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Nota di contenuto	Cover; Title Page; Copyright Page; Table of Contents; Preface; Resume of the main results; Chapter 1 Introduction and Examples; 1.1. Shape optimization problems; 1.2. Why quasi-open sets?; 1.3. Compactness and monotonicity assumptions in the shape optimization; 1.4. Lipschitz regularity of the state functions; Chapter 2 Shape optimization problems in a box; 2.1. Sobolev spaces on metric measure spaces; 2.2. The strong- and weak- convergence of energy domains; 2.2.1. The weak- convergence of energy sets; 2.2.2. The strong- convergence of energy sets 2.2.3. From the weak- to the strong- convergence 2.2.4. Functionals on the class of energy sets; 2.3. Capacity, quasi-open sets and quasi-continuous functions; 2.3.1. Quasi-open sets and energy sets from a shape optimization point of view; 2.4. Existence of optimal sets in a box; 2.4.1. The Buttazzo-Dal Maso Theorem; 2.4.2. Optimal partition problems; 2.4.3. Spectral drop in an isolated box; 2.4.4. Optimal periodic sets in the Euclidean space; 2.4.5. Shape optimization problems on compact manifolds; 2.4.6. Shape optimization problems in Gaussian spaces 2.4.7. Shape optimization in Carnot-Caratheodory space 2.4.8. Shape optimization in measure metric spaces; Chapter 3 Capacitary measures;

3.1. Sobolev spaces in  $\mathbb{R}^d$ ; 3.1.1. Concentration-compactness principle; 3.1.2. Capacity, quasi-open sets and quasi-continuous functions; 3.2. Capacitary measures and the spaces  $H^1$ ; 3.3. Torsional rigidity and torsion function; 3.4. PDEs involving capacitary measures; 3.4.1. Almost subharmonic functions; 3.4.2. Pointwise definition, semi-continuity and vanishing at infinity for solutions of elliptic PDEs  
Chapter 4 Subsolutions of shape functionals  
4.1. Introduction; 4.2. Shape subsolutions for the Dirichlet Energy; 4.3. Interaction between energy subsolutions; 4.3.1. Monotonicity theorems; 4.3.2. The monotonicity factors; 4.3.3. The two-phase monotonicity formula; 4.3.4. Multiphase monotonicity formula; 4.3.5. The common boundary of two subsolutions. Application of the two-phase monotonicity formula.; 4.3.6. Absence of triple points for energy subsolutions. Application of the multiphase monotonicity formula; 4.4. Subsolutions for spectral functionals with measure penalization  
4.5. Subsolutions for functionals depending on potentials and weights

#### Sommario/riassunto

We study the existence and regularity of optimal domains for functionals depending on the spectrum of the Dirichlet Laplacian or of more general Schrödinger operators. The domains are subject to perimeter and volume constraints; we also take into account the possible presence of geometric obstacles. We investigate the properties of the optimal sets and of the optimal state functions. In particular, we prove that the eigenfunctions are Lipschitz continuous up to the boundary and that the optimal sets subject to the perimeter constraint have regular free boundary. We also consider spectral optimization problems in non-Euclidean settings and optimization problems for potentials and measures, as well as multiphase and optimal partition problems. .