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Marcelo Moreira Cavalcanti
Featured Scientist Interview

According to a recent analysis of Essential Science IndicatorsSM *from Thomson Reuters, the work of Dr. Marcelo Moreira Cavalcanti has entered the top 1% in the field of Mathematics. His record in this field includes 23 papers cited 199 times between January 1, 1999 and October 31, 2009.*

Dr. Cavalcanti is an Associate Professor in the Department of Mathematics at the State University of Maringá in Brazil.

Below, he talks with ScienceWatch.com *about his highly cited work.*

SW: Would you tell us a bit about your educational background and research experiences?

I received my B.S., my M.S., and my Ph.D. degrees from the Federal University of Rio de Janeiro, in 1985, 1988, and 1995, respectively. I have been an Associate Professor in the Department of Mathematics at the State University of Maringá since 1989.

My research experience in mathematics is focused on partial differential equations, concerned mostly with control and stabilization of distributed systems.

SW: What would you say is the main focus of your research?

The main focus of my research is the study of the *behavior of the energy* of distributed systems. To explain more precisely the development of my research, consider a physical phenomenon which is described by a differential partial equation and, in addition, we assume that there is an external or intrinsic mechanism (damping) acting on the system and which is responsible for the dissipation of its energy. The purpose of my study is to answer some questions related to the region where the damping must be acting in order to obtain the optimal decay rate of the energy.

This subject was wisely described by one of the greatest contemporary scientists, Jacques Louis Lions (1928-2001) when he said:

> To "control" a system is to make it behave (hopefully) according to our "wishes," in a way compatible with safety and ethics, at the least possible cost. The systems considered here are distributed—i.e., governed (modeled) by partial differential equations (PDEs) of evolution. Our "wish" is to drive the system in a given time, by an adequate choice of the controls, from a given initial state to a final given state, which is the target.

"We live in a world where the natural supplies, although they are abundant, could become scarce if they are not used with prudence and wisdom."

SW: Your most-cited paper in our analysis is the 2003 *SIAM Journal on Control and Optimization,* "Frictional versus viscoelastic damping in a semilinear wave equation," (Cavalcanti MM, Oquendo HP, 42[4]: 1310-24). Would you tell us about this paper and why it is significant?

This work is concerned with wave propagation inside a material composed by two different parts: elastic and viscoelastic. A *viscoelastic* material is a kind of material that has the property of keeping past information (memory) and which is able to be used in the future. The memory effect is enough, by itself, to stabilize the wave propagation if one admits that the kernel of the memory has some kind of decay property (exponential, polynomial, etc.).

In this work, we allow the existence of two kind of simultaneous dissipative mechanisms: frictional and viscoelastic. The main contribution of this work is to prove uniform decay rates of the energy associated with the wave propagation for a wide class of possibilities of distributing and combining both these dissipative effects.

SW: Your 2008 *Nonlinear Analysis-Theory Methods & Applications* paper, "General decay rate estimates for viscoelastic dissipative systems" (Cavalcanti MM, Cavalcanti VND, Martinez P, 68[1]: 177-93, 1 January 2008), is also a highly cited paper. Would you talk a little about this aspect of your work?

"The main focus of my research is the study of the behavior of the energy *of distributed systems."*

This is also a paper regarding frictional versus dissipative effects. The main difference between this paper and the previous one is the composition of the material where the wave propagation takes place. In this case the material is completely viscoelastic and a frictional dissipation exists simultaneously on the boundary of the material. Both the boundary dissipation and the memory term have a damping effect on the wave propagation, thus it is rather natural to think that the decay of the energy should be at least as fast as in the case of the wave equation, where there is no memory term, and thus where there is only one damping term. However this is false: we proved that the energy of the solution cannot decay to zero faster than the relaxation function.

In this work we provide a simple example with some arbitrarily small (in L1) kernel combined with a frictional and linear frictional dissipation, for which the decay is never exponential. The kernel function and the damping function generate constraints (of course of a different type), and the problem of the uniform stabilization of the energy turns into an optimization problem: one seeks to construct some weight function that satisfies these constraints simultaneously. The present paper is one of the pioneers in considering kernels which are different from polynomial and exponential types, widely used before in the literature.

SW: What should the "take-away lesson" about your work be for the general public?

We live in a world where the natural supplies, although they are abundant, could become scarce if they are not used with prudence and wisdom. Within this perspective, it becomes very relevant to control the energy used for transferring a system from an initial to a final state previously established. The excessive expense of energy or the bad control of it can lead the planet to chaos. Taking this concept into account, that is, seeking minimal energy costs, our work is developed.

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Marcelo Moreira Cavalcanti's current most-cited paper in *Essential Science Indicators*, with 14 cites:

Cavalcanti MM, Cavalcanti VND, Martinez P, "General decay rate estimates for viscoelastic dissipative systems," *Nonlinear Anal-Theor. Meth. App.* 68(1): 177-93, 1 January 2008. Source: *Essential Science Indicators* from Thomson Reuters.

Additional information:

Marcelo Moreira Cavalcanti is a New Entrant for February 2010 in Mathematics.

KEYWORDS: PARTIAL DIFFERENTIAL EQUATIONS, DISTRIBUTED SYSTEMS, STABILIZATION, CONTROL, BEHAVIOR, ENERGY, DAMPING, OPTIMAL DECAY RATE, WAVE PROPAGATION, ELASTIC MATERIAL, VISCOELASTIC MATERIAL, FRICTIONAL EFFECTS, DISSIPATIVE EFFECTS, MEMORY, KERNEL FUNCTION.

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