

$$\begin{aligned}
V_k(\mathbf{v}) = & \frac{1}{(2\pi)^{(k+1)/2}} \frac{\omega_2}{\omega_{2-k}\omega_k} \left( \frac{\sigma_1}{\sqrt{2}\sigma_0} \right)^k e^{-\mathbf{v}^2/2} \{H_{k-1}(\mathbf{v}) \\
& + \left[ \frac{1}{6} S^{(0)} H_{k+2}(\mathbf{v}) + \frac{k}{3} S^{(1)} H_k(\mathbf{v}) + \frac{k(k-1)}{6} S^{(2)} H_{k-2}(\mathbf{v}) \right] \sigma_0 + o(\sigma_0^2) \}
\end{aligned}$$