**TARLETON SLIDE NOTES – April 2013 - Sergio Pissanetzky**

**SLIDE 1**. THE UNIFICATION OF SYMMETRY AND CONSERVATION

**SLIDE 2.** THE THEORY
I propose a new theory of Mechanics.
It has one fundamental principle: Causality.
It has one postulate: the action functional.
It is discrete and scale-free.
There are no assumptions of differentiability or smoothness.
The theory applies to all causal systems;.

**SLIDE 3.** PLACING THE THEORY
A system in state A that can transition to B, C or D, or from B to E, F, G, H.
In statistical methods, transition probabilities and a statistical distribution are assumed.
So there is an approximation right from the start.
In differential methods, smoothness is assumed. Another approximation.
In Causal Mechanics, probabilities are irrelevant and smoothness is not required.

**SLIDE** 4. THE MODEL
The model for the theory is a causal set.
If you are not familiar with causal sets, think of a computer program.
The action functional is the metric for causal sets.
The system is described by variables, states, transitions, trajectories.
Variables ⬄ elements, transitions ⬄ precedence relations, trajectories ⬄ permutations.

**SLIDE** 5. SYMMETRY
A causal set always has a symmetry of the action,
represented by the legal permutations of the causal set.
A causal set always has a conservation law and a conserved quantity;
The principle of symmetry follows.
All conserved quantities can be calculated from the theory.

**SLIDE 6.** LEAST-ACTION
The least-action trajectories are those with the least value of the functional.
The set of least-action trajectories is a grupoid, and it has a block system.
The block system is a partition of the causal set invariant under all trajectories.
This block system is the conserved quantity.
Hence, the principle of least-action follows naturally from causation.
The notion of conservative system also follows.

**SLIDE 7.** PREDICTIONS
In 2011, I predicted that dendritic trees in the brain should be optimally short,
against the accepted non-optimal 4/3 power law.
In 2012, Cuntz proposed an optimally short 2/3 power law, confirming my prediction.
This is an important success for the theory.
Noether’s theorem follows from the theory. I proved a small part.

**SLIDE 8.** FEATURES
Works seamlessly across boundaries in Physics:
complex/simple, macro/micro-scale, classic/relativistic, differential or not.
Other fundamental principles follow from the theory:
Unifies symmetry and conservation.
Applies to all systems.
Only theory where detail is important and no other theories exist;
 **SLIDE 9.** Web site.