

**IMSE Online 2022:
16th International Conference on
Integral Methods in Science and Engineering**

*Abstracts of the Minisymposium 'Asymptotic Analysis:
Homogenization and Thin structures'*

Schedule

July 13th Local time (+3:00 Romania / +2:00 Austria; Italy; Spain / +1:00 UK)

13:00 E. Zappale

13:30 D. Gómez

14:00 L. Balilescu

14:30 L. D'Elia

15:00 R. Orive-Illera

15:30 M.E.Pérez-Martínez

Title: Periodic homogenization in the context of structured deformations

Authors: Elvira Zappale (elvira.zappale@uniroma1.it), Micol Amar, José Matias, Marco Morandotti

Affiliation(s): Sapienza University of Rome, Rome, Italy

Abstract: An energy for first-order structured deformations in the context of periodic homogenization is provided. Its definition relies on the relaxation of an initial energy of integral type featuring contributions of bulk and interfacial terms. An integral representation, in terms of relaxed bulk and interfacial energy densities, is obtained. Mixing blow-up techniques, averaging processes,

proper of the theory of homogenization, and comparison arguments of Gamma convergence, the energy densities are obtained via asymptotic cell formulae.

Title: Local effects and low frequencies in a banded domain

Authors: Delfina Gómez (gomezdel@unican.es)

Affiliation(s): Departamento de Matemáticas, Estadística y Computación, Universidad de Cantabria, Santander, Cantabria, Spain

Abstract: We consider a Dirichlet spectral problem for a second order differential operator, with piecewise constants coefficients which depend on a small parameter ϵ , posed in a planar banded domain. We address the asymptotic behavior, as ϵ tends to zero, for the eigenvalues and the corresponding eigenfunctions. In particular, under certain assumptions and once we have rescaled the eigenvalues, we provide the convergence of the low frequencies with conservation of the multiplicity. We also show new localization effects for the corresponding eigenfunctions.

Some references:

- [1] D. Gómez, M. Lobo, S.A. Nazarov, M.-E. Pérez-Martínez, Spectral stiff problems in domains surrounded by thin bands: asymptotic and uniform estimates for eigenvalues, *J. Math. Pures Appl.* 85 (2006) 598–632.
- [2] D. Gómez, M. Lobo, S.A. Nazarov, M.-E. Pérez-Martínez, Spectral stiff problems in domains surrounded by thin stiff and heavy bands: local effects for eigenfunctions, *Netw. Heterog. Media* 6 (2011) 1–35.
- [3] D. Gómez, M. Lobo, S.A. Nazarov, M.-E. Pérez-Martínez, A Dirichlet spectral problem in domains surrounded by thin stiff and heavy bands. In: *Computational and analytic methods in science and engineering*, Birkhäuser/Springer (2020) 101–126.
- [4] D. Gómez, M. Lobo, S.A. Nazarov, M.-E. Pérez-Martínez, Localization effects for Dirichlet problems in domains surrounded by thin stiff and heavy bands, *J. Differential Equations* 270 (2021), 1160–1195.

Title: Bloch waves spectral analysis and Burnett coefficients

Authors: Loredana Balilescu (smaranda@dim.uchile.cl)

Affiliation(s): University of Pitesti, Pitesti, Arges, Romania

Abstract: In this talk, we use Bloch decomposition to introduce a macroscopic quantity, namely the dispersion tensor or the Burnett coefficients in the class of periodic media, as well as in the generalized Hashin–Shtrikman microstructures and we study the dependence of the fourth-order tensor in terms of the microstructure. We first review the results in periodic media, where we deal with the one-dimensional case and also some structures in

higher dimension. Then, in the case of two-phase materials associated with the periodic Hashin–Shtrikman structures, we settle the issue that the dispersion tensor has a unique minimizer, which is the so called Apollonian-Hashin-Shtrikman microstructure.

Title: Gaps in the spectrum of two-dimensional square packing of stiff disks

Authors: Lorenza D'Elia (lorenza.delia@tuwien.ac.at)

Affiliation(s): Vienna University of Technology, Vienna, Austria

Abstract: Using an asymptotic approach, we discuss the opening of gaps in the spectrum of a stiff problem for the Laplace operator in the plane perforated by contiguous circular holes. Due to the geometry setting, the leading terms of the expansions of eigenvalues and eigenfunctions are given by Bessel functions of the first kind and their zeros.

References:

L. D'Elia & S. A. Nazarov: "Gaps in the spectrum of two-dimensional square packing of stiff disks", *Appl. Anal.* (2022), 1-17.

Title: Spectral gaps in a double-periodic perforated waveguide

Authors: Rafael Orive Illera (rafael.orive@icmat.es)

Affiliation(s): Universidad Aut´onoma de Madrid, Madrid, Spain

Abstract: We examine the band-gap structure of the spectrum of the Neumann and Dirichlet problems for the Laplace operator in a strip with periodic dense transversal perforation by identical holes of a small diameter.

Title: Boundary homogenization problems for the elasticity system with high contrasts

Authors: Maria Eugenia Pérez-Martínez (meperez@unican.es)

Affiliation(s): Universidad de Cantabria, Santander, Cantabria , Spain

Abstract: We consider a homogenization problem for the elasticity operator posed in a bounded domain of the upper half-space, a part of its boundary being in contact with a plane. We assume that this surface is free outside small regions in which we impose Robin-Winkler boundary conditions linking stresses and displacements and containing a large reaction parameter. These small regions are periodically placed along the plane while its size is much smaller than the period. We provide a map of the possible homogenized

problems depending on certain asymptotic relations between the period, the size of the regions and the reaction parameter. We show the convergence of solutions for different critical sizes of the reaction regions. We also consider associated spectral problems.

Some references

[1] D. Gómez, S.A. Nazarov ; M.-E. Pérez-Martínez. Asymptotics for spectral problems with rapidly alternating boundary conditions on a strainer Winkler foundation. *Journal of Elasticity*, 2020, V. 142, p. 89-120.

[2] D. Gómez, S.A. Nazarov ; M.-E. Pérez-Martínez. Spectral homogenization problems in linear elasticity with large reaction terms concentrated in small regions of the boundary. In: *Computational and Analytic Methods in Science and Engineering*. Birkhäuser, Springer, N.Y., 2020, pp. 121-143

[3] D. Gómez, S.A. Nazarov ; M.-E. Pérez-Martínez. Boundary homogenization with large reaction terms on a strainer-type wall. Submitted.

[4] M.-E. Pérez-Martínez. Homogenization for alternating boundary conditions with large reaction terms concentrated in small regions. In: *Emerging problems in the homogenization of Partial Differential Equations*. ICIAM2019 SEMA SIMAI Springer Series 10, 2021, p.37-57.

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