

Localisation and radiation in thin complex plates

Carlos García A., Nicolas Dauchez and Gautier Lefebvre

Université de technologie de Compiègne, Laboratoire Roberval (Mechanics, energy and electricity), Centre de recherche Royallieu
CS 60319 - 60203 Compiègne cedex, France

Introduction

The landscape of localisation allows us to predict the vibration properties of localized modes. What could we say about the radiation?

Landscape of localisation

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 of localisation 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

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

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

The landscape controls the localisation zones

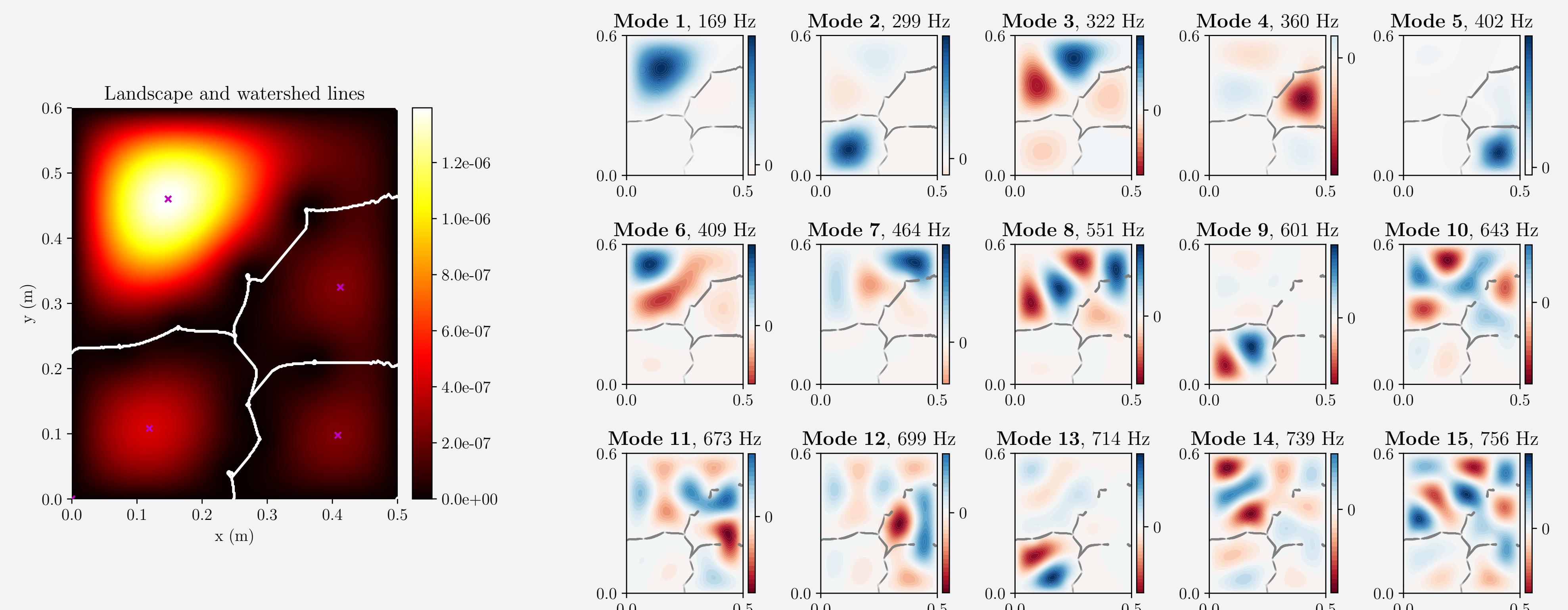


Figure 1. Simply supported homogeneous plate with fixed points inside the domain to induce localisation.

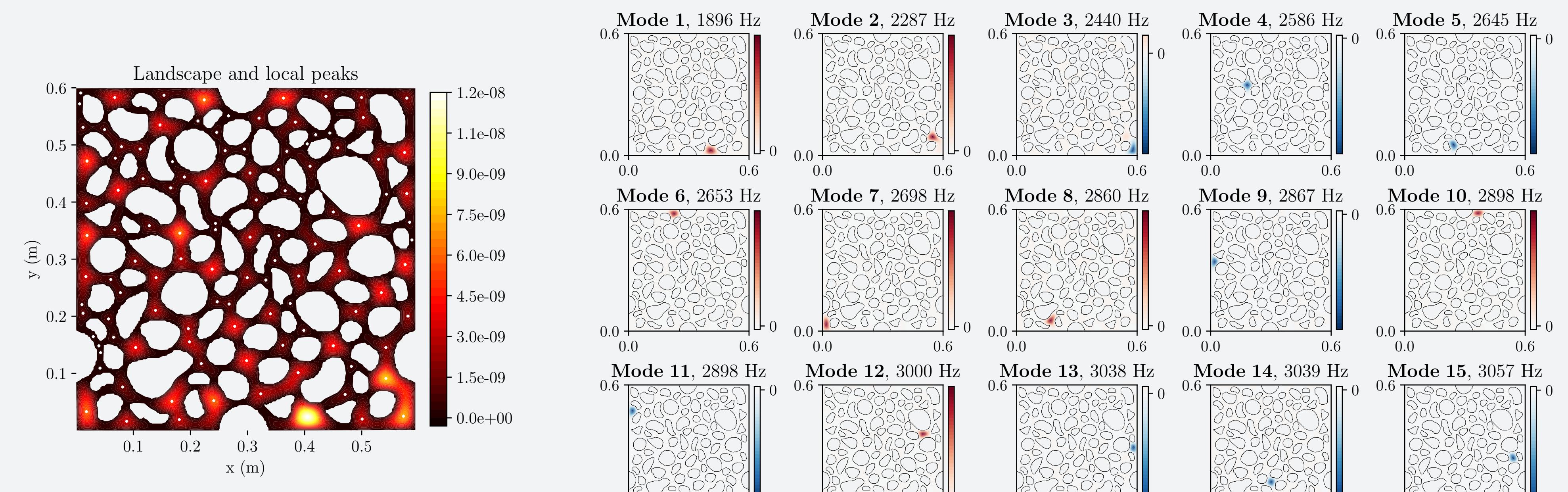
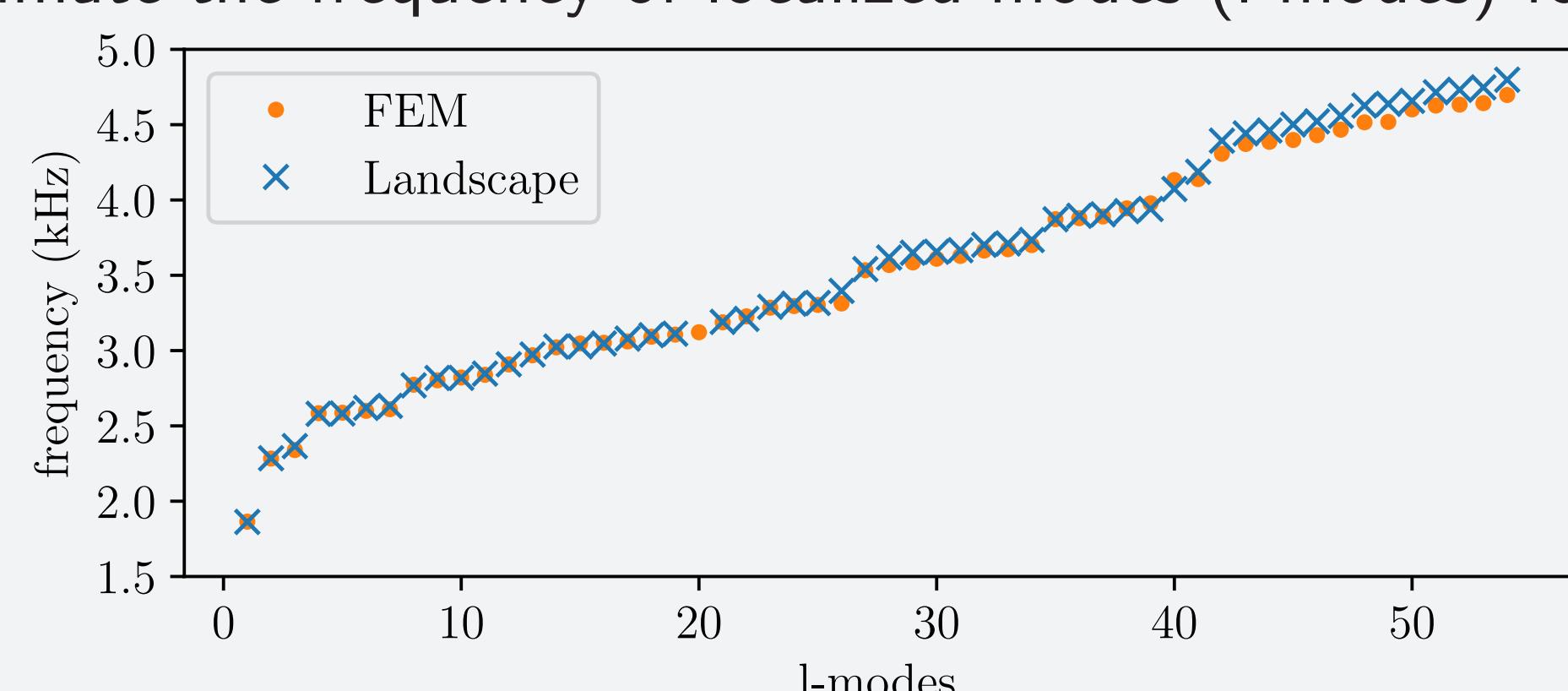


Figure 2. Irregular plate simply supported on inside and outside boundaries.

Frequency estimation

We can estimate the frequency of localized modes (l-modes) for complex structures. For the plate in Fig. (2).



	Mode #				
	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 first l-modes with just one calculation.

Global indicators

Based on the estimated frequency, it is possible to deduce the radiation of l-modes. For the plate in Fig. (1) on a infinite baffle.

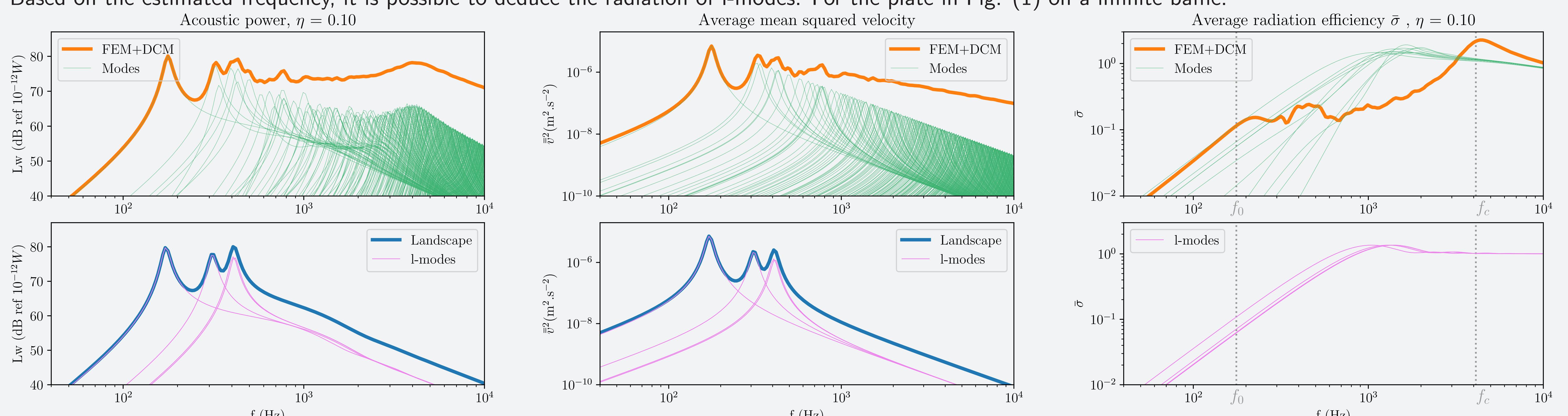


Figure 3. By taking all possible punctual excitations, the radiation indicators are expressed as an independent contribution of each mode.

Conclusion

The main features of the radiation of localizing structures can be recovered by means of the landscape of localisation.

Scan some references here →

