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**Locally Supported Eigenvectors of Graph-Laplacian  
Matrices**

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Certain types of simple configurations in the periphery of an undirected and unweighted graph yield graph Laplacian matrices (GLs) with some eigenvectors that are locally-supported, or nonzero only on the vertices within the individual configurations. For certain classes of scale-free graphs, such configurations are highly likely and we use locally-supported eigenvectors to solve eigenproblems associated with GLs with improved efficiency. We demonstrate that the configurations are locally detectable and that the associated locally supported eigenvectors are locally computable. Additionally, we show that an aggregation-based coarsening process yields a smaller graph whose GL represents all other eigenpairs of the original GL. We provide an approximation result that shows this representation is exact. In other words, the detection of such configurations provides a first coarsening that introduces no spectral approximation error. We discuss the scope for application of these results and demonstrate their use on some examples.