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Eigenvalues of 2-edge-coverings

A 2-edge-covering between G and H is an onto homomorphism from the vertices of G to the vertices of H so that each edge is covered twice and edges in H can be lifted back to edges in G. In this note we show how to compute the spectrum of G by computing the spectrum of two smaller graphs, namely a (modified) form of the covered graph H and another graph which we term the anti-cover. This is done for both the adjacency matrix and the normalized Laplacian. We also give an example of two anti-cover graphs which have the same normalized Laplacian, and state a generalization for directed graphs.