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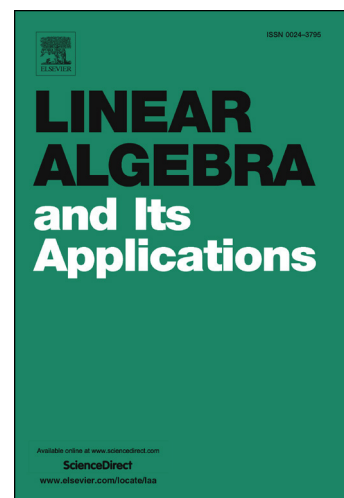
PII: S0024-3795(17)30011-3  
DOI: <http://dx.doi.org/10.1016/j.laa.2016.12.041>  
Reference: LAA 13999

To appear in: *Linear Algebra and its Applications*

Received date: 12 July 2016  
Accepted date: 30 December 2016

Please cite this article in press as: J.-M. Guo et al., Maximizing the least signless Laplacian eigenvalue of unicyclic graphs, *Linear Algebra Appl.* (2017), <http://dx.doi.org/10.1016/j.laa.2016.12.041>

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# Maximizing the least signless Laplacian eigenvalue of unicyclic graphs\*

Ji-Ming Guo<sup>†</sup>, Ji-Yun Ren, Jin-Song Shi

College of Science, East China University of Science and Technology,  
Shanghai, 200237, China

**Abstract** In this paper, a graph with the maximum least signless Laplacian eigenvalue among all connected unicyclic graphs with fixed order is determined.

**AMS** classification: 05C50.

**Keywords:** Signless Laplacian matrix; signless Laplacian characteristic polynomial; the least signless Laplacian eigenvalue; eigenvector

## 1 Introduction

Let  $G = (V, E)$  be a simple connected graph with vertex set  $V = \{v_1, v_2, \dots, v_n\}$  and edge set  $E$ . Its adjacency matrix  $A(G) = (a_{ij})$  is defined as  $n \times n$  matrix  $(a_{ij})$ , where  $a_{ij} = 1$  if  $v_i$  is adjacent to  $v_j$ ; and  $a_{ij} = 0$ , otherwise. Denote by  $d(v_i)$  or  $d_G(v_i)$  the degree of the vertex  $v_i$ . The matrices  $L(G) = D(G) - A(G)$  and  $Q(G) = D(G) + A(G)$  are called the Laplacian matrix and the signless Laplacian matrix of graph  $G$ , respectively, where  $D(G) = \text{diag}(d(v_1), d(v_2), \dots, d(v_n))$  denotes the diagonal matrix of vertex degrees of  $G$ . It is easy to see that  $L(G)$  is a positive semidefinite symmetric matrix with the smallest eigenvalue 0 and the corresponding eigenvector is the column vector of all ones. Fiedler [10] showed that the second smallest eigenvalue of  $L(G)$  is 0 if and only if  $G$  is disconnected. Thus the second smallest eigenvalue of  $L(G)$  is popularly known as the *algebraic connectivity* of  $G$ .

It is well known that  $A(G)$  is a real symmetric matrix and  $Q(G)$  is a positive semidefinite symmetric matrix. The eigenvalues of  $Q(G)$  can be ordered as

$$q_1(G) \geq q_2(G) \geq \dots \geq q_n(G) \geq 0,$$

respectively. The smallest eigenvalue  $q_n(G)$  of  $Q(G)$  is called the least signless Laplacian eigenvalue of the graph  $G$ , denoted by  $q(G)$ . It is a well known fact that for a connected graph  $G$ ,  $q(G) = 0$  if and only if  $G$  is bipartite [3]. A pendant vertex is a vertex with degree one. If  $v$  is a pendant vertex and  $v$  is adjacent to  $u$ , then  $v$  is called the pendant vertex of  $u$ .

\*This research is supported by NSFC (No. 11371372)

<sup>†</sup>Corresponding author; E-mail address: jimingguo@hotmail.com (J.-M. Guo), 1653833119@qq.com (J.-Y. Ren), pineshi@163.com (J.-S. Shi)

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