^{inx}e^{-i(m-n)x}) \\
&= \frac{1}{2^m}\sum_{n=0}^{m}\binom{m}{n}e^{i(2n-m)x}
\end{aligned} \tag{4}$$

And thus:

$$\begin{aligned}
\Sigma(\vec{k}) &= \sum_{j=0}^{\infty}\sum_{m=0}^{j}\sum_{n=0}^{m} \frac{L(k\gamma r_1)^{2j}}{2^m(1+k^2\gamma^2 r_1^2)^{1+\nu+j}} \binom{\nu+j}{j}\binom{j}{m}\binom{m}{n} \Delta^{j-m}(1-\Delta)^m\epsilon^m \exp(i2(2n-m)(\phi-\phi_0)) \\
&= \sum_{j=0}^{\infty}\sum_{m=0}^{j}\sum_{n=0}^{m} a_{jmn}\mu_{jmn}(\vec{k}),
\end{aligned} \tag{5}$$

where

$$a_{jmn}(L,\Delta,\epsilon,\phi_0) = L\Delta^{j-m}(1-\Delta)^m\epsilon^m\exp(-i2(2n-m)\phi_0) \tag{6}$$

and

$$\mu_{jmn}(\vec{k}) = \frac{(k\gamma r_1)^{2j}}{2^m(1+k^2\gamma^2 r_1^2)^{1+\nu+j}} \binom{\nu+j}{j}\binom{j}{m}\binom{m}{n} \exp(i2(2n-m)\phi). \tag{7}$$

For galsim, let $k\gamma r_1 \to k$. Note that

$$a_{jmn} + a_{jm(m-n)} = L\Delta^{j-m}(1-\Delta)^m \epsilon^m 2\cos(2(2n-m)\phi_0) \tag{8}$$

and

$$\begin{aligned}
\mu_{jmn} + \mu_{jm(m-n)} &= \frac{k^{2j}}{2^m(1+k^2)^{1+\nu+j}} \binom{\nu+j}{j}\binom{j}{m}\binom{m}{n} 2\cos(2(2n-m)\phi) \\
&= \frac{k^{2j}}{2^{m-1}(1+k^2)^{1+\nu+j}} \frac{\Gamma(\nu+j+1)}{\Gamma(\nu+1)j!} \frac{j!}{(j-m)!m!} \frac{m!}{(m-n)!n!} \cos(2(2n-m)\phi) \\
&= \frac{k^{2j}}{2^{m-1}(1+k^2)^{1+\nu+j}} \frac{\Gamma(\nu+j+1)}{\Gamma(\nu+1)} \frac{1}{(j-m)!} \frac{1}{(m-n)!n!} \cos(2(2n-m)\phi)
\end{aligned} \tag{9}$$

We can further rearrange terms such that μ only depends on the combination $2n-m$:

$$a_{jmn} + a_{jm(m-n)} = \frac{L\Delta^{j-m}(1-\Delta)^m \epsilon^m \cos(2(2n-m)\phi_0)}{2^{m-2}(j-m)!(m-n)!n!} \tag{10}$$

and

$$\mu_{jmn} + \mu_{jm(m-n)} = \frac{k^{2j}}{(1+k^2)^{1+\nu+j}} \frac{\Gamma(\nu+j+1)}{\Gamma(\nu+1)} \cos(2(2n-m)\phi) \tag{11}$$

If we let $q = 2n - m$ and restrict $q \geq 0$ (which we can do since cos is an even function), then we can rewrite Eqn. 5 as a double sum instead of a triple sum.

$$\Sigma(\vec{k}) = \sum_{j=0}^{\infty} \sum_{q=0}^{j} a_{jq} \mu_{jq}(\vec{k}). \tag{12}$$

To determine which m and n correspond to a given q, note that $m + q = 2n$ is even and that $n \leq m \Rightarrow (m+q)/2 \leq m \Rightarrow q \leq m$ sets a lower limit for m and $m \leq j$ sets the upper limit. With this in mind, we determine that :

$$a_{jq} = \sum_{\substack{m=q \\ m+q\,\text{even}}}^{j} \frac{L\Delta^{j-m}(1-\Delta)^m \epsilon^m \cos(2q\phi_0)}{2^{m-2}(j-m)!(\frac{m-q}{2})!(\frac{m+q}{2})!} \tag{13}$$

and

$$\mu_{jq} = \frac{k^{2j}}{(1+k^2)^{1+\nu+j}} \frac{\Gamma(\nu+j+1)}{\Gamma(\nu+1)} \cos(2q\phi) \tag{14}$$

TODO: a_{j0} is only half as large as above formula.