

TIME DELAY SYSTEMS

Webinar

TDS

2024

Dynamics with implicit state-dependent delay and post-Newtonian gravitational models



ERIK VERRIEST

Professor

School of Electrical and Computer Engineering
Georgia Institute of Technology

Apr. 5, 2024, Friday @ 4:00 pm (CET)

7:00 am (PDT), 10:00 am (EDT), 10:00 pm (CST)

Event will take place via Zoom

ABSTRACT: In this presentation, I will first discuss some problems regarding causality in systems with varying delays. These problems relate to the well-posedness (existence and uniqueness) and causality of the mathematical models for physical phenomena and illustrate why one might consider the physics first and then the mathematics.

In the second part, I consider the post-Newtonian gravitational problem as a problem with state-dependent delay. Einstein's field equations relate space-time geometry to matter and energy distribution. These tensorial equations are so unwieldy that solutions are only known in some very specific cases. Therefore, a semi-relativistic approximation is desirable: One where space-time may still be considered flat, but where Newton's equations (where gravity acts instantaneously) are replaced by a post-Newtonian theory, involving propagation of gravity at the speed of light. This approximation, assuming weak fields and slow speeds, implies that retardation depends on the geometry of the point masses, and a dynamical system with state-dependent delay results, where delay and state are implicitly related. We set up the equations for the gravitational potential and field from first principles and investigate several problems with the Lagrange-Bürman inversion technique and perturbation expansions. Interesting phenomena (gravitational entrainment, dynamic friction, fission, and orbital speeds) not explainable by the Newtonian theory emerge.

BIO: Professor Erik I. Verriest is the Director of the Mathematical System Theory Laboratory (MASTLab) at the Georgia Institute of Technology. After receiving his Engineer's degree from the University of Ghent, Belgium, he was with the Control Systems Laboratory and the Hybrid Computation Centre, Ghent, Belgium, from 1973 to 1974. He obtained a Ph.D. degree from Stanford University and joined the faculty of Electrical and Computer Engineering at the Georgia Institute of Technology in 1980. He has contributed to model reduction for linear and nonlinear systems, system structure for periodic and switched systems and distributed estimation. His present interests are in mathematical system theory, with a focus on delay-differential equations, generalized functions in impulsive systems, and optimal control with applications in ecology and robotics. He served on several conference IPCs, is a member of the IFAC Committee on Linear Systems, a Fellow of the IEEE (2012), a member of the Royal Flemish Academy of Belgium for Science and the Arts (elected 2012), and received the Distinguished Professor award at ECE, Georgia Tech in 2014. He was a plenary speaker at the 2nd IFAC Workshop on Linear Time Delay Systems in Grenoble, France (2000), the 13-th IFAC Workshop on Time Delay Systems in Istanbul, Turkey (2016), the International Conference on Difference Equations and Applications in Paris, France (2022). In the Summer of 2022, he held the Giovanni Prodi Chair at the Mathematics Institute of the Julius-Maximilians-Universität, Würzburg, Germany.



Questions? Contact: Gabor Orosz, orosz@umich.edu