# Tercer taller de conferencias sobre Sociología y Matemáticas

## Programa

10.30-11.30 M. Ianelli (Universitá di Trento): "Age structured populations: a framework for Demography, Economics, Epidemics".

11.30-12.30 G. Diaz and J.I. Diaz (IMI, UCM): "Spatial symmetrization of solutions of some diffusive age structured populations models and applications".

12. 30-13.30 J.C. Micó (Instituto de Matemática Multidisciplinar (IM2). Universitat Politècnica de València), A.Caselles and S. Amigó (Universitat Politècnica de València): "An attempt to state a bridge between Physics and Psychology: Classical and Quantum Mechanics approach to Personality theory".

13.00- 15.30 Descanso

15.30- 16.30 M.T. Sanz (Universidad de Valencia), B. Elizalde (Universidad Pública de Navarra) and V. Díaz (Universidad Carlos III); "Study of the relationship between family policies and fertility from a mathematical

**Organizado por el Instituto de Matemática Interdisciplinar (IMI), el grupo UCM MOMAT y la Universidad Carlos III. Responsables: G. Díaz (IMI,UCM) y V. Díaz-Gandasegui (Univ. Carlos III)**

**Fecha: 22 de noviembre de 2019**
**Hora: de 10:30 a 16:30 horas**
**Lugar: Aula 209 (Seminario Alberto Dou)**
**Facultad de CC Matemáticas, UCM**

# Tercer taller de conferencias sobre Sociología y Matemáticas

22 de Noviembre de 2019

## 10.30-11.30 M. Ianelli (Universitá di Trento) "**Age structured populations: a framework for Demography, Economics, Epidemics"**

**Abstract**

The theory of age structured populations began with the work of Lotka in the years 1907-1911 and was based on the integral equation approach (the so called renewal equation), equivalent to the nowadays formulation as a hyperbolic P.D.E. with a non local boundary condition (introduced by McKendrick in 1926). The original context motivating Lotka studies concerned Demography and in fact the asymptotic results on the renewal equation, usually known as the stable population theory, are a basic paradigm in Demography and have been highly infuential in the feld of population theories.

In this talk we will recall the fundamentals of the Lotka-McKendrick approach and will present some problems in Demography, Economics and Medical Science that take advantage of the basic description of a population through its age distribution. Such a framework, in fact, allows to model the behaviour of individuals according to their age, so providing a realistic formulation of the processes and a possibly complex dynamics of the population.

11.30-12.30 G. Diaz & J.I. Diaz (IMI and U. Complutense de Madrid)
**"Spatial symmetrization of solutions of some diffusive age structured population models and applications"**

**Abstract**
We consider an age-dependent structured population model with a spatial diffusion which can be nonlinear and slow (such as proposed by Gurtin and Mc Camy on 1974).
Our aim is to find sufficient conditions on the coefficients in order to get some useful information on this population through the comparison with a virtual parallel population spatially symmetric obtained by the symmetrization of the spatial domain and the data of the problem. In our approach, we take advantage of some fixed point arguments developed by V. Barbu and M. Ianneli (2002) and the Trotter-Kato formula for an abstract formulation of the problem. Our mathematical conclusions are quite coincident with the ones obtained by a multidisciplinary team of the CSIC who analyzed the 174 more populated cities of the world.

12.30-13.30 J.C. Micó, A. Caselles and S. Amigó "**An attempt to state a bridge between Physics and Psychology: Classical and Quantum Mechanics approach to Personality theory"**

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**Abstract**
General Systems Theory (GST) represents an attempt to state a common mathematical language of science. One of the main strategies of this attempt is to develop the "Isomorphism Theory", i.e., the search of bridges between established mathematical theories to other contexts of science:
1. To solve their particular problems.
2. To extend them to further limits of research.
Our presentation can rather be classified in the second type of research. Particularly, Classical and Quantum Mechanics are physical theories that solve successfully the macroscopic and microscopic dynamics of natural systems. Note that when a natural system is described mathematically by a system of second order differential equations, whose Lagrangian is described by a known potential, the Hamiltonian and the corresponding Quantum Schrödinger equation can be stated, and the macroscopic and microscopic dynamics can be studied. In Personality theory, the authors have obtained and contrasted experimentally an integro-differential equation that reproduces the short time term dynamical response of the organism to a stimulus. This equation can be redefined as a second order differential equation. In this step, the problem is inverse respect to the physical case: ¿has this equation a Lagrangian?
This problem is known as the "Lagrange inverse problem". The answer is positive, and a "kinetic energy" and a "potential" can be found as part of a Lagrangian. From the Lagrangian, the Hamiltonian is also found and, by using the known quantization rules, the corresponding Schrödinger equation is found.
Some challenging questions are then posed:
1. Is the Planck constant the usual value used in Quantum Mechanics?
2. The Schrödinger equation found is time-dependent due to the stimulus is, in general, explicitly time-dependent. Thus, can it be solved analytically?
The first question is not clear by the moment, but the second one can be dealt with solving the corresponding time-independent Schrödinger equation in the initial time of the Hamiltonian, whose solution is function of the Hermite polynomials, and dealing with the time-dependent Schrödinger equation by the eigenfunctions expansion method. However, the problem becomes a system of first temporal order difference-differential equations depending on an infinite set of positive integers. This is the top, by the moment, of our theoretical research. However, the energies become quantized as eigenvalues of the corresponding eigenfunctions. The present challenges of the authors are to discover:
1. How to solve the first temporal order difference-differential equations.
2. How this approach could explain the sudden change of personality observed for some individuals, which can be considered unusual or even tragic.

15.30- 16.30 V. Díaz, M.T. Sanz García y B. Elizalde-San Miguel **"Study of the relationship between family policies and fertility from a mathematical sociology perspective"**


## Abstract

The relationship between family policies and the fertility of a country constitutes, in recent years, a prolific line of research, but it has not reached yet conclusive results. This study aims to contribute to this line of research through the application of a mathematical model that establishes the degree of relationship between fertility and family policies. To this end, it is proposed to apply the Family Policy Index (XFPI), a tool designed to analyze, compare and raise awareness about the degree of development of family policies aimed for families with children under three years. The index is constructed from three subsystems: a) educational services, b) parental leave and c) economic transfers, considered by the scientific literature the main tools used by public policies to reconcile work and family life. The relationship between public policies and fertility is established through a stochastic dynamic mathematical model, defined by sex and age, a model in which the XFPI is introduced through fertility rates. The study has been conducted in two European countries that differ markedly in the development and objectives of their family policies, Spain and Norway. The results presented will be divided into two parts: a) an analysis of the historical trend (2007-2015), and b) a simulation of the future trend (2016-2030). In both parts, the influence of independent variables on the dependent variable is measured and analyzed through: a) a graphical examination, which allows observing the trend and making a qualitative analysis of the tendency of some variables over others, and b) the adjustment of a mathematical function of the data, which quantitatively reports the observed relationships with the calculation of the coefficients of determination. The results show that the most generous family public policy models (which incorporates the gender equality perspective) are the most successful in increasing fertility. On the other hand, erratic and insufficient support models generate more gender inequalities and clearly contribute to maintaining fertility at very low levels.