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$$\int_0^{\frac{\pi}{4}} \int_1^2 r e^{-r^2} dr d\theta = \int_0^{\frac{\pi}{4}} \left[-\frac{1}{2} e^{-r^2} \right]_1^2 d\theta$$
$$= \int_0^{\frac{\pi}{4}} \left(-\frac{1}{2} e^{-2} + \frac{1}{2} e^{-1} \right) d\theta$$
$$= \frac{\pi}{4} \cdot \frac{1}{2} \left(\frac{1}{e} - \frac{1}{e^2} \right) = \frac{\pi}{8} \left(\frac{1}{e} - \frac{1}{e^2} \right)$$

$$\int_{r_1}^{r_2} \int_{\theta_1}^{\theta_2} f(r \cos \theta, r \sin \theta) \cdot r d\theta dr$$

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