Angle measures for an MPT characterisation of a computed irregular polyhedron

22nd March 2024

We consider an irregular polyhedron $B = B_1 \cup B_2$ with B_1 being an irregular tetrahedron with vertices

$$\boldsymbol{v}_1 = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, \boldsymbol{v}_2 = \begin{bmatrix} 7 \\ 0 \\ 0 \end{bmatrix}, \boldsymbol{v}_3 = \begin{bmatrix} 5.5 \\ 4.6 \\ 0 \end{bmatrix}, \boldsymbol{v}_4 = \begin{bmatrix} 3.3 \\ 2 \\ 5 \end{bmatrix}, \tag{1}$$

and B_2 the irregular tetrahedron with vertices

$$\boldsymbol{v}_1 = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, \boldsymbol{v}_2 = \begin{bmatrix} 7 \\ 0 \\ 0 \end{bmatrix}, \boldsymbol{v}_3 = \begin{bmatrix} 5.5 \\ -3.0 \\ 0 \end{bmatrix}, \boldsymbol{v}_4 = \begin{bmatrix} 3.3 \\ 2 \\ 5 \end{bmatrix} \tag{2}$$

with $B_1 \cap B_2 \neq \varnothing$ and $|B_1| > |B_2|$. The object is chosen to have $\alpha = 0.001$m and homogeneous materials $\mu_r = 32$ and $\sigma_* = 1 \times 10^7$ S/m.To discretise the object, $L = 3$ layers of prismatic elements following the "geometric increasing" strategy are included resulting in a mesh consisting of 18 413 unstructured tetrahedra and 6461 prisms.

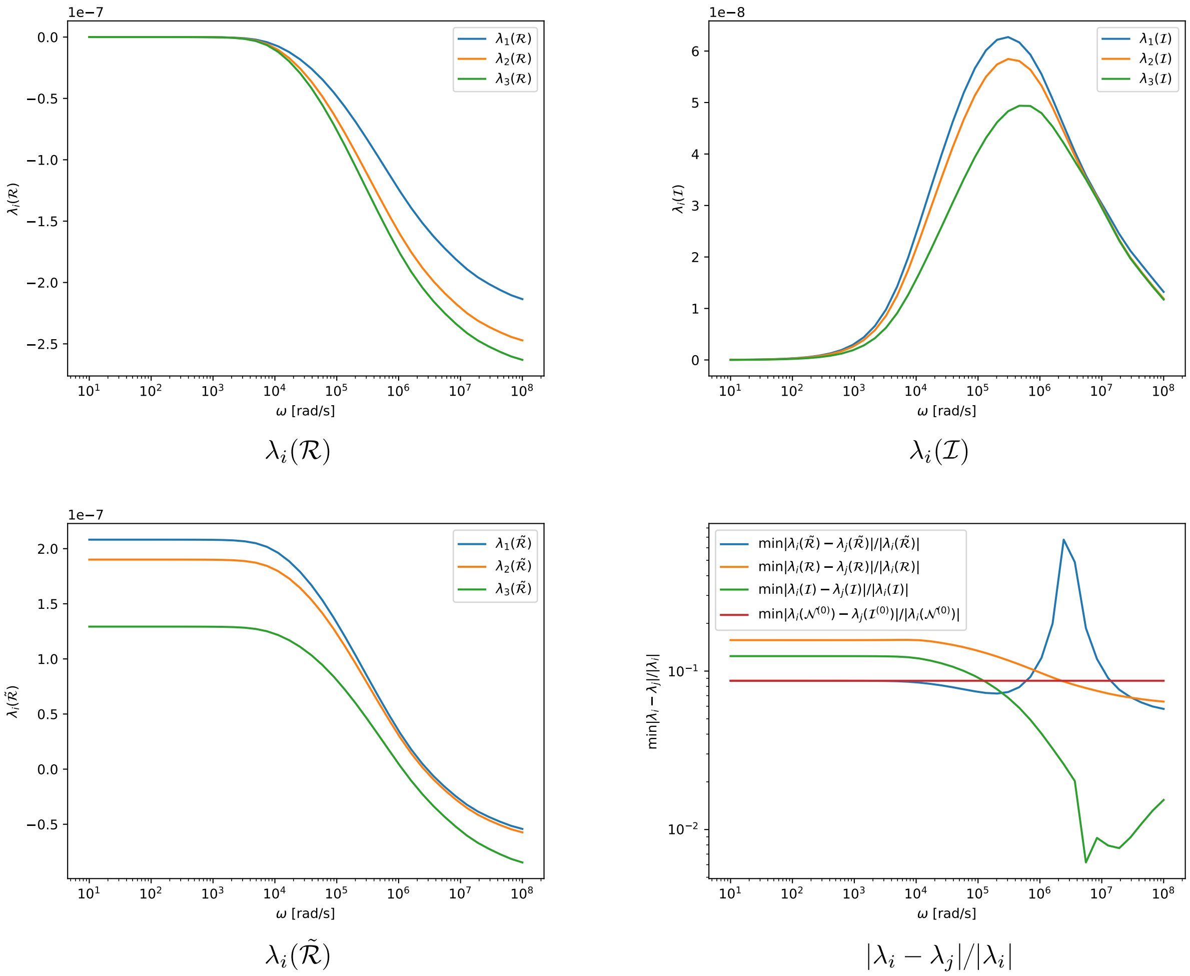

Figure 1: Computed eigenvalue spectral signatures and eigenvalue proximity an irregular polyhedron.

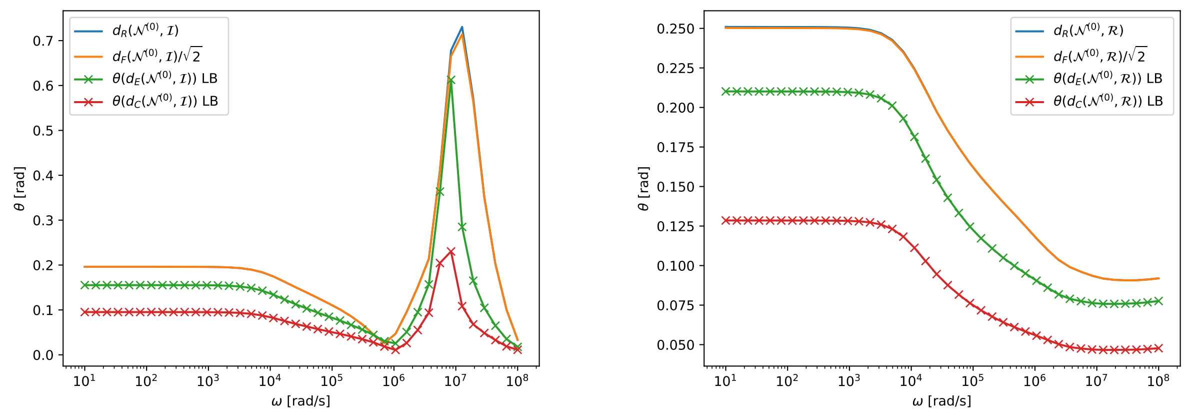

Figure 2: Irregular polyhedron. Left: Angle measures $d_R(\mathcal{N}^{(0)},\mathcal{I})$ and $d_F(\mathcal{N}^{(0)},\mathcal{I})/\sqrt{2}$ using the eigenvectors and $\theta(d_E(\mathcal{N}^{(0)},\mathcal{I})$ and $\theta(d_C(\mathcal{N}^{(0)},\mathcal{I})$ without using the eigenvectors Right: Angle measures $d_R(\mathcal{N}^{(0)},\mathcal{R})$ and $d_F(\mathcal{N}^{(0)},\mathcal{R})/\sqrt{2}$ using the eigenvectors and $\theta(d_E(\mathcal{N}^{(0)},\mathcal{R})$ and $\theta(d_C(\mathcal{N}^{(0)},\mathcal{R})$ without using the eigenvectors

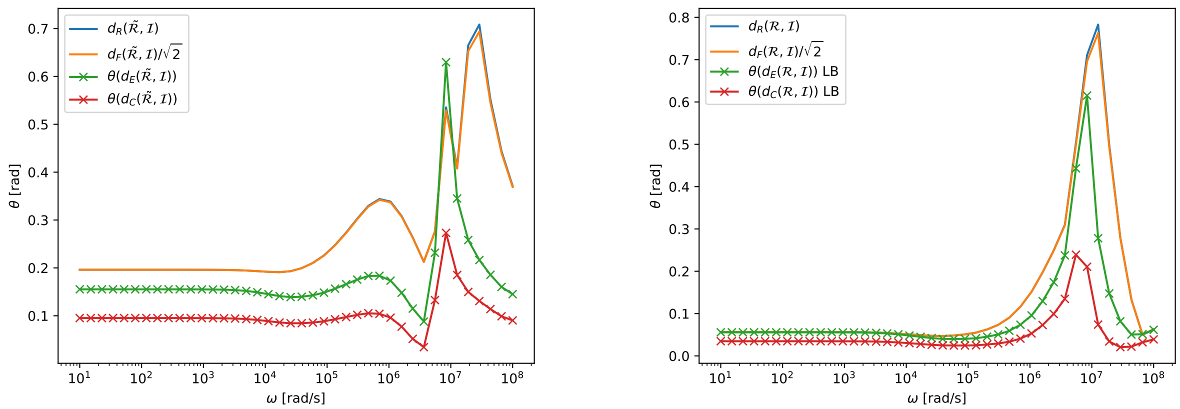

Figure 3: Irregular polyhedron. Left:Angle measures $d_R(\tilde{\mathcal{R}}, \mathcal{I})$ and $d_F(\tilde{\mathcal{R}}, \mathcal{I})/\sqrt{2}$ using the eigenvectors and $\theta(d_E(\tilde{\mathcal{R}}, \mathcal{I})$ and $\theta(d_C(\tilde{\mathcal{R}}, \mathcal{I})$ without using the eigenvectors. Right:$d_R(\mathcal{R}, \mathcal{I})$ and $d_F(\mathcal{R}, \mathcal{I})/\sqrt{2}$ using the eigenvectors and $\theta(d_E(\mathcal{R}, \mathcal{I})$ and $\theta(d_C(\mathcal{R}, \mathcal{I})$ without using the eigenvectors