Jim,

I am looking for a solution to this equation

$$L(1/r) = \delta^{(2)}(\mathbf{r}) = \delta(x)\delta(y) \qquad \mathbf{r} = (x,y) \qquad r = \sqrt{x^2+y^2}$$

where L is some differential operator in 2 dimensions, presumably a linear differential operator.

I have thought about your suggestion that perhaps $Lf = r\,\partial_r^2(rf)$ so this would say

$$r\,\partial_r^2(r[1/r]) = \text{constant} * \delta^{(2)}(\mathbf{r}) \qquad \mathbf{r} = (x,y) \qquad r = \sqrt{x^2+y^2}$$

First of all, assuming "constant" has no dimensions, the dimensions of the equation are wrong since they say $(\text{length})^{-1} = (\text{length})^{-2}$.

Apart from that detail, I agree that for $r > 0$, the equation is true since $0 = 0$, but I am unable to see why this would be true for some arbitrary "test function" $\varphi(r)$,

$$\int_0^\infty dr\ \varphi(r)\ r\,\partial_r^2(r[1/r]) = \text{constant} * \varphi(0)$$

You mentioned doing some limiting procedure, but I don't know how to do that.

So I continue to be mystified by this little problem.

-Phil

Jim modified his suggestion on 1.11.11 to be this:

$$(1/r)\,\partial_r^2(r[1/r]) = \delta(r)$$

This has two problems. First, the dimensions are still wrong since we have $L^{-3} = L^{-1}$. I could fix that up by saying

$$\partial_r^2(r[1/r]) = \delta(r)/r$$

What happens if we integrate this from $-\varepsilon$ to ε?

$$\int_{-\varepsilon}^{\varepsilon} dr\ \partial_r^2(r[1/r]) = \int_{-\varepsilon}^{\varepsilon} dr\ \delta(r)/r$$