Why is there a π in the Green's function solution of the diffusion equation?

$$p(x,t) = \frac{c(x,t)}{N}.$$

N particles were kept at $x=0$ at $t=0$.

$$\int_{-\infty}^{\infty} p(x,t)\,dx = 1.$$

What if $p(x,t) = \frac{1}{2\sqrt{Dt}} e^{-x^2/4Dt}$? (without π!)

$$\int_{-\infty}^{\infty} \frac{1}{2\sqrt{Dt}} e^{-x^2/4Dt}\,dx = \frac{1}{2\sqrt{Dt}} \int_{-\infty}^{\infty} e^{-\frac{x^2}{4Dt}}\,dx = \frac{1}{2\sqrt{Dt}} \cdot \frac{\sqrt{\pi}}{(2\sqrt{Dt})^{-1}}$$

$$= \sqrt{\pi}.$$

So, there must be π.

Note: $\int_{-\infty}^{\infty} e^{-\alpha x^2}\,dx = \sqrt{\frac{\pi}{\alpha}}$

How?
consider $\left(\int_{-\infty}^{\infty} e^{-\alpha x^2}\,dx\right)\left(\int_{-\infty}^{\infty} e^{-\alpha y^2}\,dy\right) = \int_{-\infty}^{\infty} e^{-\alpha(x^2+y^2)}\,dx\,dy$

$$= \int_0^{2\pi}\int_0^{\infty} e^{-\alpha r^2}\, r\,dr\,d\theta = \left(\int_0^{2\pi} d\theta\right)\left(\int_0^{\infty} e^{-\alpha r^2}\, r\,dr\right)$$

& $\int_0^{\infty} e^{-u}\frac{du}{(-2\alpha)} = \frac{-1}{2\alpha} e^{-u}\Big|_0^{\infty}$ | Let $u = -\alpha r^2$. $du = -2\alpha r\,dr \Rightarrow r\,dr = \frac{du}{-2\alpha}$

$$= \frac{1}{2\alpha}$$

$$\therefore \int_{-\infty}^{\infty} e^{-\alpha x^2}\,dx = \sqrt{\frac{2\pi}{2\alpha}} = \sqrt{\frac{\pi}{\alpha}}$$