Abstract of Eduardo Kausel's talk

In this talk we shall focus on a selection of problems in classical dynamics which exhibit some surprising characteristics. The characteristics to be described will be exact in the mathematical-physical sense, so it is curious that they should not be known better, by at least a minority of specialists.

The problems that we will elaborate on are the following:

A) Normal modes: The normal modes of vibration of a dynamic system "know by themselves" how to be "normal" in length. Although such normalization in practice is always carried out *after* the modes have been determined, it will surprise the listeners to know that normalization is an intrinsic property of a dynamical systems, and can in theory be accomplished without knowing the modes, or even any full mode.

B) Energy supply mechanism for moving loads: For many decades now, the dynamic response to vertical loads (or weights) moving at a constant speed on a damped sub-stratum has been studied extensively; a typical example is that of a moving train. The surprising thing is that no one to date seems to have observed that such solutions violate the physical principles of causality, since inasmuch as the sub-stratum is dissipative, there are irrecoverable energy losses that occur when the load moves. But since the vertical load (or weight) does not move in its own direction but only laterally, then it cannot deliver any energy to the system that compensates for the energy that is continually being lost to the ground. If so, the media would only report losses, and no sources, which simply cannot be. Where, then, does such energy come from?

C) A discrete system can, in certain particular cases, simulate a continuous system: A fundamental dogma (or postulate) in elastodynamics is that no matter how refined a discrete model of a system is (whether with finite elements or with finite differences), it will never be able to reproduce exactly in its finest details the behavior of the continuous system that it replaces. We will demonstrate here that there is at least one "simple" system that violates such a postulate, and therefore, violate also the so-called "representation theorems". Furthermore, the proof that we shall give will be in *closed form*, so there will be no doubt whatsoever about the veracity of this discovery. This is perhaps the most surprising result of all of those we are considering herein, as it challenges decades of mathematical developments in the theory of elasticity.

We will address these fascinating and curious problems succinctly but completely in our presentation.