Central limit theorem of random quadratics forms involving random matrices

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Let random variables $\{v_{ij}, i, j = 1, 2, \cdots, \}$ be i.i.d.with $Ev_{11}^4 < \infty$ and define $s_i = \frac{1}{\sqrt{N}}(v_{i,1}, \cdots, v_{i,N})^T$ and $S = (s_1, s_2, \cdots, s_K)$. The central limit theorem of the random quadratic forms $s_1^T(SS^T)^i s_1$ is established, which comes from the application to wireless communication. In addition, a multidimensional central limit theorem of its is established as well.