Jacob Palis

Professor at the Instituto de Matemática Pura e Aplicada (IMPA), Rio de Janeiro

2010 Balzan Prize for Mathematics (pure and applied)
For his fundamental contributions to the Mathematical Theory of Dynamical Systems.

Institution Administering Research Funds:
Instituto de Matemática Pura e Aplicada (IMPA), Rio de Janeiro

Adviser for the Balzan General Prize Committee: Étienne Ghys

Dynamical Systems, Chaotic Behaviour – Uncertainty, Linear Cocycles and Lyapunov Exponents

Jacob Palis is coordinating his Balzan Research Project together with Jean-Christophe Yoccoz at the Instituto de Matemática Pura e Aplicada, IMPA, Rio de Janeiro, Brazil. The creation of the modern theory of dynamical systems, towards the end of the nineteenth century, is attributed to Henri Poincaré. It is the principal mathematical approach used to model the evolution of many phenomena in nature. Classical examples are population growth of species, weather and climate prediction. Perhaps the same theory can be applied to understand certain aspects of turbulence in physics. Since Poincaré we have been wondering if it is possible to understand the typical behaviour of a typical dynamical system, where *typical* should be understood in a probabilistic sense to cover almost all possibilities.

Starting from a selected initial position of the system, one tries to describe the behaviour of its future trajectory, defined by its successive positions as time evolves. For example, the motion of the atmosphere is governed by a very complicated evolution equation, which cannot be solved explicitly. In 1963, Edward Norton Lorenz, a theoretical meteorologist, proposed a "toy" weather model, involving only three dimensions and intended to be much easier to understand. The question of knowing whether this oversimplified model still captures the main properties of the actual atmospheric motion is controversial among physicists and meteorologists. However, Lorenz was able to observe "chaotic behaviour" in his "toy" model. Minute changes in the initial

data used were shown to produce extremely radical changes in the outcome. This was very surprising at the time. Jacob Palis' research project proposes to tackle several conjectures which would imply that the phenomenon witnessed by Lorenz is not an exception but, on the contrary, may capture some fundamental features of general dynamics. The research project will study (and hopefully prove) a set of conjectures for dynamical systems that leads to a global perspective in this important branch of Mathematics.

The Research Project will take place in the period 2011-2015. Part of the funds of the project will support the activities of young researchers at IMPA in research on *Dynamical Systems, Chaotic Behaviour and Uncertainty*. Also, as part of the project, three Balzan Symposia will take place, two of them at IMPA and one at the Institut Henri Poincaré in Paris, in subsequent years. The first Palis-Balzan Symposium on Dynamical Systems was held at IMPA, Rio de Janeiro, in June 2012. These symposia are designed to review advances and to stimulate further progress along the lines of the research project.

Papers presented at the First Palis-Balzan Symposium on Dynamical Systems IMPA, June 25th-29th, 2012: Artur Ávila – IMPA, Rio de Janeiro and CNRS, France - *On the metric properties of Feigenbaum-Julia sets;* Pierre Berger – CNRS, France - *Zoology in the Hénon family from twin baby Hénon-like attractors*; Christian Bonatti – Université de Bourgogne, Dijon - *Foliated hyperbolicity*; Sylvain Crovisier – CNRS, France - *Newhouse phenomenon and uniformity of extremal bundles*; Lorenzo Diaz – Pontifícia Universidade Católica do Rio de Janeiro (PUC) - *Robust vanishing of all central Lyapunov exponents*; Luiz Henrique de Figueiredo - IMPA, Rio de Janeiro - *Images of Julia sets that you can trust*; Nicolas Gourmelon - Université Bordeaux 1 - *C'dichotomies between Newhouse phenomena and dominated splittings, at homoclinic points*; Pablo Guarino - IMPA - *Rigidity of Critical Circle Map*; Alejandro Kocsard - Universidade Federal Fluminense (UFF), Niterói, RJ, Brazil - *Distributionally uniquely ergodic diffeomorphisms*; Andrés Koropecki - UFF, Niterói, RJ - *Prime ends rotation number and periodic points*; Yuri Lima - Weizmann Institute of Science, Rehovot, Israel - *Stationary spaces of discrete groups: an Abramov formula*; Jorge Eric López – IMPA - *Stable projections of cartesian products of regular Cantor sets*; Michael Lyubich – SUNY at Stony Brook, USA - *On homoclinic tangencies in the complex Henon family*; Marco Martens – SUNY at Stony Brook , USA - *On the hyperbolicity of Lorenz renormalization*; Carlos Gustavo Moreira – IMPA, Rio de Janeiro - *On the continuity of fractal dimensions of horseshoes in dimenson 3*; Sheldon Newhouse - Michigan State University - *The Lorenz equations: A survey*

of rigorous results; Maria José Pacífico – Universidade Federal do Rio de Janeiro - *Fiber contracting maps versus Lorenz-like attractors*; Vilton Pinheiro - Universidade Federal da Bahia, Brazil - *Measures with historic behavior*; Rafael Potrie - Universidad de la República, Uruguay - *Partial hyperbolicity and leaf conjugacy in nilmanifolds*; Enrique Pujals – IMPA, Rio de Janeiro; *Critical points for surfaces diffeomorphisms, abundance of periodic orbits and structural stability*; Alvaro Rovella - Universidad de la República, Uruguay - *Structural stability in dimension two*; Martín Sambarino – Universidad de la República, Uruguay - *Some questions, problems and remarks regarding C^r dynamics*; Carlos Matheus Santos – CNRS, France - *Fractal geometry of non-uniformly hyperbolic horseshoes*; Waliston Luiz Silva - Universidade Federal de São João Del-Rei - *On the geometry of horseshoes*; Sebastian Van Strien – Imperial College London - *On stochastic stability of expanding circle maps with neutral fixed points*; J. Regis Varão - Universidade de São Paulo, São Carlos, Brazil - *Center foliation: Absolute continuity, disintegration and rigidity*; Marcelo Viana – IMPA, Rio de Janeiro - *Time 1 maps of geodesic flows*; Jiagang Yang - UFF Niterói, RJ - *Diffeomorphisms with contracting Center*.

Researchers
Supervisor
Jean-Christophe Yoccoz, IMPA

There will be a number of fellowships (3-12 months).

Links:
http://www.impa.br/opencms/pt/eventos/store/evento_1203
http://video.impa.br/index.php?page=first-palis-balzan-symposium-on-dynamical-systems