

Localisation and radiation in thin complex plates

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Localization

The landscape of localisation constrains the vibrational modes by

$$\frac{|\phi_m|}{\|\phi_m\|_{L^2(\Omega)}} \leq \omega_m^2 u \quad \text{in } \Omega \quad (1)$$

where u is the landscape function. The landscape is summarized in Dirichlet problem

$$\begin{aligned} \mathcal{L}u &= 1 & \text{in } \Omega \\ u &= 0 & \text{on } \partial\Omega. \end{aligned} \quad (2)$$

Radiation

The acoustical power is defined as

$$\mathcal{P}(\omega) = \frac{1}{2} \{\hat{v}_n\}^H [\Psi^H] [\mathbf{R}] [\Psi] \{\hat{v}_n\} \quad (3)$$

where $[\mathbf{R}]$ is the radiation resistance matrix. The spatial average mean squared velocity

$$\bar{v}^2 = \sum_m^{\infty} \frac{F^2}{2M^2} \frac{\omega^2}{(\omega_m^2 - \omega^2)^2 + \eta^2 \omega_m^4} \quad (4)$$

and the average radiation efficiency

$$\bar{\sigma} = \frac{\sum_{m=1}^{\infty} \sigma_m \left[(\omega_m^2 - \omega^2)^2 + \eta^2 \omega_m^4 \right]^{-1}}{\sum_{m=1}^{\infty} \left[(\omega_m^2 - \omega^2)^2 + \eta^2 \omega_m^4 \right]^{-1}} \quad (5)$$

where σ_m is the modal radiation efficiency and ω_m the resonant frequency.

Landscape of localisation and modes

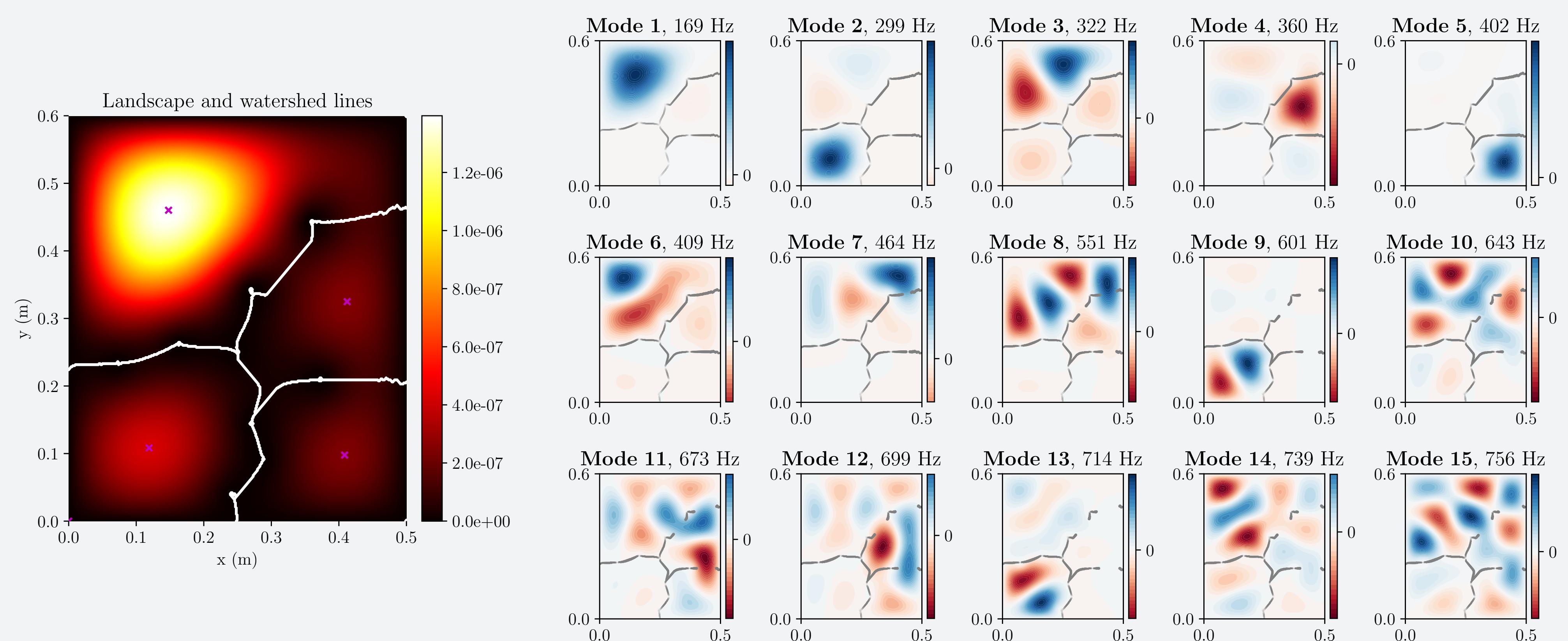


Figure 1. Simply supported homogeneous plate with fixed points inside the domain to induce localisation.

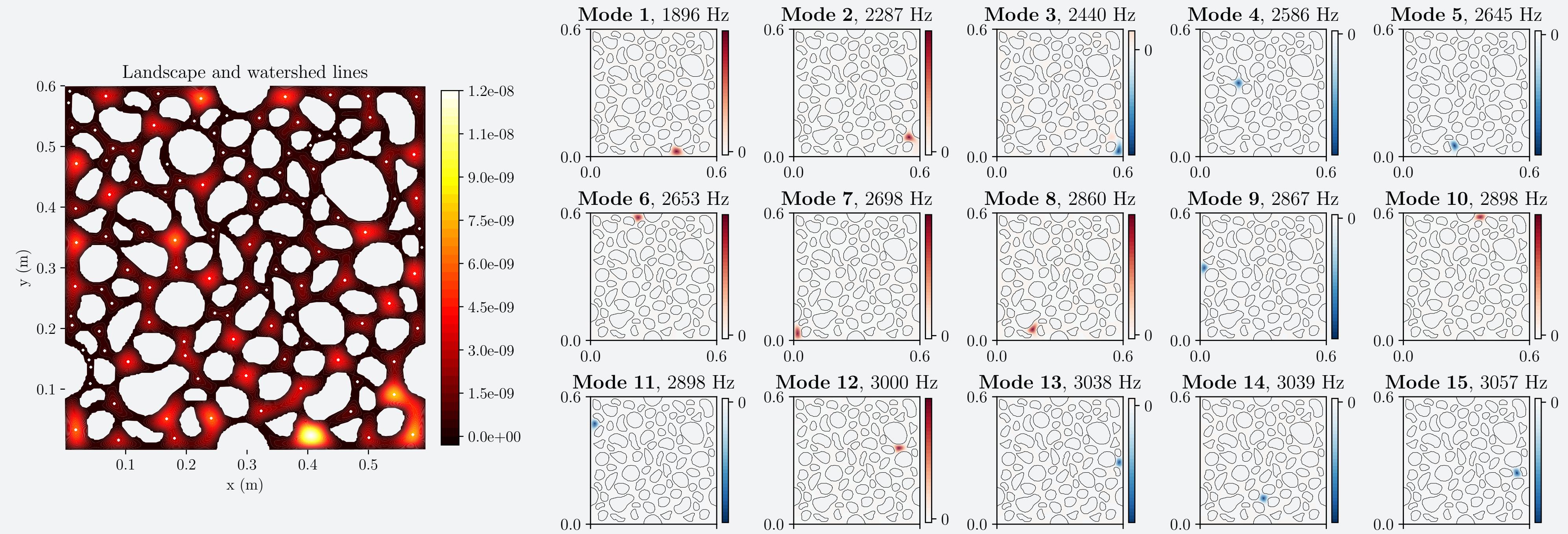


Figure 2. Simply supported plate with irregular perforations inside the domain.

Global indicators

When a **small amount** of l-modes are present, we might use standard global indicators. For a baffled plate in Fig. (1).

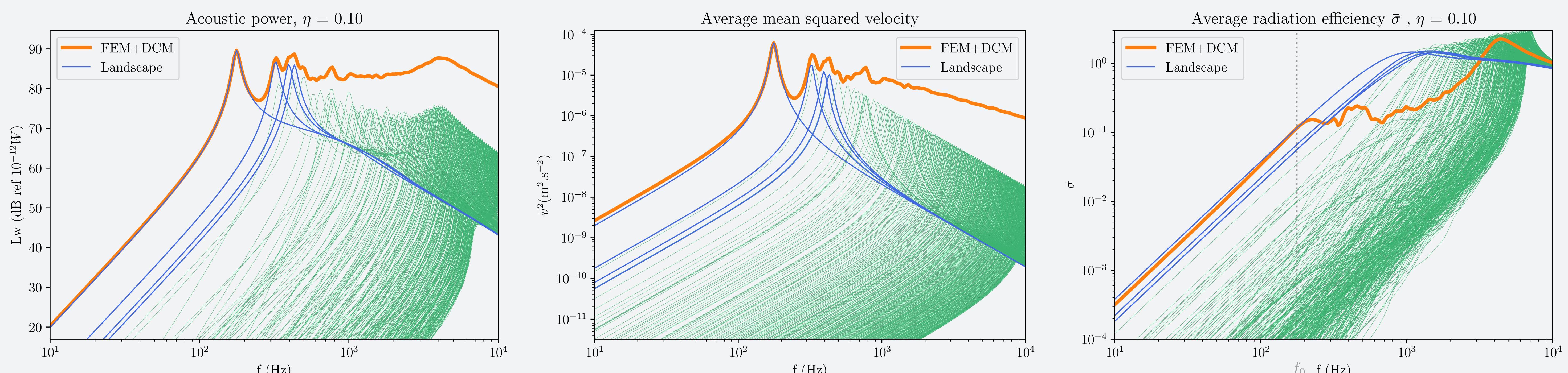
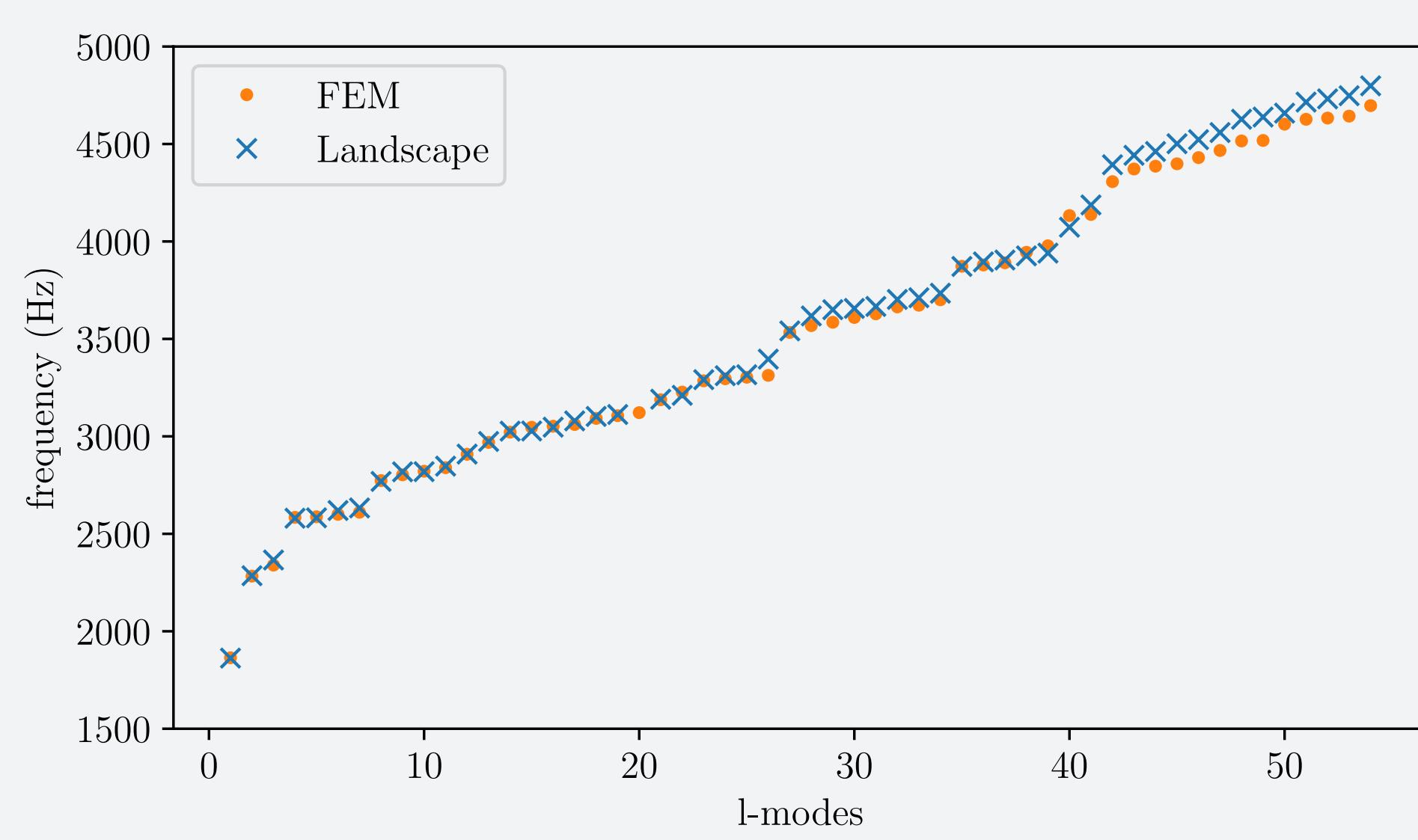


Figure 3. By taking all possible punctual excitations, the radiation indicators are expressed as an independent contribution of each mode (in green).

Frequency estimation

For a **large amount** of l-modes, we can still easily estimate the frequency of the localized modes. For a baffled plate in Fig. (2).



| | Mode number | | | | |
|-----------------------|-------------|---------|---------|---------|---------|
| | 1 | 2 | 3 | 30 | 50 |
| FEM (Hz) | 1864.19 | 2282.99 | 2339.51 | 3609.94 | 4601.69 |
| Landscape (Hz) | 1862.33 | 2285.07 | 2365.65 | 3656.33 | 4658.29 |
| diff % | -0.09 | 0.09 | 1.10 | 1.26 | 1.21 |

Table 1. Estimation of the fist l-modes with just one calculation.

