

RESEARCH ACTIVITY

Problems under study: parabolic and elliptic PDE's. Reaction-diffusion equations and systems, diffusive Hamilton-Jacobi equations, chemotaxis models, population dynamics, nonlocal equations, free-boundary problems, equations on manifolds, linear semigroups

Questions under study for these problems:

- Asymptotic behavior
- Blow-up and extinction phenomena. Analysis of singularities
- A priori estimates and universal bounds of solutions
- Local-in-time theory (existence, uniqueness, regularity)
- Stationary solutions: existence, regularity, singularities, a priori estimates
- Elliptic and parabolic Liouville-type theorems

Former research topics:

- Periodic solutions (nonlinear wave and heat equations, differential systems); almost-periodic functions
- Stability for hyperbolic equations
- Asymptotic behavior of solutions of second order ODE's

MOST SIGNIFICANT RESULTS

- Resolution in dimensions 3 and 4 of the **Lane-Emden conjecture** on elliptic systems ([63] and [58])
- **Keller-Segel system** (chemotaxis): rigorous proof of the predictions of Chavanis and Sire concerning the mass concentration asymptotics [60]
- Resolution of the problem of Friedman and Giga concerning **single-point blow-up** for parabolic systems [61]
- Bidimensional **Kardar-Parisi-Zhang model** (interface growth): observation of the new phenomenon of single-point gradient blow-up on the boundary [65]
- **Selection-migration model in population genetics**: description of dimensional effects in the asymptotic behavior, solving an open problem of Aronson and Weinberger (1975) [67]
- **Elliptic Schrödinger systems arising in the modeling of Bose-Einstein multi-condensates**. Obtention of optimal Liouville-type results and a priori estimates, improving on work of Dancer, Tavares, Terracini, Wei, Weth, ... [70, 71]
- New connections between **nonlinear Liouville-type theorems** and local properties of solutions for elliptic and parabolic problems via a “doubling” method ([58, 59] et [62, 64])
- Explanation of the critical role of the Brezis-Turner exponent for the **regularity of very weak solutions** of elliptic problems [51]
- Introduction and development of L^p_δ **space methods** for the study of nonlinear parabolic equations and elliptic systems ([20] and [40, 47, 51])
- Introduction and development of the notion of **universal bound** of all solutions for superlinear parabolic problems ([20] and [31, 36, 38, 40, 59, 64])
- Diffusion-absorption equation: observation of the **fast mechanism of formation of the dead-core** [50]
- Precise description of the phenomenon of **global blow-up with boundary layer** for nonlocal reaction-diffusion equation [12, 45]