Universidad de Concepción
Facultad de Ciencias Físicas y Matemáticas
Departamento de Matemática

COLOQUIOS DE MATEMÁTICA

"An eigenvalue optimization problem"

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Resumen: The following questions arise quite naturally from what we see around us. Why are soap bubbles that float in air approximately spherical? Why does a herd of reindeer form a round shape when attacked by wolves? Of all geometric objects having a certain property, which ones have the greatest area or volume; and of all objects having a certain property, which ones have the least perimeter or surface area? These problems have been stimulating much mathematical thought. Mathematicians have been trying to answer such questions and this has led to a branch of mathematical analysis known as "shape optimization problems". A typical shape optimization problem is, as the name suggests, to find a shape which is optimal in the sense that it minimizes a certain cost functional while satisfying given constraints. Isoperimetric problems form a special class of shape optimization problems. A typical isoperimetric problem is to enclose a given area with a shortest possible curve. In many cases, the functional being minimized depends on the solution of a given partial differential equation defined on the variable domain.
We currently deal with the following shape optimization problem where the cost functional is an eigenvalue: Given a bounded open disk B in a plane, how to place an obstacle P of fixed shape and size within B so as to maximize or minimize the fundamental eigenvalue λ_1 of the Dirichlet Laplacian on $B \setminus P$. This means that we want to find extremal of the function $\rho \to \lambda_1(B \setminus \rho(P))$, where ρ runs over the set of rigid motions such that $\rho(P) \subset B$. We study this problem in the case where P is invariant under the action of a dihedral group D_n, and where the distance from the centre of the obstacle P to the boundary is monotonous as a function of the argument between two axes of symmetry. The extremal configurations correspond to the cases where the axes of symmetry of P coincide with a diameter of B. The maximizing and the minimizing configurations are identified for n even.

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