TGD as Topological GeometroDynamics

extended to

Tire to Ground Dynamics

Magnus Roland

Chairman and CEO

SWEDISH ADVANCED AUTOMOTIVE BUSINESS AB

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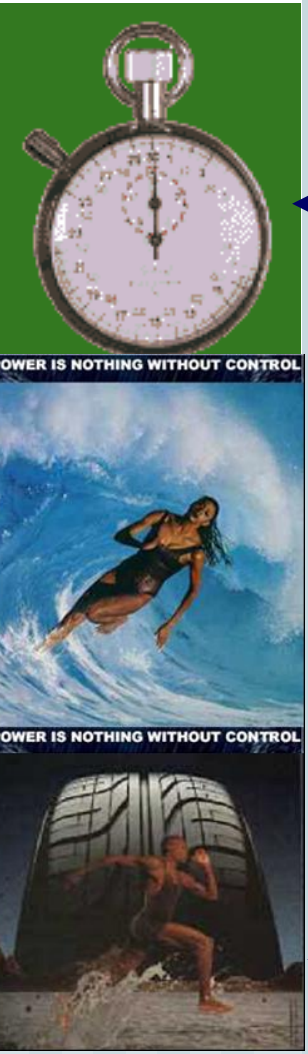
Formula One

LeMans



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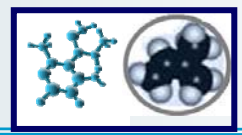
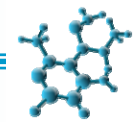
Power to be controlled is the action in the tire to road foot-print.

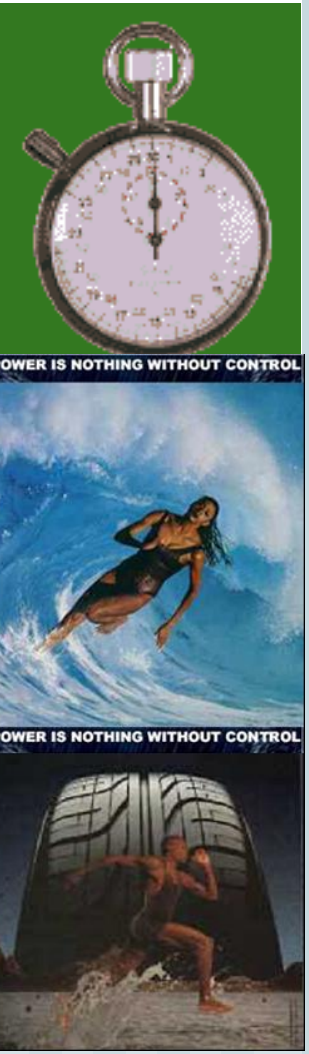
Power without waste demands “no friction” → zero energy losses.

Power with “zero friction” to be controlled in the tire to road foot-print is firm structural bonding.

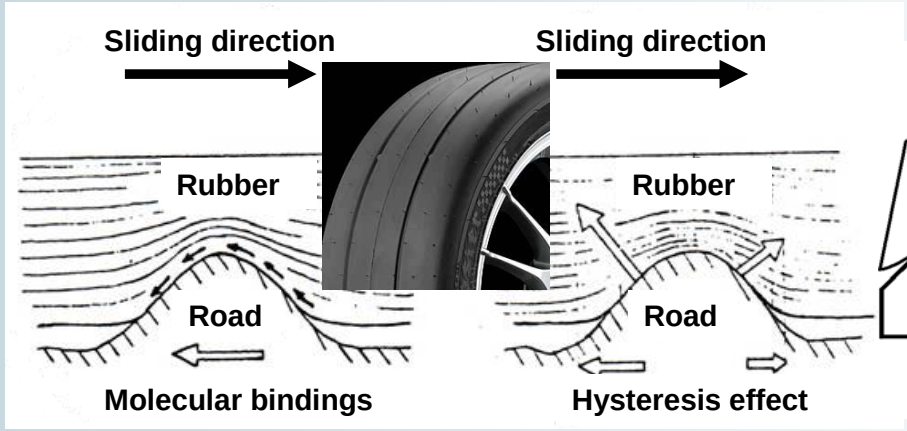


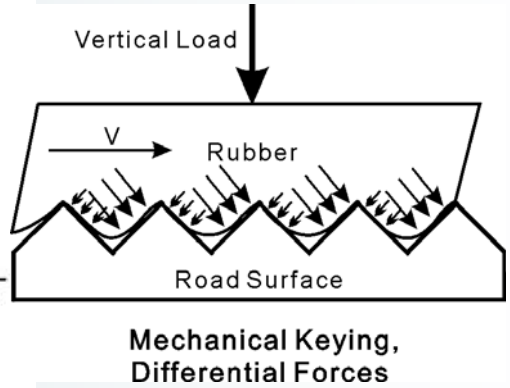
Suspension topology should maximize structural bonding on atomic level of the rubber to ground monolayer.



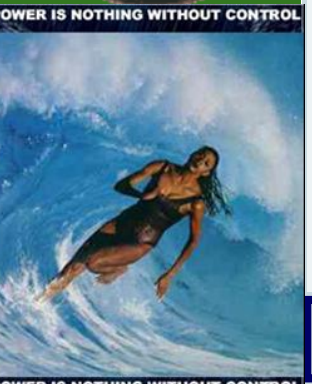


The “State of Art” defines rubber friction as a combination of 1) adhesion, 2) hysteresis and 3) gearing or “mechanical keying”.





TGD as Topological GeometroDynamics extended to Tire to Ground Dynamics



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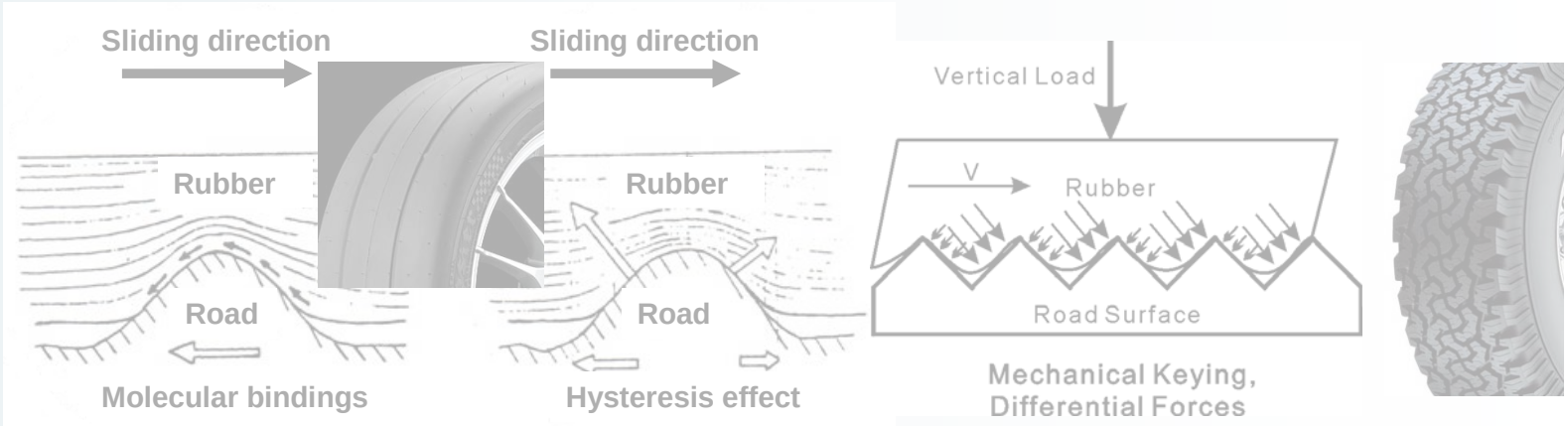
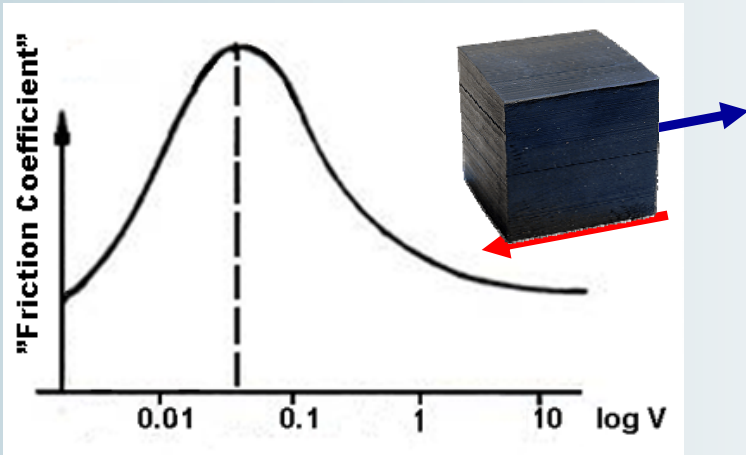
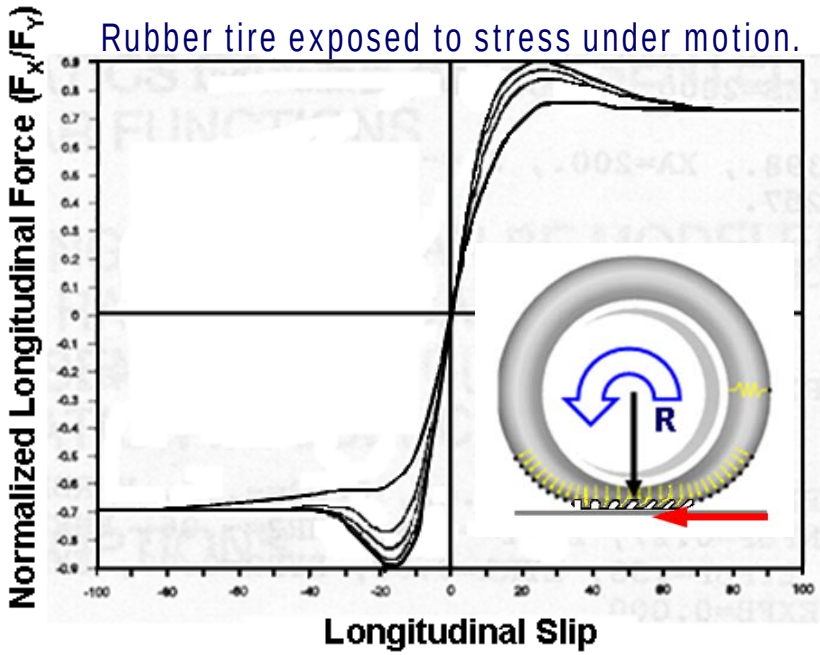


Rubber is a "semi frozen" fluid, which does not have static friction.

Rubber block sliding on a surface.



Rubber tire exposed to stress under motion.



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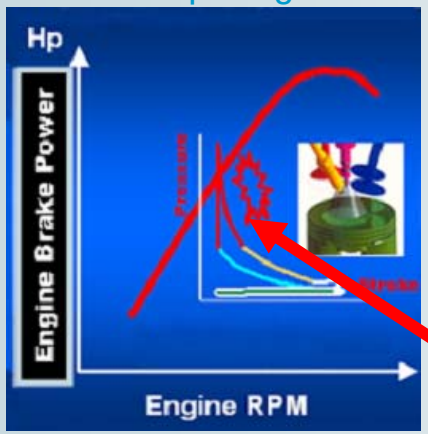
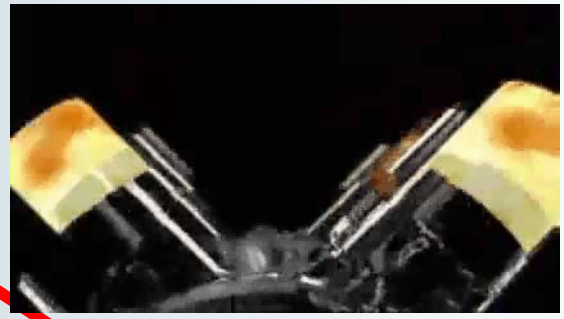
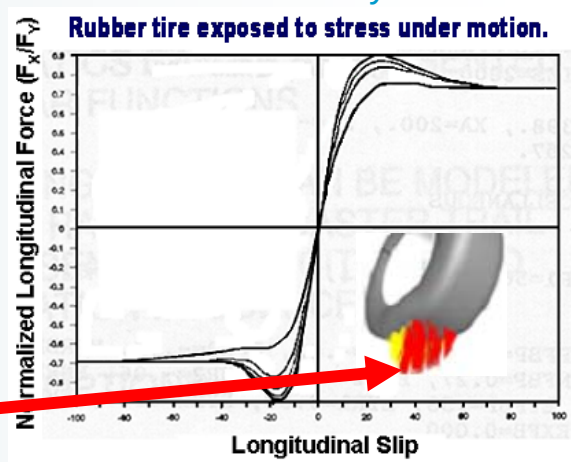
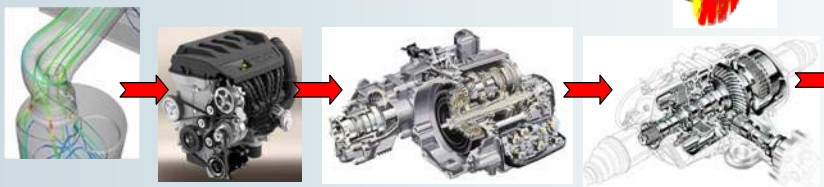
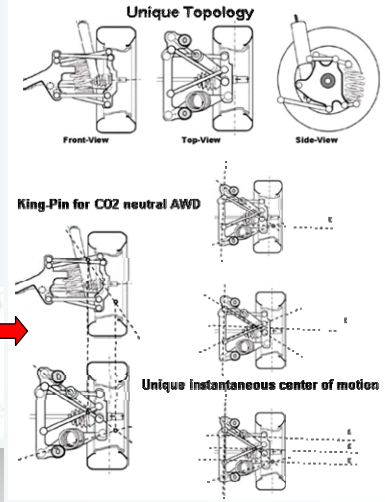






"Engine Indicated Power" as p=mxv propagates throughout the entire system of engine, transmission, drive-line and suspension.





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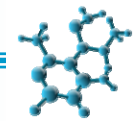
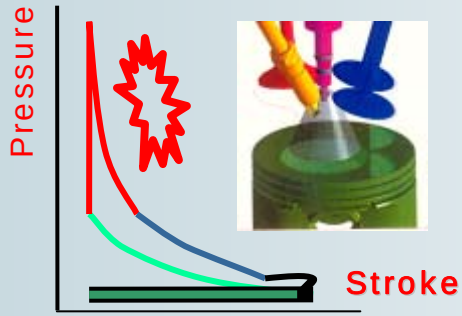
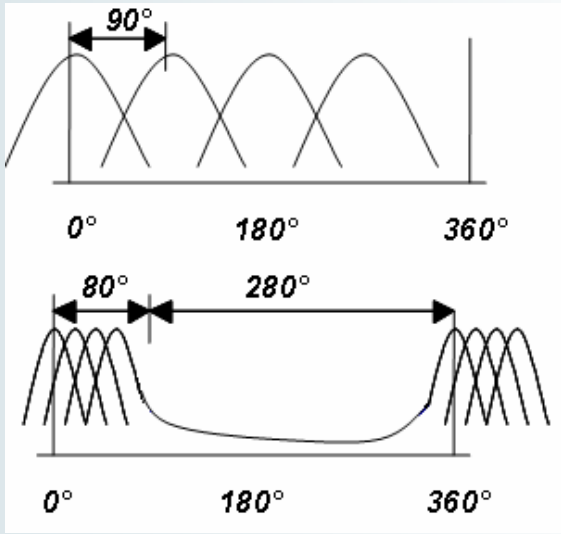


Mechanical systems could outperform any electronic intervention.



Adiabatic Compression
Isochoric Heating, Adiabatic Expansion
Adiabatic Expansion, Isochoric Cooling
Isobaric Exhaustion, Isobaric Intake



The Honda ”Big Bang”-engine ignites four cylinders during 80° of engine rotation and ”rests” during 280°

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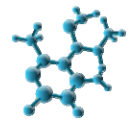

POWER IS NOTHING WITHOUT CONTROL

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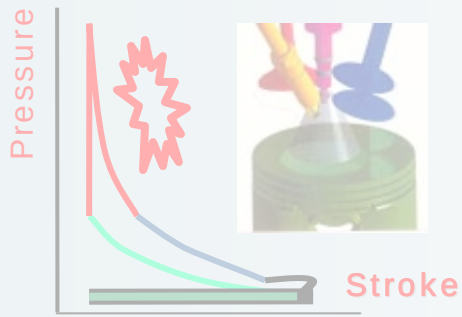

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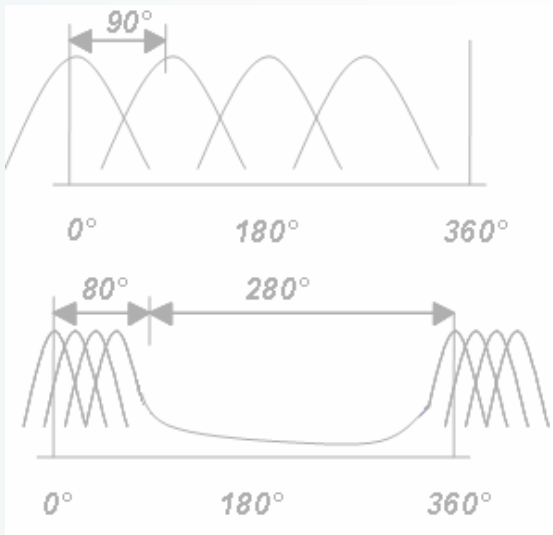

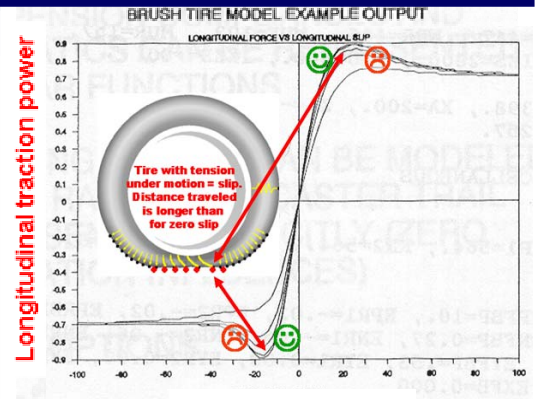

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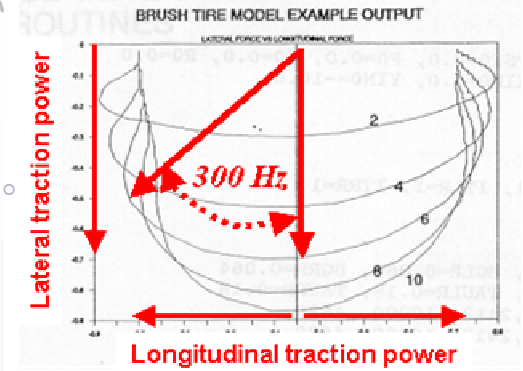
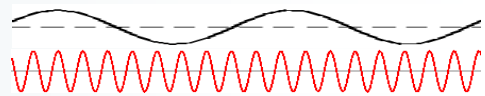


At 18 000 rpm power impulses of ~300 Hz occur.
(Compare ABS-, TCS- and ESP-control of ~10 Hz).

The motorbike inertia does not react for 300 Hz!



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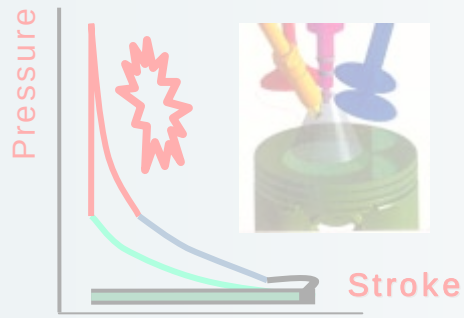

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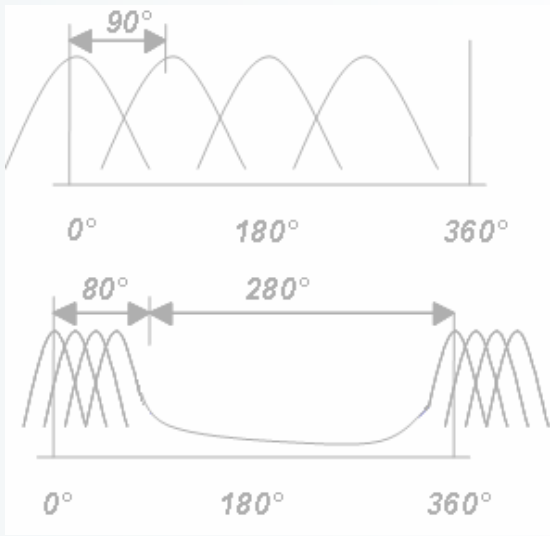

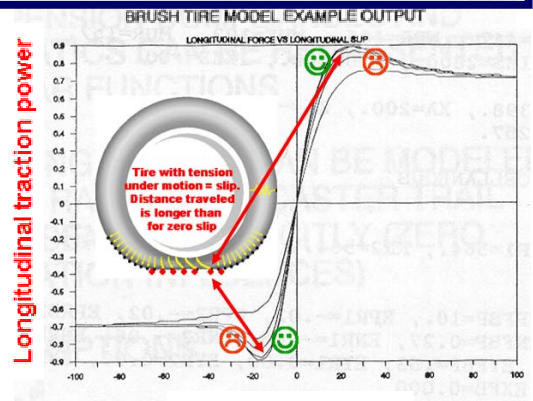

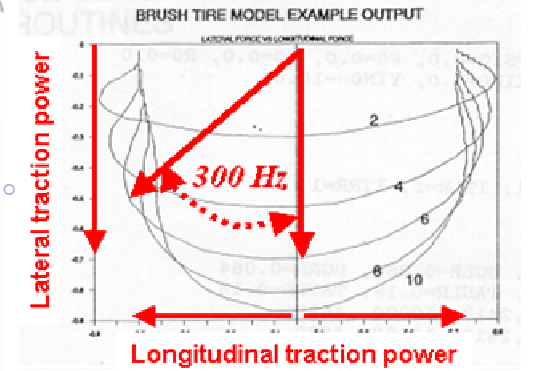

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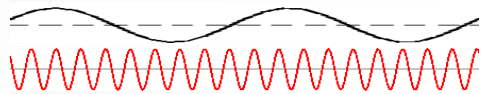

Maximized road grip in appropriate direction operates between forward propulsion impulses of 0.0007 sec. and lateral grip during 0.0025 sec.

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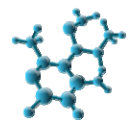
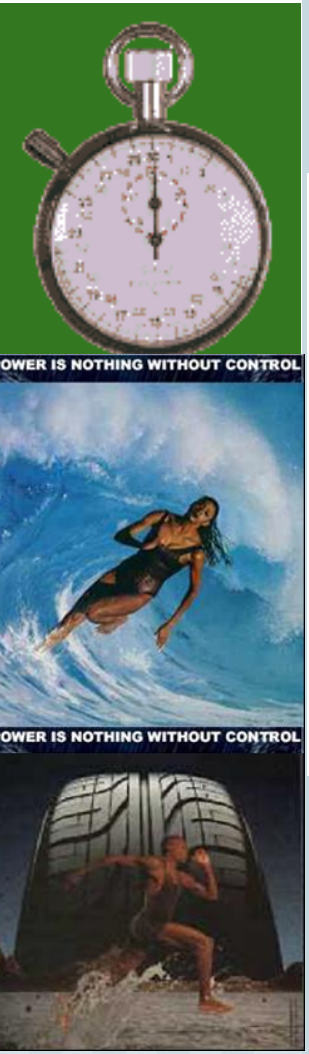
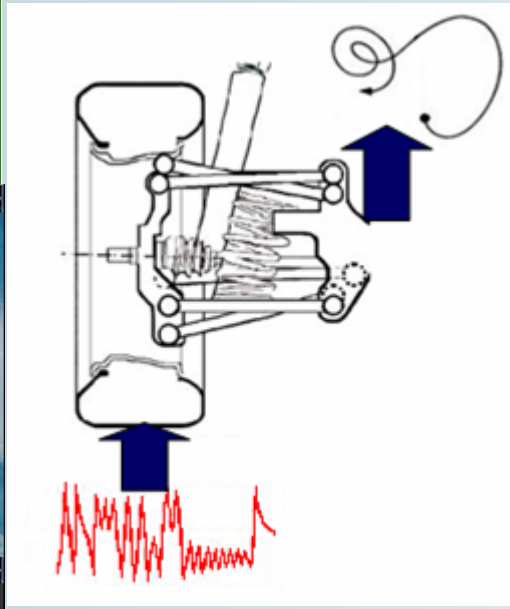
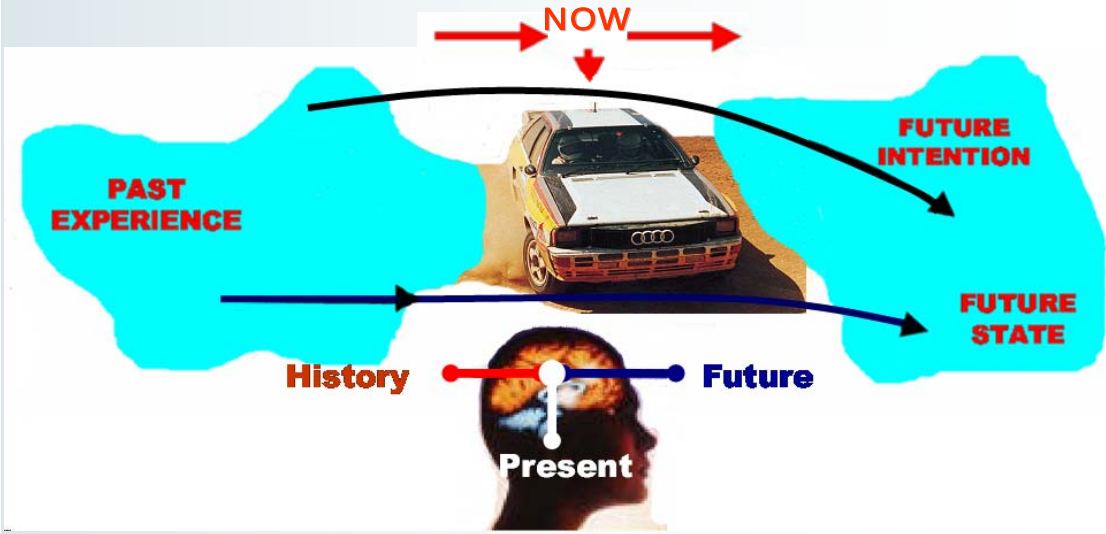




Suspension topology shall transform chaotic road impacts into dynamic order.





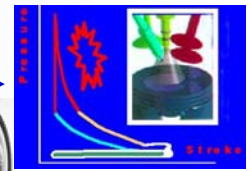
[*H*omogeneous *C*harged *C*ompression *I*gnition]

&

[*H*omogeneous *C*ontact *C*ompression *I*nteraction]

X

[*H*uman *C*ompatible *C*ontrol *I*nterface]



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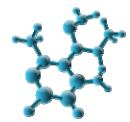
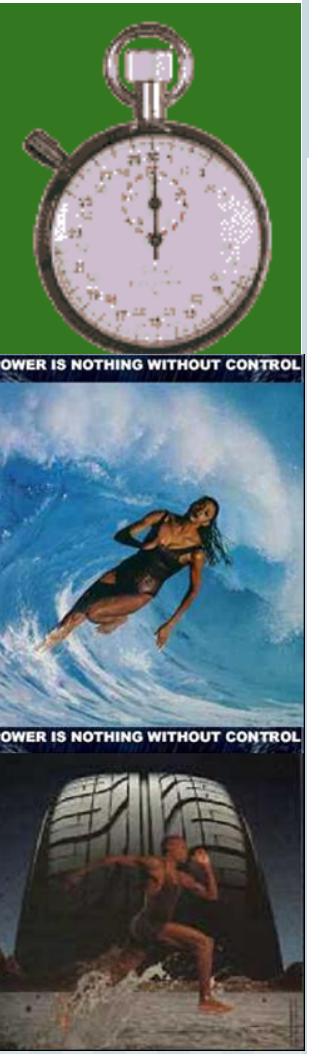
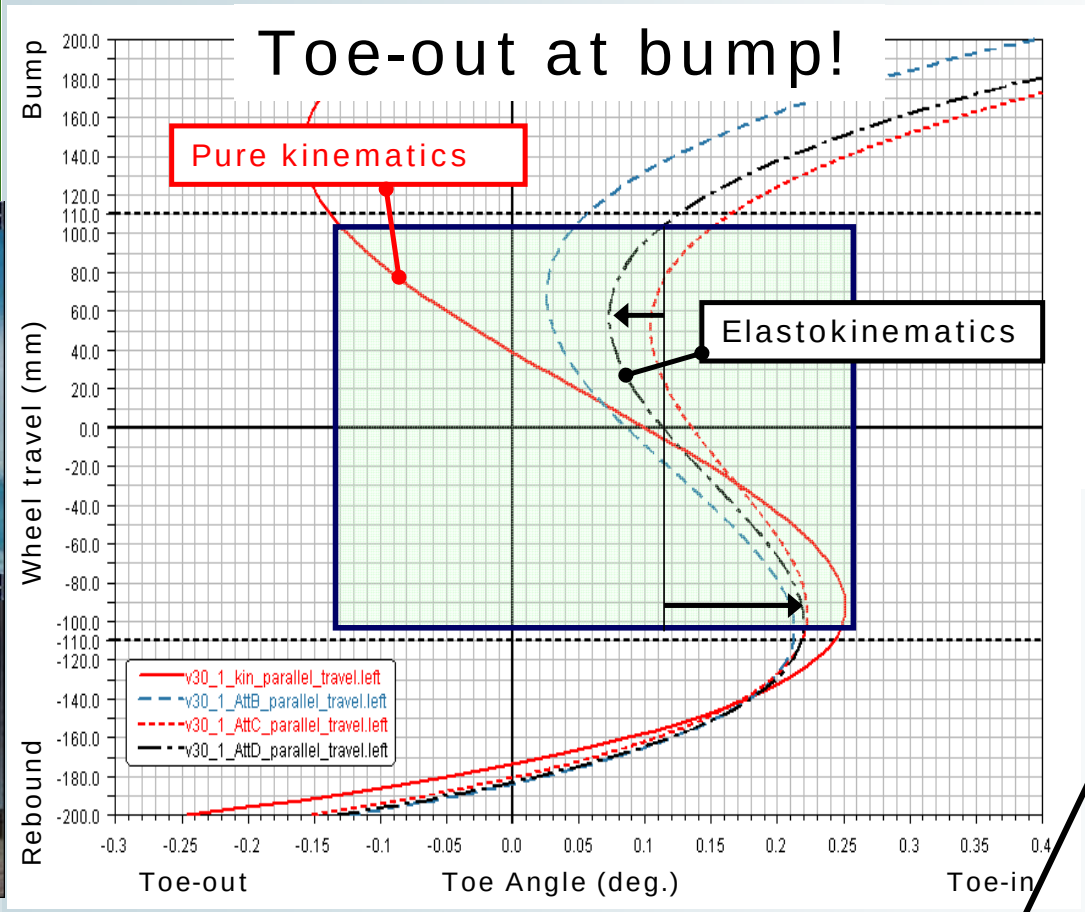
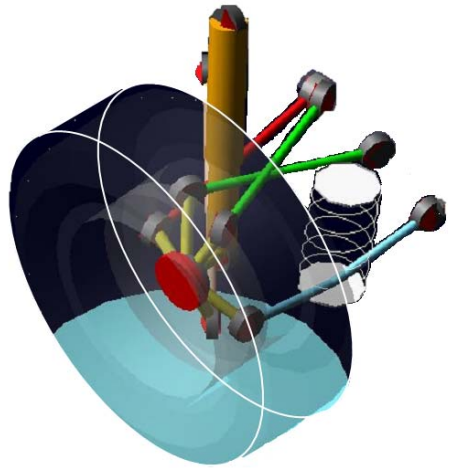
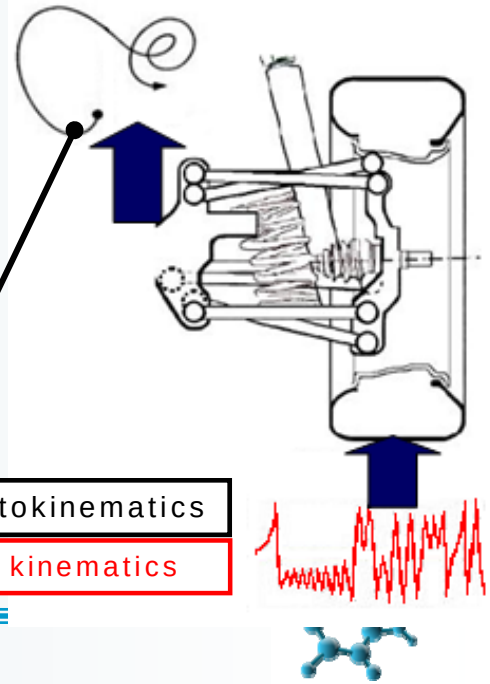


A de-coupled 5-Link rear suspension can independently control each of the superimposed dynamics of 0.1-1.4 Hz, 10-14 Hz, 25-30 Hz and 350-400 Hz!



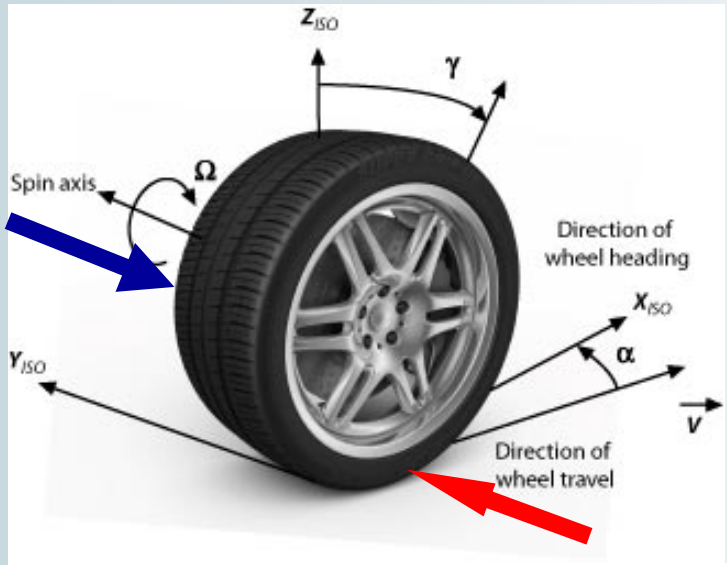


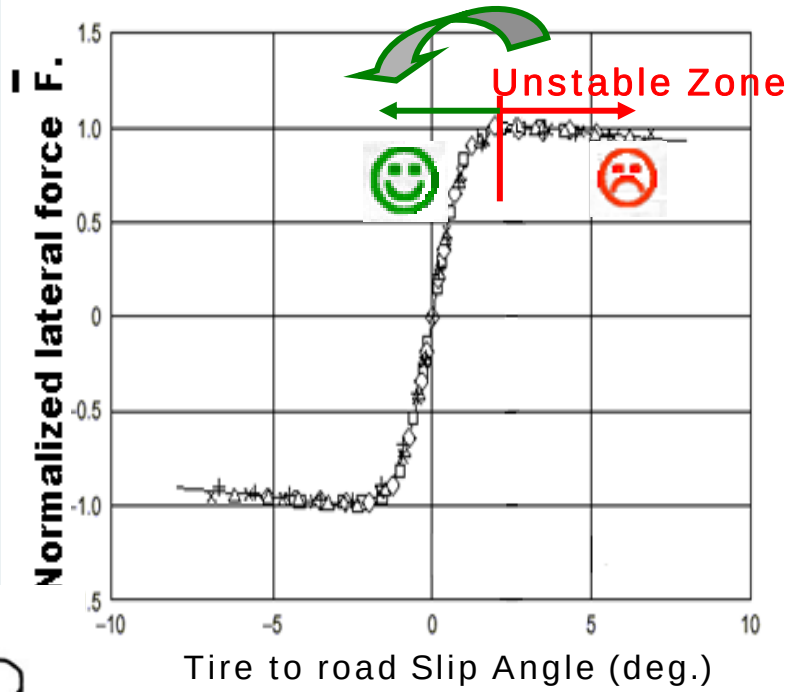


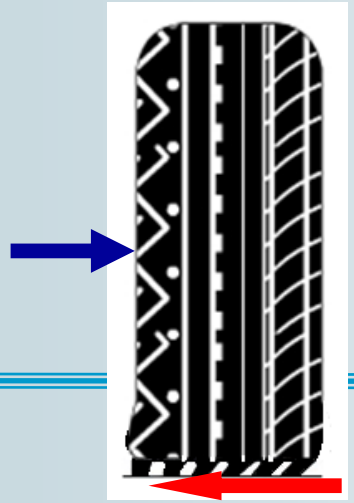


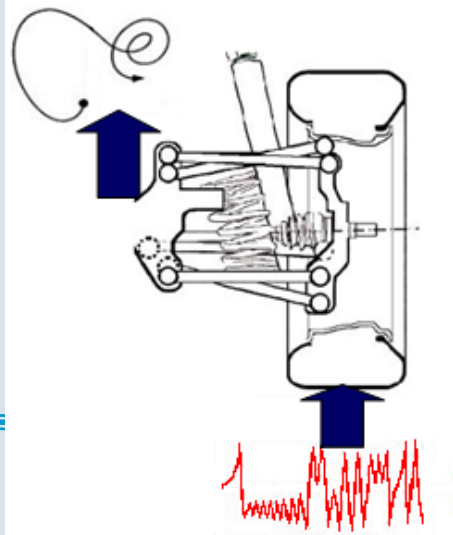
Toe-out at bump as reversed main stream kinematics for rear suspensions, uses high frequency small amplitude vertical stochastic road input to reduce tire to road slip for human compatible control at tire peak performance.

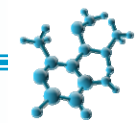
For cornering and lateral direction this is what ABS makes longitudinally!



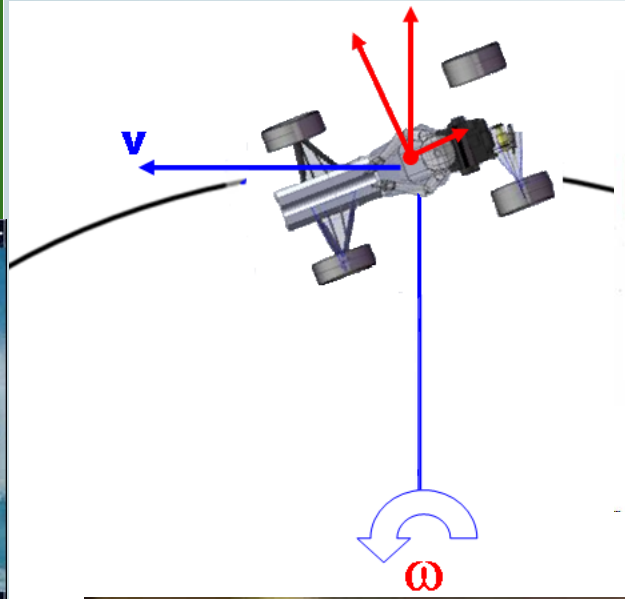


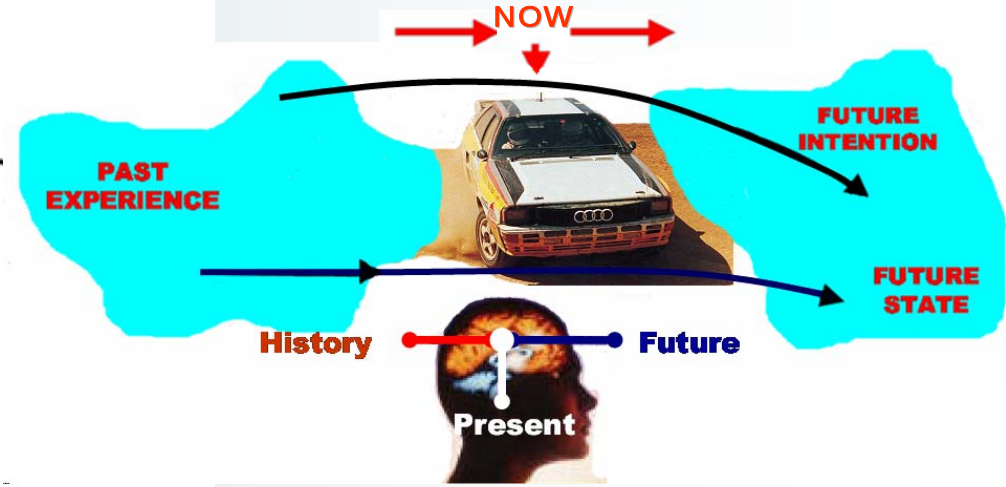


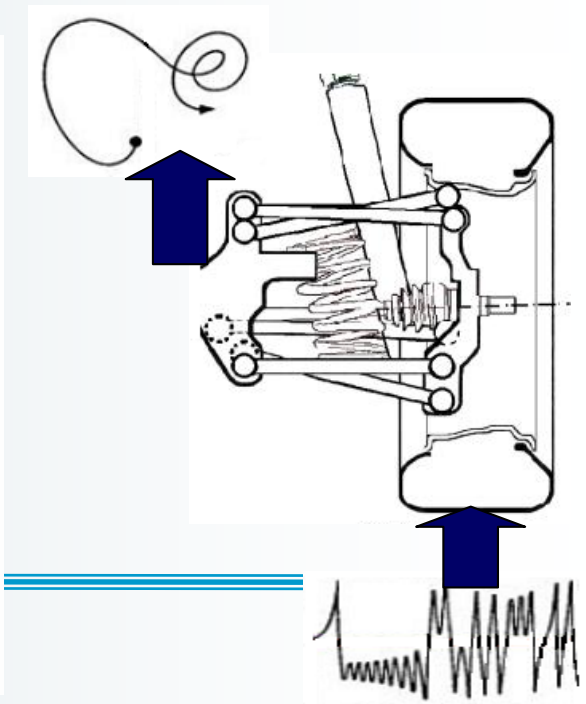




Toe-out at bump as reversed main stream kinematics for rear suspensions, also improves load transfer over the wheel base, which stabilizes the rear.







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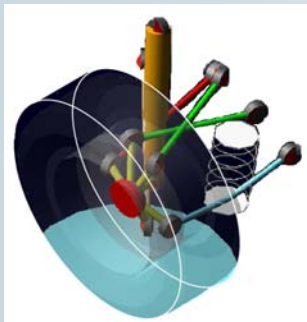
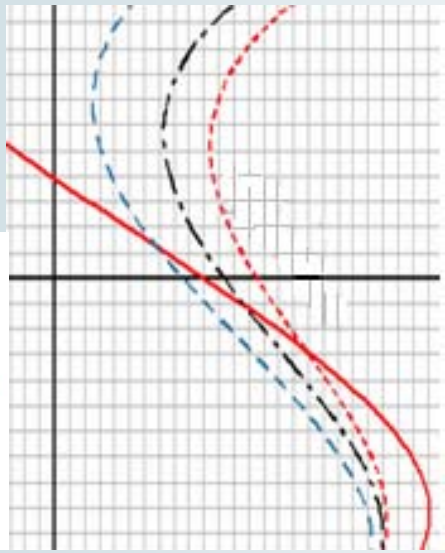
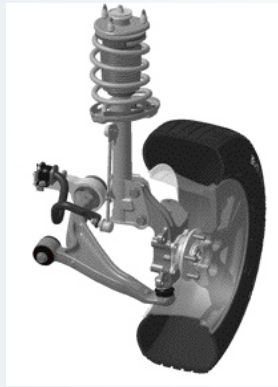
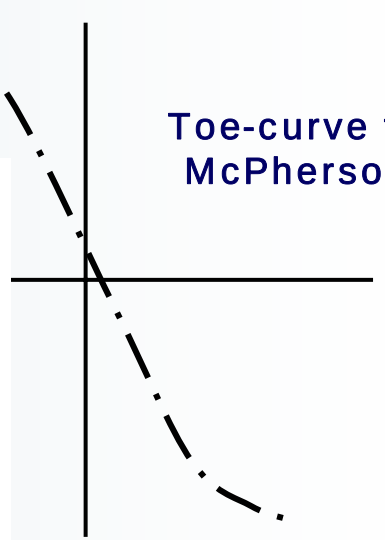
Toe-out at bump as reversed main stream kinematics for rear suspensions, counter intuitively improves lateral acceleration response from precession. Toe-out provides negative camber, which is 30 times faster than toe-steer. Also the gyroscopic effect eliminates all free play in the wheel bearings.









Toe-curve for McPherson!

S-shape for bump steer gives “robust” zero ride steer!

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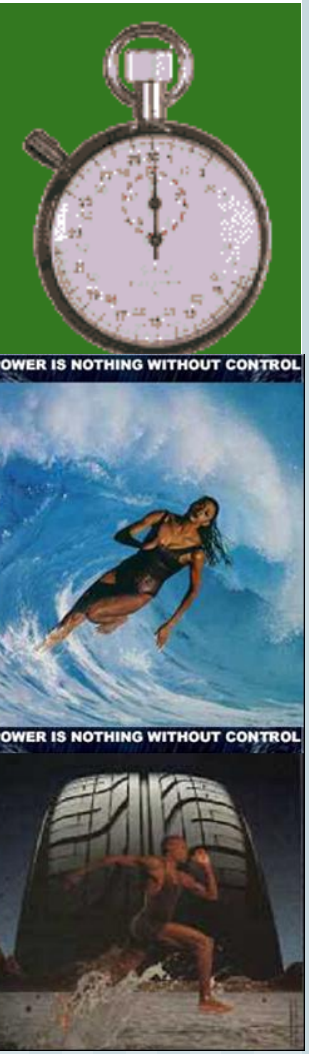
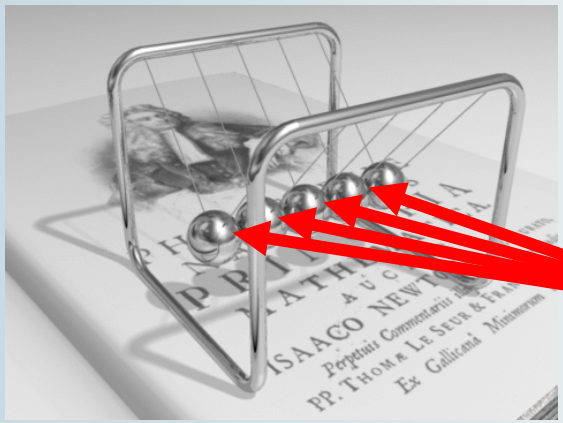


Conservation of Momentum is the most Fundamental Principle in Physics.

Since momentum [physical memory] is related to the motion of objects, we can use its conservation to predict cause and effect in collisions of matter.

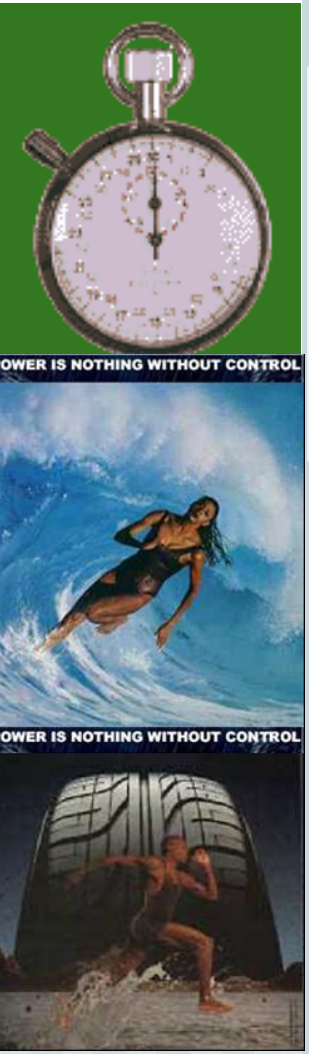
Linear Momentum [p=mv] is analogous to a linear physical memory.
Angular Momentum [L=Iω] is expressed as the cross-product of the moment on inertia of the object and its angular velocity vector [spin].



Local space-time events in between the physical reality we could observe!

SWEDISH ADVANCED AUTOMOTIVE BUSINESS

TGD as Topological GeometroDynamics extended to Tire to Ground Dynamics



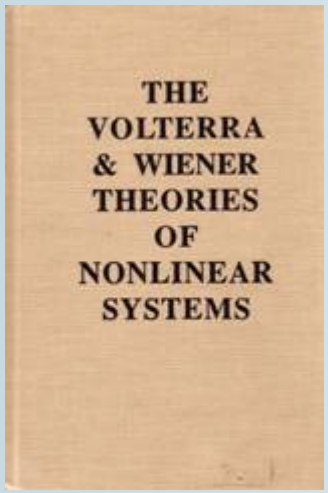
Conservation of Momentum is the most Fundamental Principle in Physics.

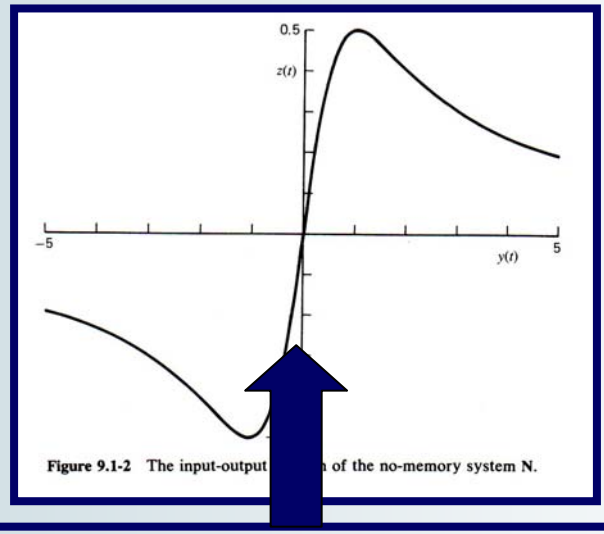
Since momentum [physical memory] is related to the motion of objects, we can use its conservation to predict cause and effect in collisions of matter.

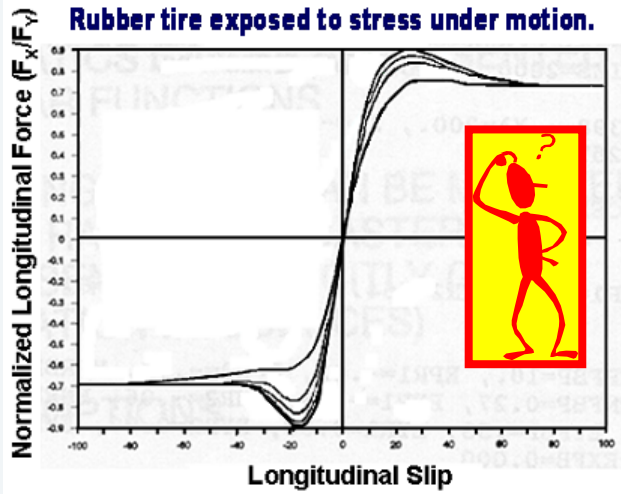
Linear Momentum [p=mv] is analogous to a linear physical memory.
Angular Momentum [L=Iω] is expressed as the cross-product of the moment on inertia of the object and its angular velocity vector [spin].

Topological GeometroDynamics is a modification of General Relativity inspired by the conceptual problems related to the definitions of Inertial and Gravitational Energy in General Relativity. – Matti Pitkänen

Department of Physical Sciences University of Helsinki







The input-output relation of a no-memory system.

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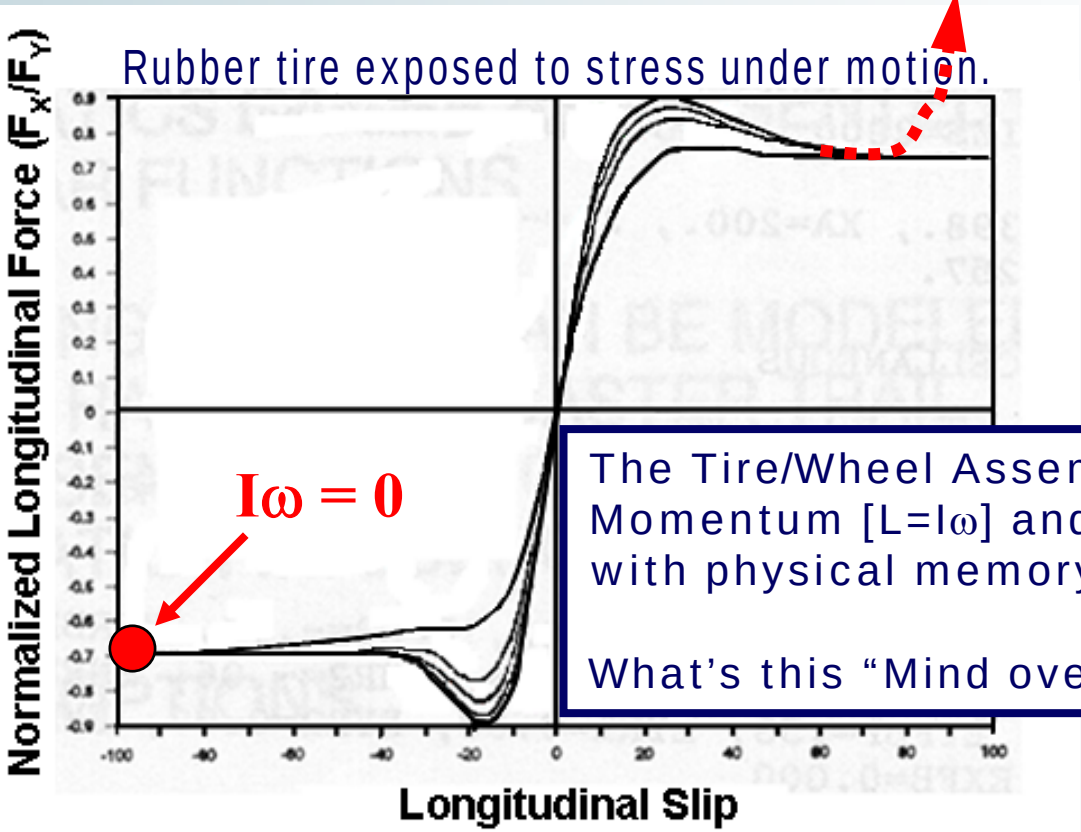
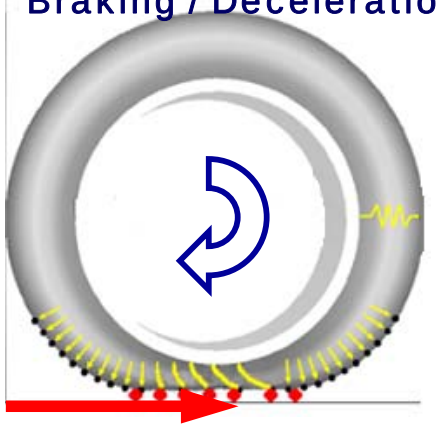
$I\omega \neq 0$



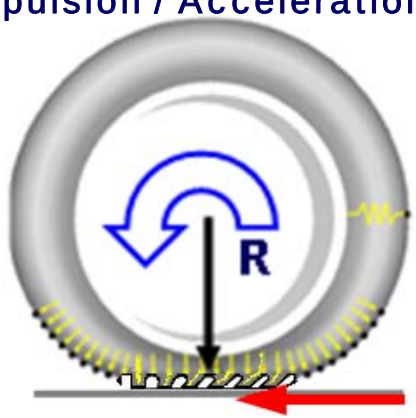
The Tire/Wheel Assembly has Angular Momentum [$L=I\omega$] and is a system with physical memory and "intention".

What's this "Mind over Matter" doing?

Braking / Deceleration



Propulsion / Acceleration



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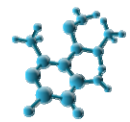
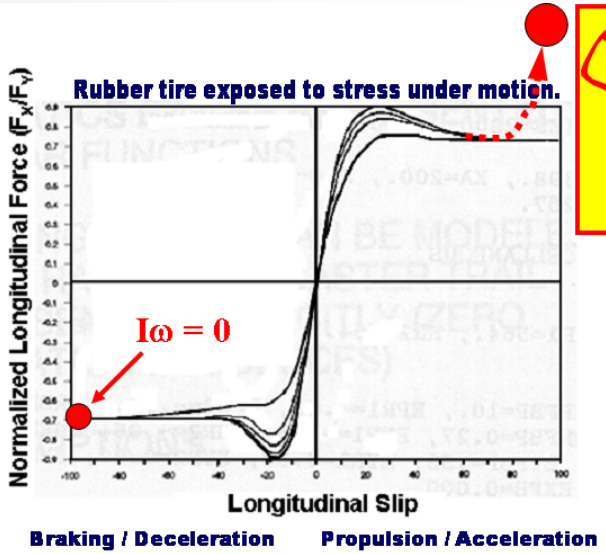


Top Fuel Dragster
Asphalt & Slicks!
Tire/Wheel $L=I\omega\neq 0$
8000 Hp → 5.2g

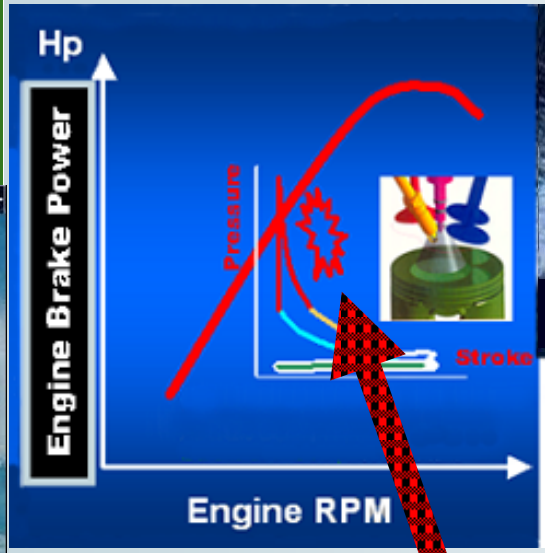


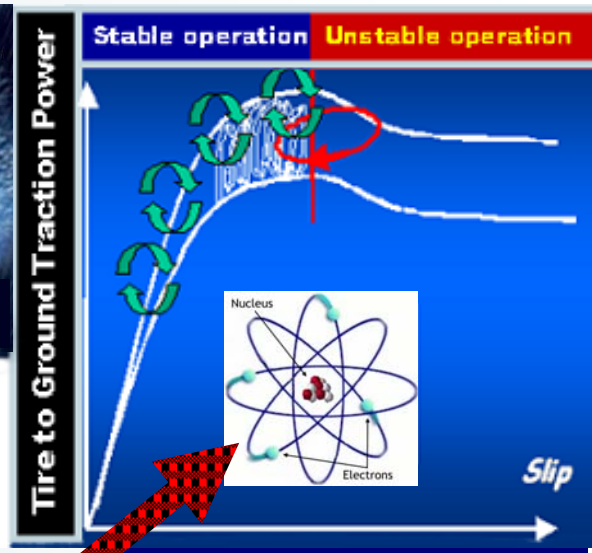
Pikes Peak
Gravel Roads & Slicks!
Tire/Wheel $L=I\omega\neq 0$
850 Hp → Winner!!!

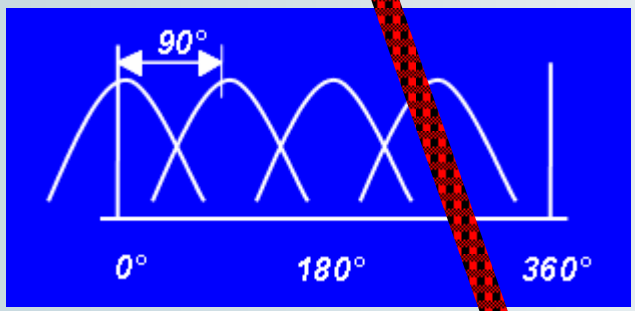
SWEDISH ADVANCED AUTOMOTIVE BUSINESS

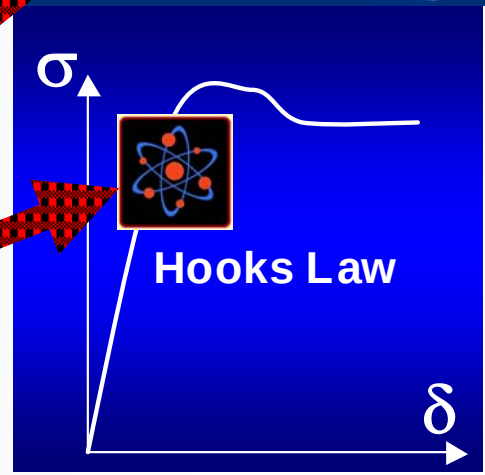
TGD as Topological GeometroDynamics extended to Tire to Ground Dynamics

"Global" tire traction power compares to engine brake power. This "quasi steady state" is a convoluted integral of all attractions in singular points of the tire foot print as "stress under motion" similar to Hooks Law.





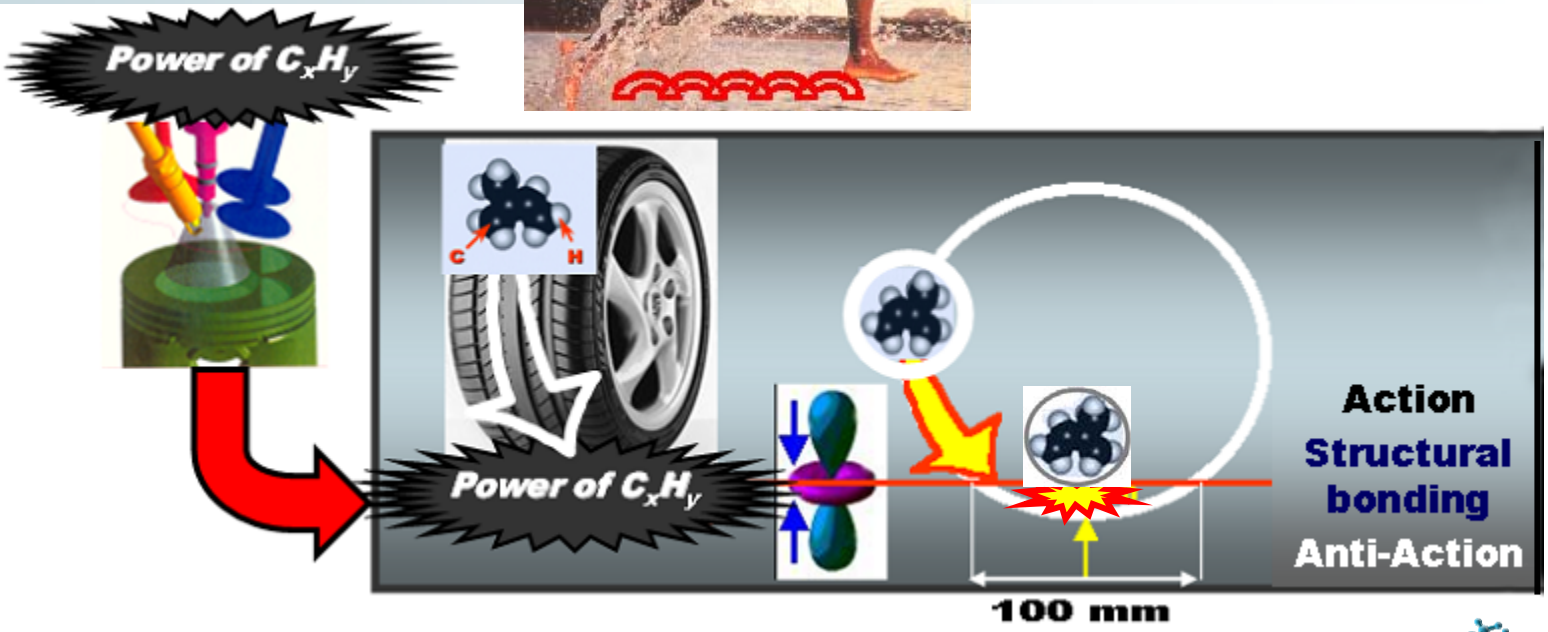




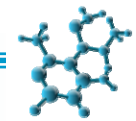
Indicated Power is what "nails" the car to the road!

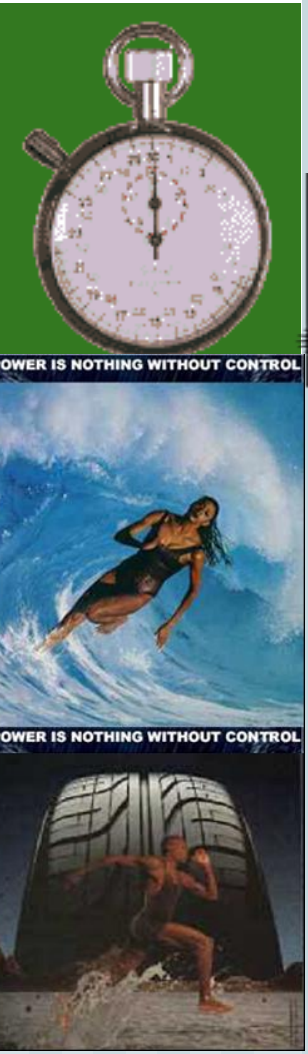
SWEDISH ADVANCED AUTOMOTIVE BUSINESS

For the car on the road at a speed of 40m/s (144 km/h) the tire footprint with a length of 100 mm will see an impulse deflecting the tire periphery with ΔZ ~25 mm during Δt of ~1.25 milliseconds



SWEDISH ADVANCED AUTOMOTIVE BUSINESS





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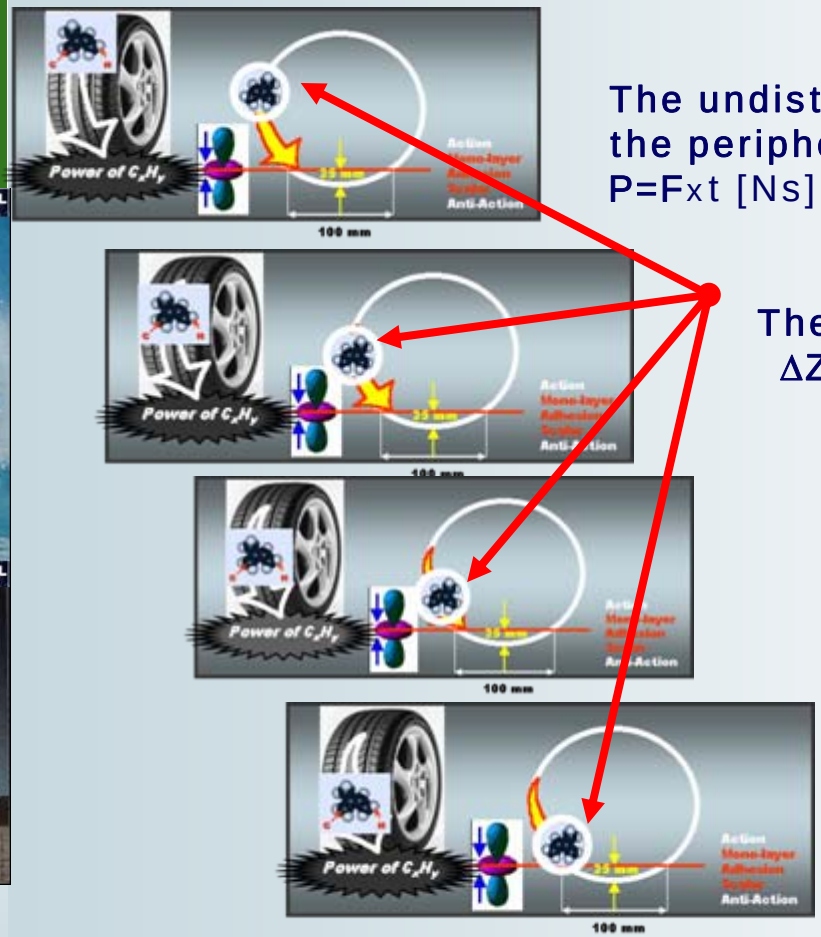
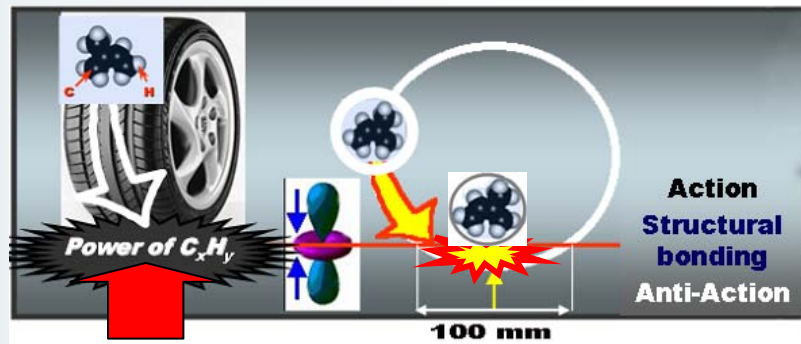


The undisturbed motion of rubber molecules at the periphery of the tire will see an impulse P=Fxt [Ns] caused by the road impact.

The impulse deflects the tire periphery ΔZ ~25 mm within Δt ~1.25 milliseconds.

From Newtonian dynamics $s=\frac{1}{2}at^2$ or $a=2s/t^2$ the acceleration in the vertical direction is 3300 g!



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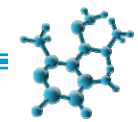

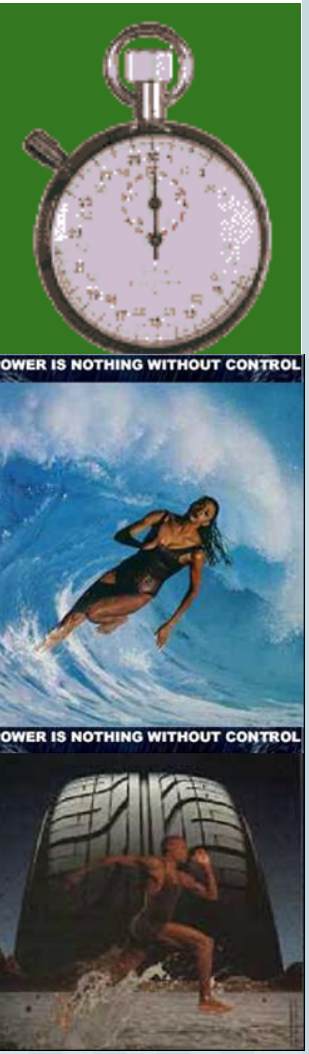

The man on the street would agree that we cannot control a car on the road without gravity.

Aerodynamic down force ~0.5G

Newtonian ground contact ~1.5G

Aerodynamic down force ~2.5G

Newtonian ground contact ~3.5G

Isaac Newton's 2nd Law originates from the observation that the apple in acceleration must be caused by a force called "gravity" and the associated acceleration the "acceleration due to gravity", → F = m x g.

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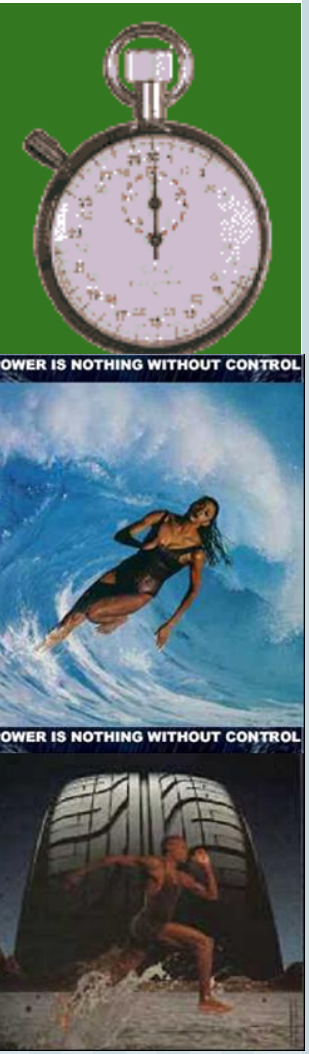

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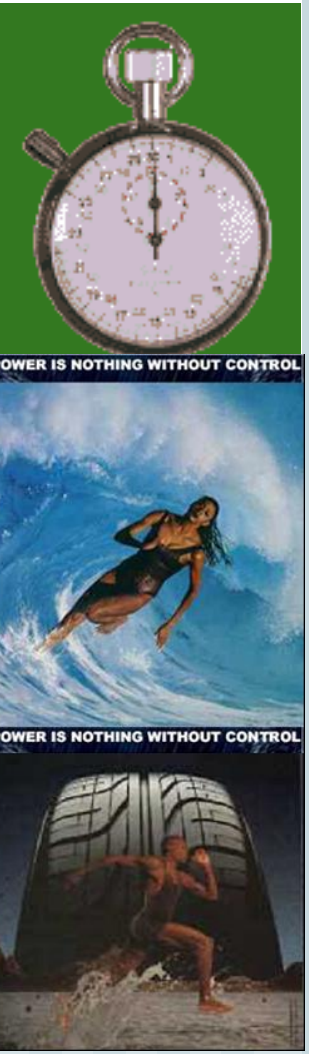
SWEDISH ADVANCED AUTOMOTIVE BUSINESS



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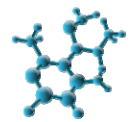
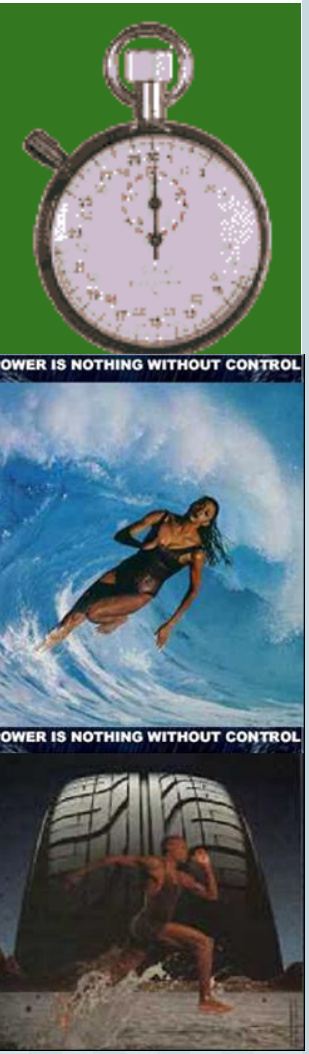
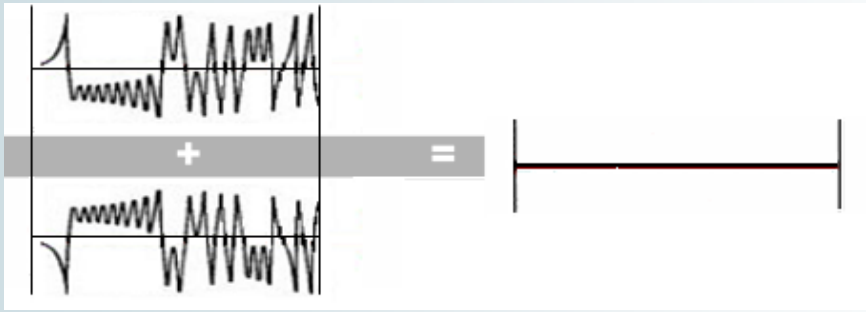
Our suspension concept builds upon the new and more relevant principles of gravity, also reflected in our proposed extended view of Van der Waals forces providing traction as structural bonding within microseconds.

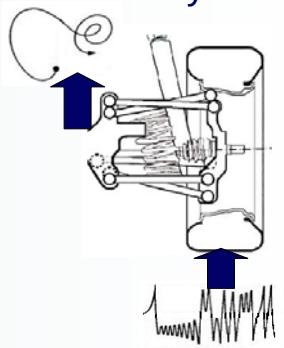
SWEDISH ADVANCED AUTOMOTIVE BUSINESS





"Destructive interference" builds upon the capability of the controller to adaptively provide a mirror-image to cancel out any kind of chaotic impact in order to build dynamic structures of human compatible harmony.





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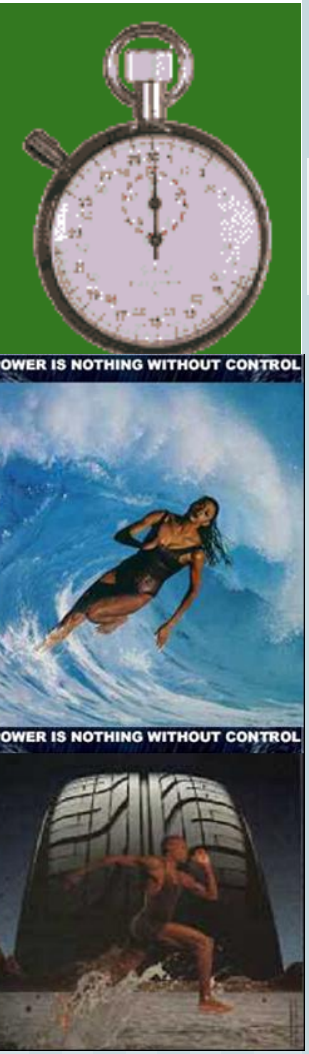

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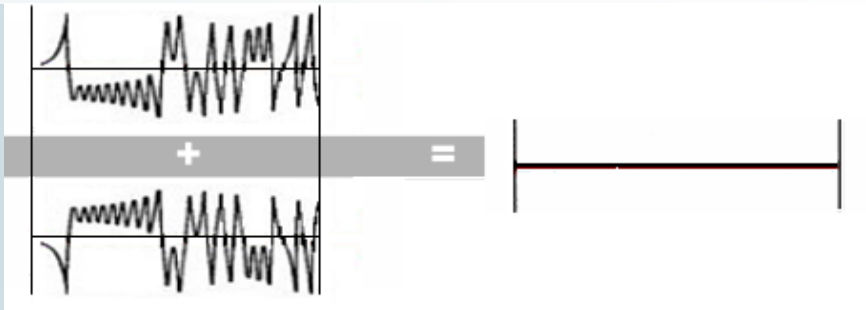
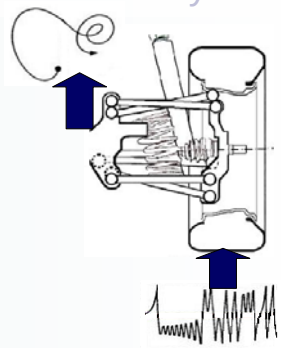
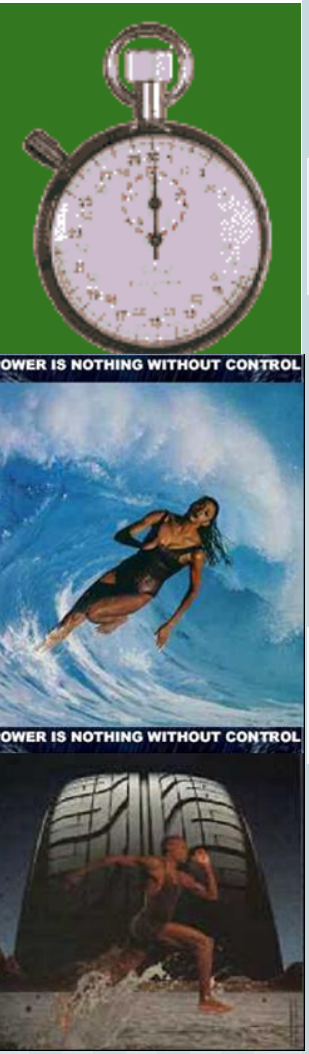




Consider a spring-loaded door that opens a few centimeters when you push on it and swings shut when you stop pushing. Suppose that whenever a person pushes on the door, you push back with an exact mirror picture.

The door is opened and anti-opened such that no visible action is detected.

SWEDISH ADVANCED AUTOMOTIVE BUSINESS



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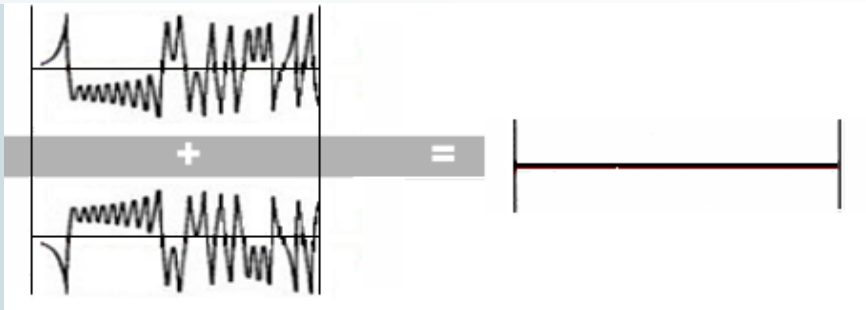

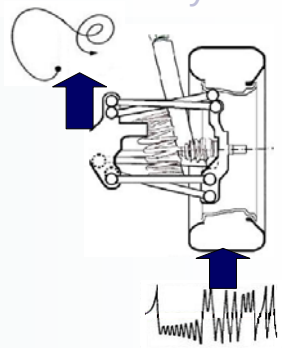

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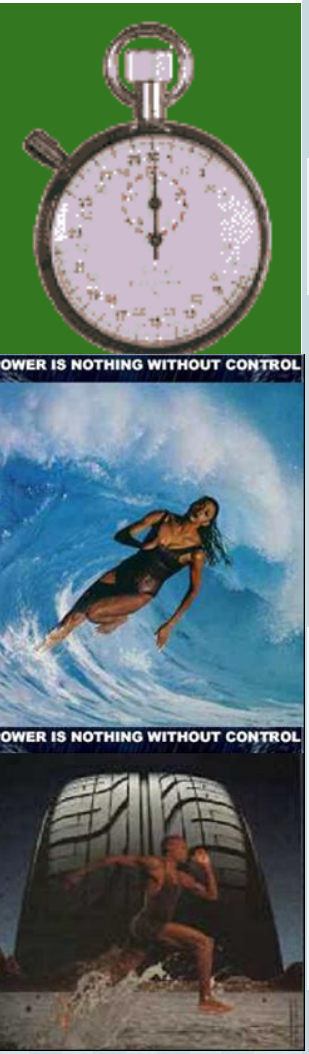
The door is opened and anti-opened such that no visible action is detected.

The non-event is an effect caused by an active operator with capability to adaptively change the "input impedance" or "driving point impedance" on the other side of the door when the first person is pushing.

SWEDISH ADVANCED AUTOMOTIVE BUSINESS



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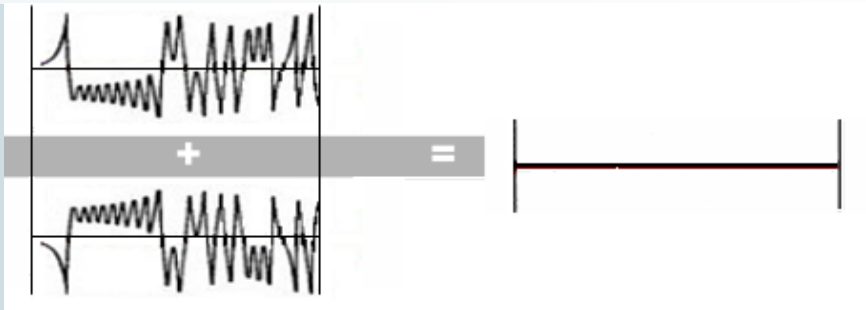

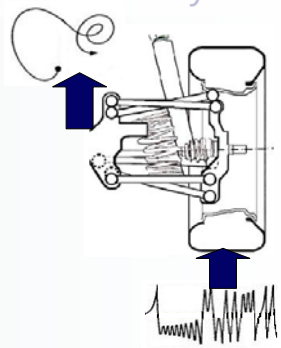

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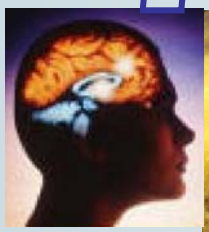
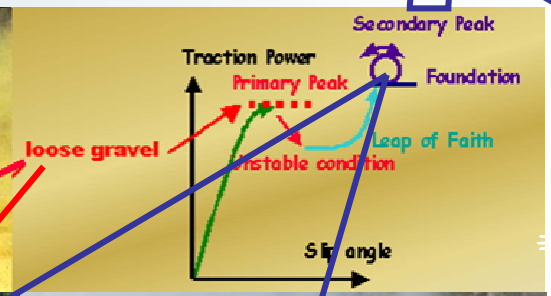
Total destructive interference demands reading the mind-action of the first person and from the other side of the door provide an exact mirror image.

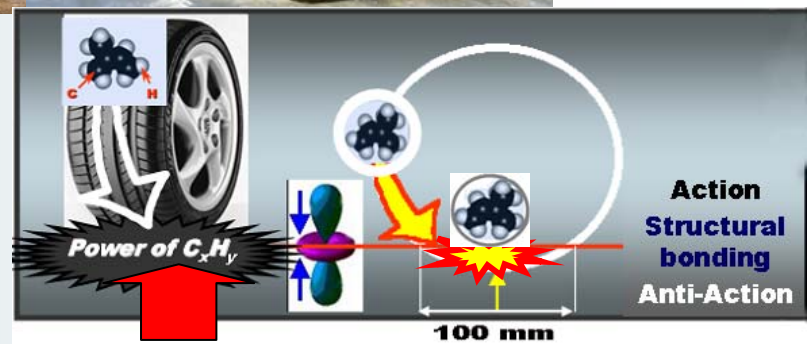
The "door" being opened and anti-opened is the tire-to road interface, where the road has a very high "driving point impedance" and the controller with capability to mirror the suspension action is the suspension itself.

SWEDISH ADVANCED AUTOMOTIVE BUSINESS

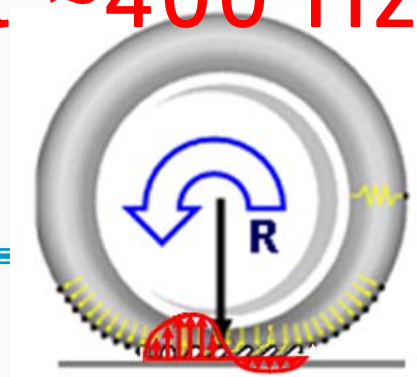
TGD as Topological GeometroDynamics extended to Tire to Ground Dynamics







3300g at ~400 Hz



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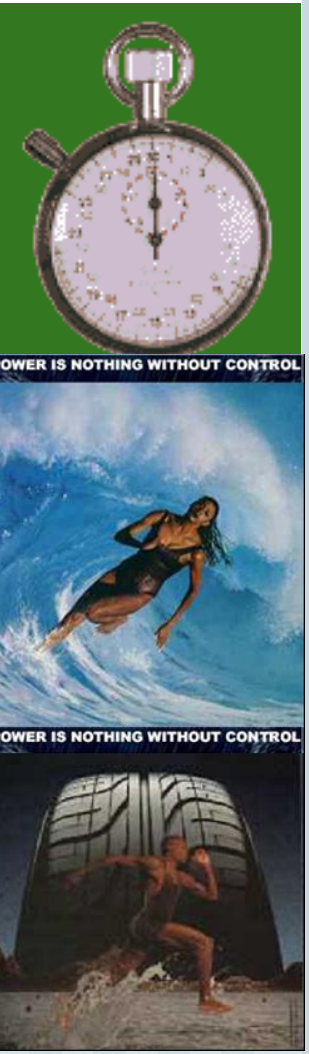
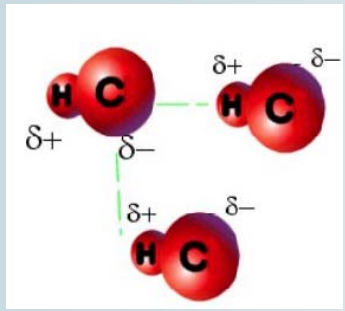
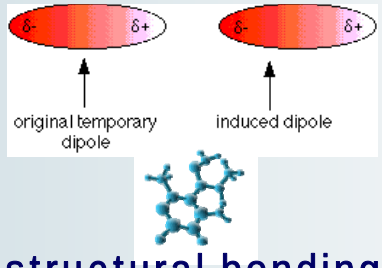


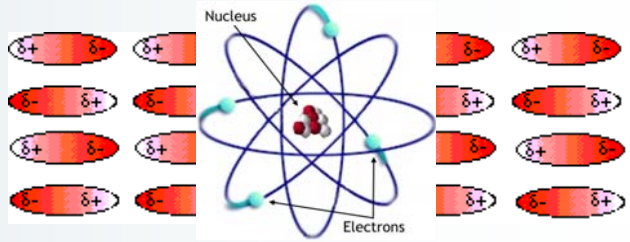
Van der Waals forces act during microseconds!

Van der Waals forces describe intermolecular attractions in the free motion of molecules in gases and fluids. Those attractions are very weak.





structural bonding



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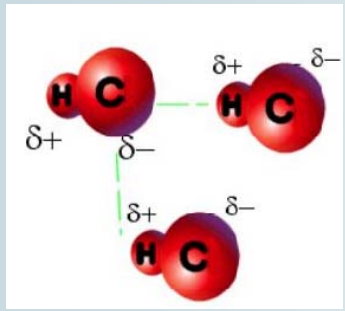

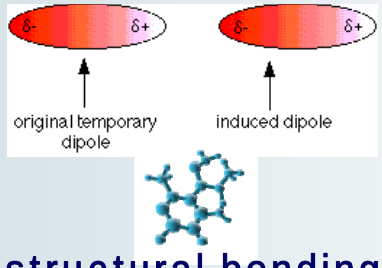

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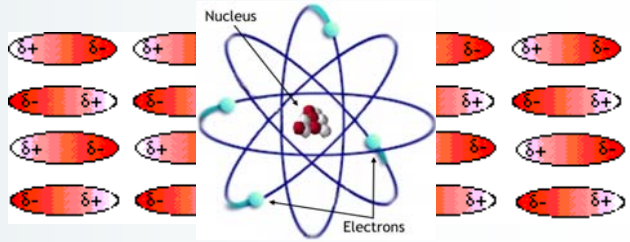
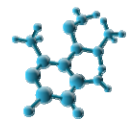


structural bonding

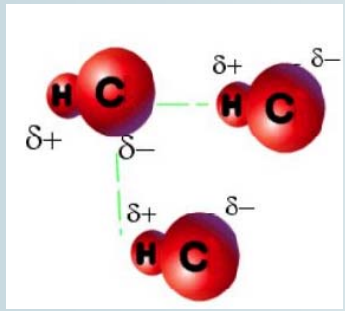
Causal rigor in valid models of physics makes credible to introduce

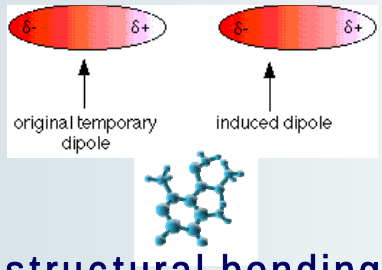
a dipole effect from an extended view of Van der Waals forces.



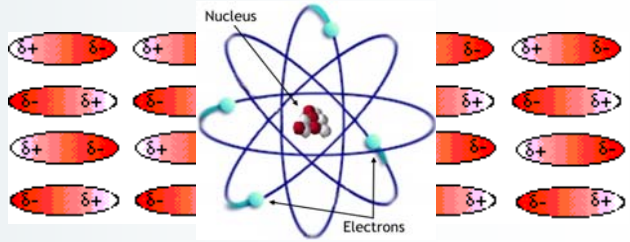
Van der Waals forces act during microseconds!

Van der Waals forces describe intermolecular attractions in the free motion of molecules in gases and fluids. Those attractions are very weak.





structural bonding



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The road impact will hit the rubber molecule with an exposure of 3300 g! The local carbon and hydrogen atoms due to their very different atomic weights and different inertia will be exposed to different impacts Fxt = mxv.

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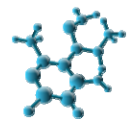

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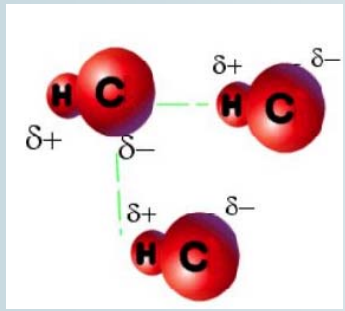

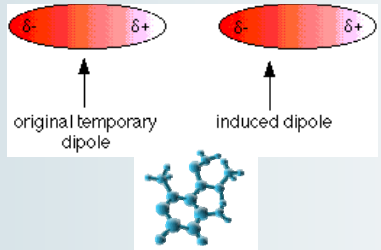

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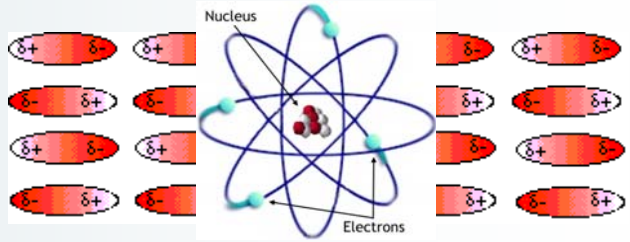

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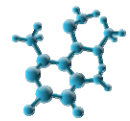
The hypothesis is that a "forced" dipole occurs in the tire rubber molecules as a result of the physical contact from the road. This in itself sets up an induced dipole in the molecules of the road and

structural bonding occurs.



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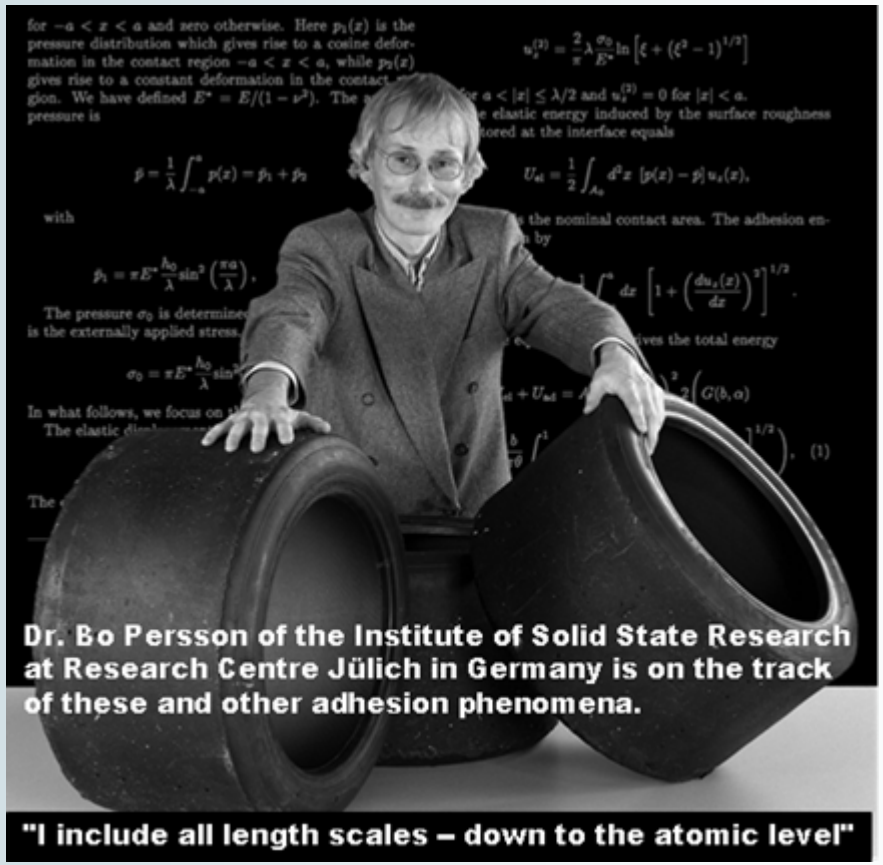
The new view of physical principles for tire to road traction capability

a dipole effect from an extended view of Van der Waals forces.

is also supported by Dr. Bo Persson of the institute of Solid State Research



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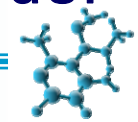
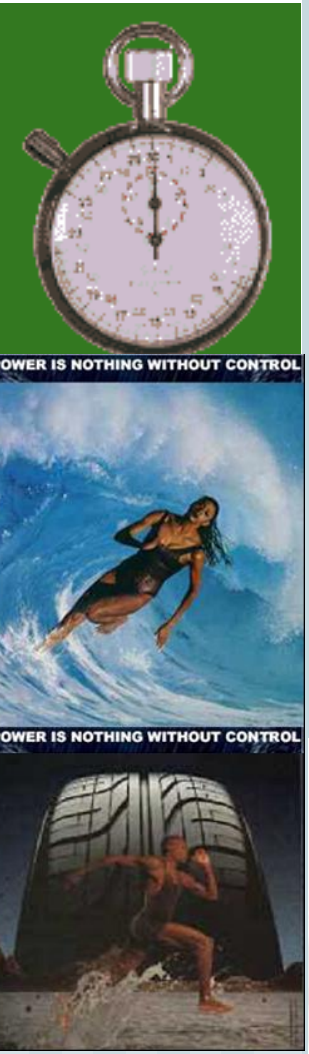
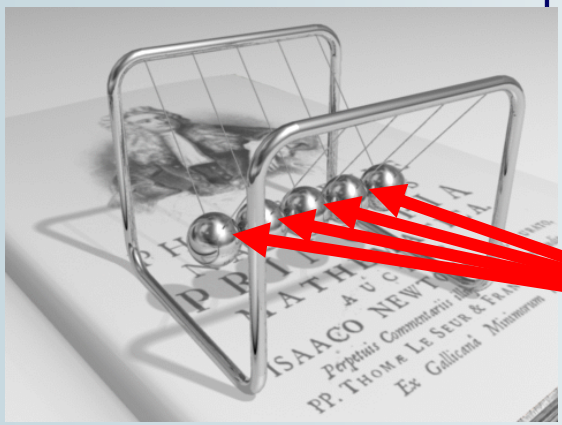


TGD as Topological GeometroDynamics extended to Tire to Ground Dynamics

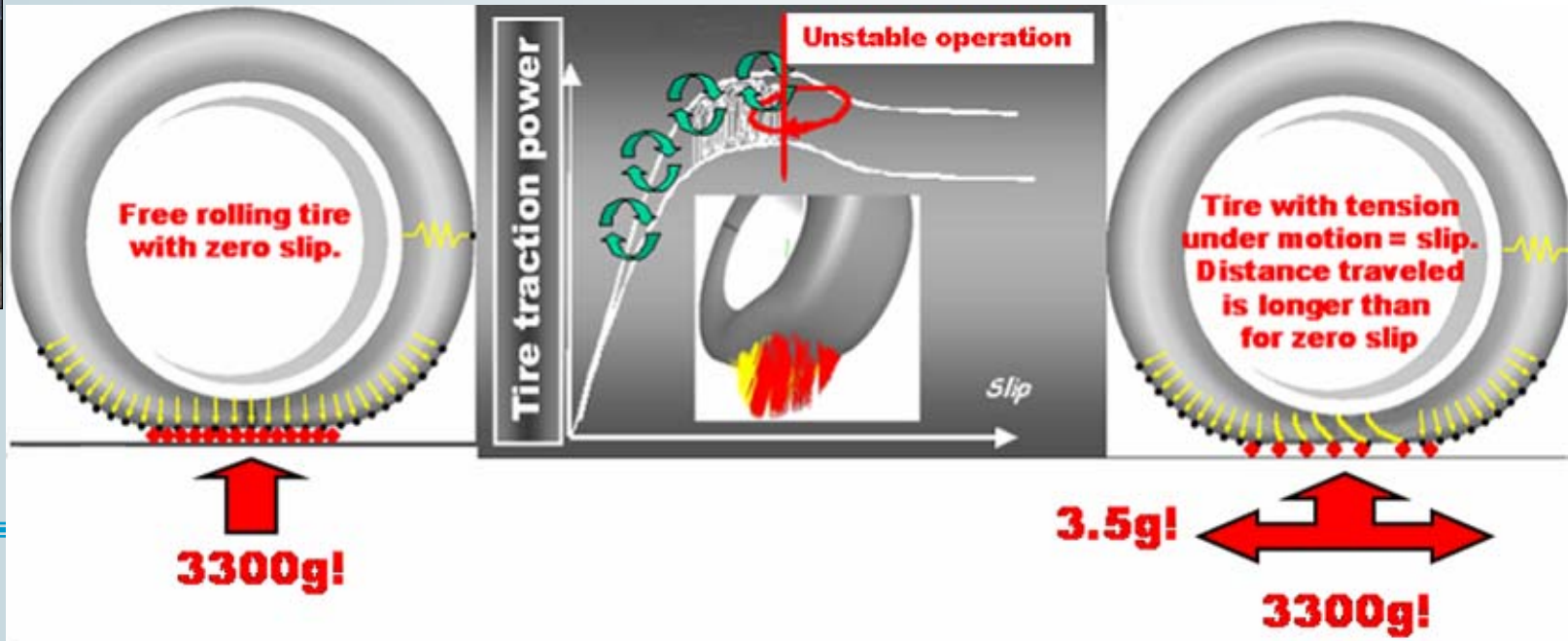


Engine brake power is the over time integrated pulses from engine indicated power, each as a convoluted integral of space-time microsecond impulses acting on the top of the moving piston as “compression under motion”.

Tire traction power is the over time convoluted integral of all space-time events of microsecond di-pole attractions in singular points of the foot print.



Local space-time events in between the physical reality we could observe!



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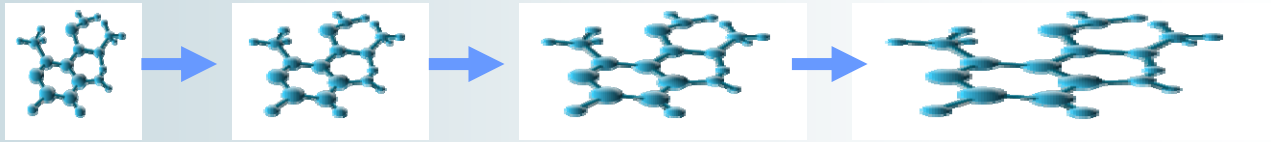
The “local” tire performance is a vector cross product of stress under motion or $\Delta\sigma$ (change in stress) per Δv (change in velocity).



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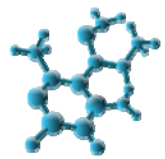

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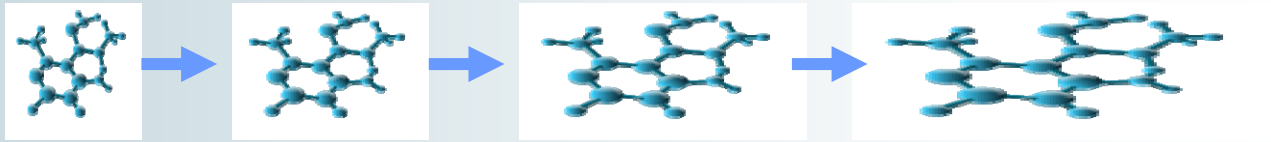

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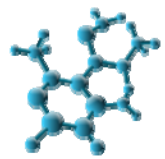

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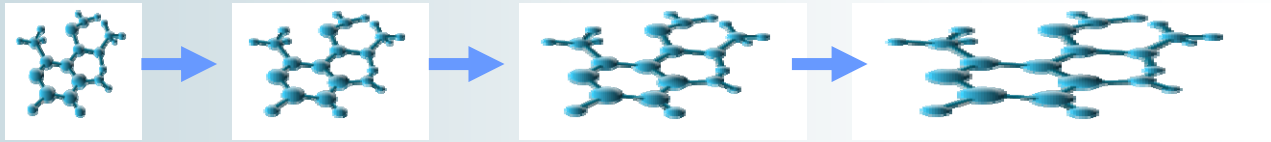

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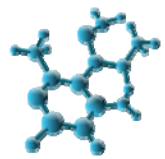

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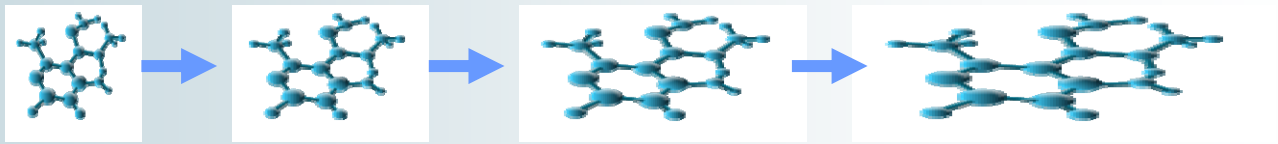

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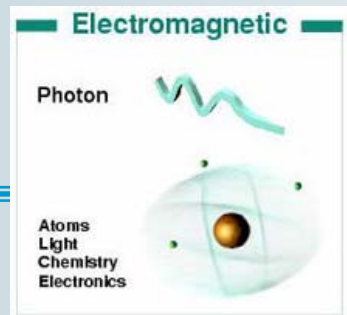
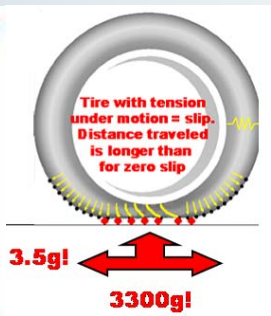
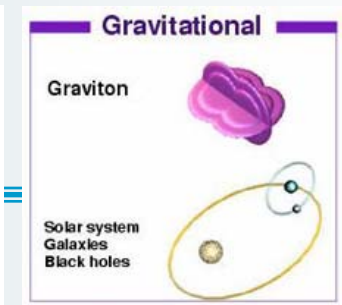
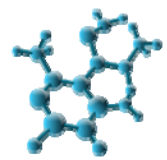
"Local ripples in space-time" has an analogy in Maxwell's unification of the electric and magnetic forces. A hidden property called "gauge symmetry" - means that absolute direction of power propagation change in space-time.









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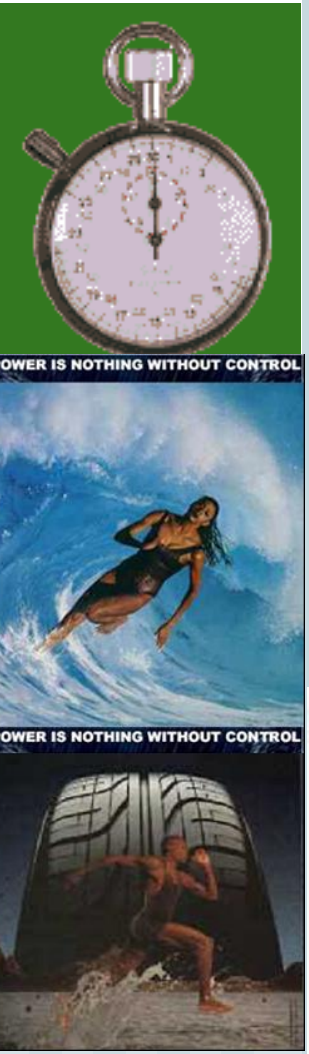
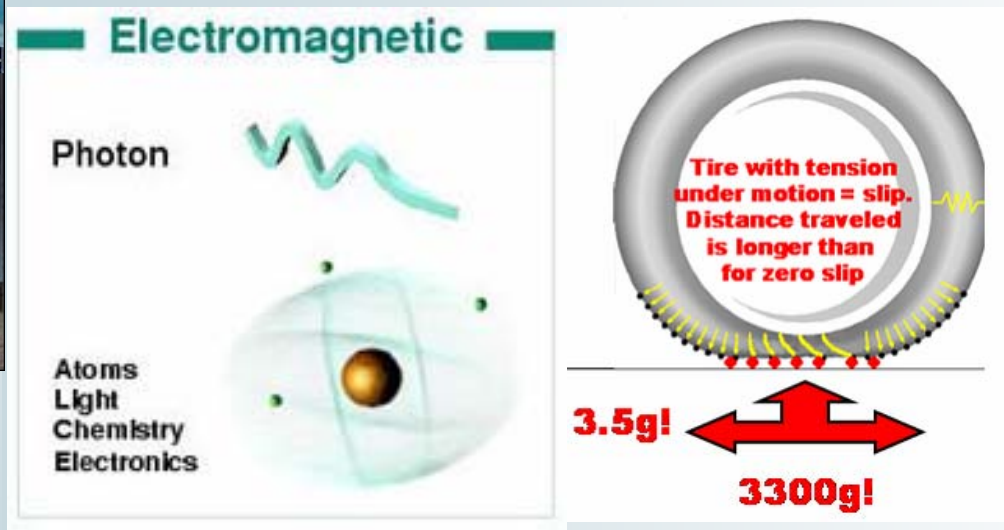
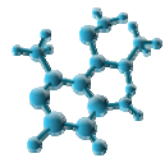


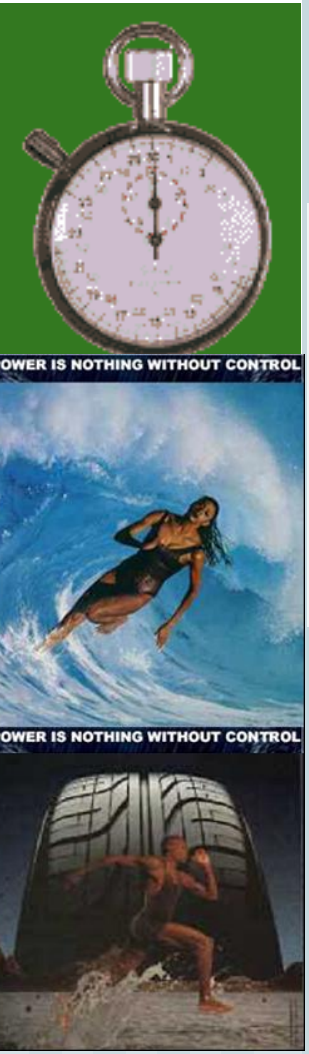
"Local ripples in space-time" (gravitational white noise) are the gravitational equivalence to photons, called gravitons. Dynamics beyond the frequencies of light and atomic vibrations cannot be measured as singular events.

$$G^{\mu\nu} - \Lambda g^{\mu\nu} = 8\pi G_N/c^4\ T^{\mu\nu}$$

The above field equation of Albert Einstein is a high level synthesis of all the complex mathematics behind his thesis of gravity and geometrodynamics:







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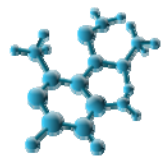

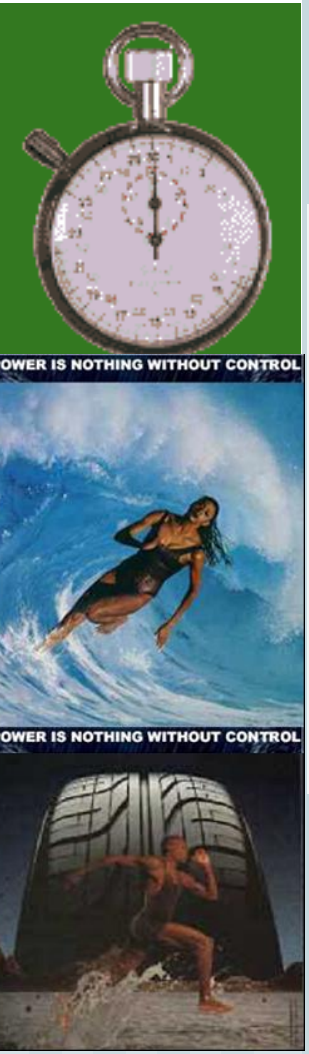

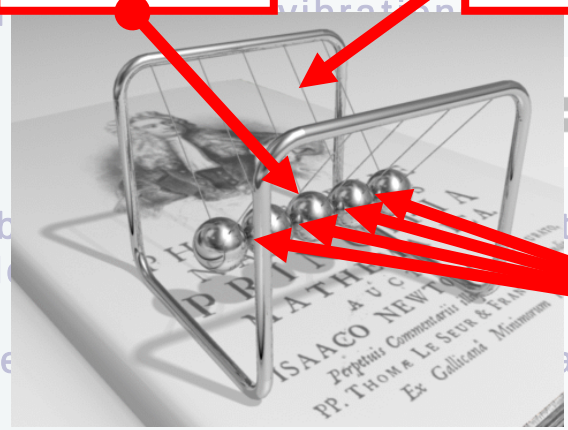

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Compare this with how a topology in a suspension defines:

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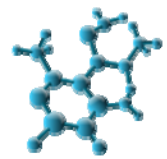

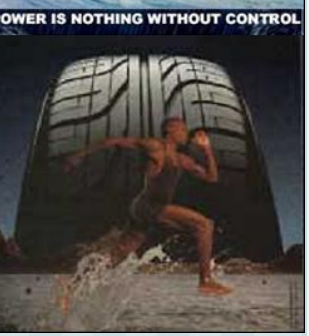

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The whole purpose of a suspension topology is to transform a chaotic road impact into well ordered dynamics. The identity of Power of Gravity is that of transforming the Power of Chaos into well defined order.

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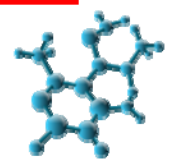

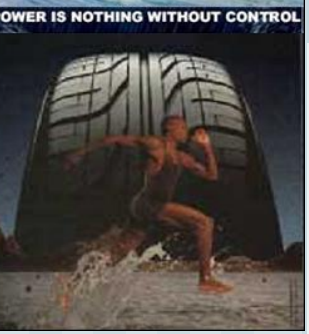

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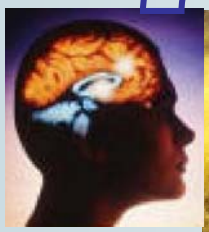

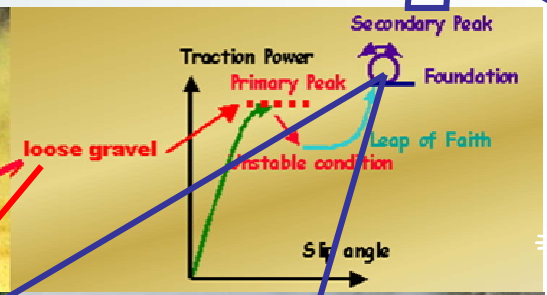

Van der Waals forces during microseconds provide rally peak performance. Extra propulsion power of spinning wheels is applied to ”wipe away” the loose gravel to find tires contact to firm ground of structural bonding!

Also Top Fuel Dragsters have spinning wheels but in that case with a rigid axle to control one degree of freedom in motion on smooth asphalt.

Rally cars with six degrees of freedom for each of four interdependent tire/wheel interactions with a road topology, which generates stochastic impacts present engineering challenges of a very different magnitude.

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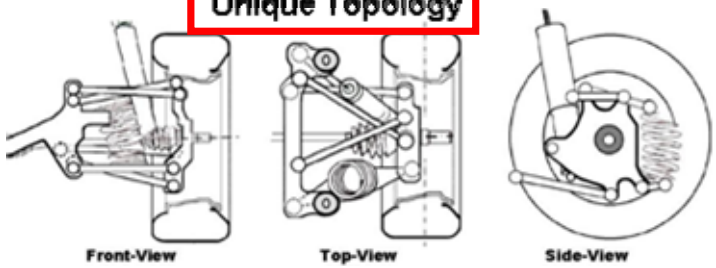
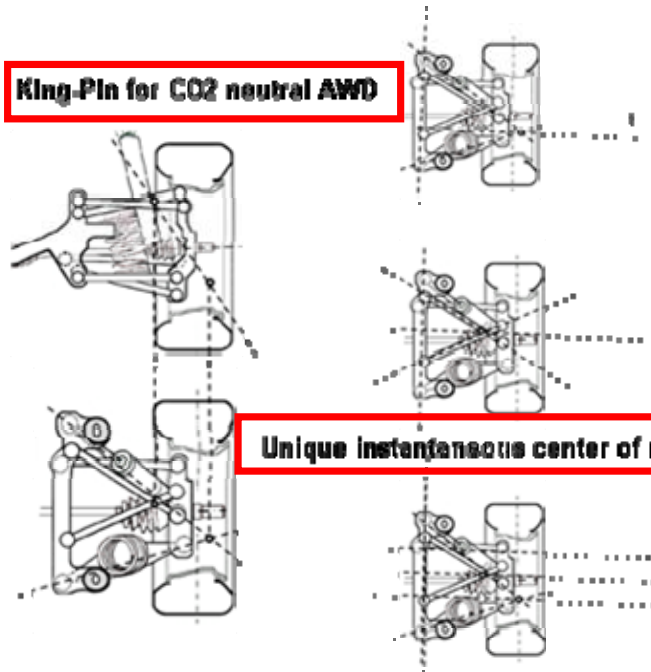
Six firm and de-coupled elements is what is needed in order to control dynamics over the actual and complete frequency domain from very low frequencies up to at least 400 Hz in six degrees of freedom!

Patent Application WO 2008/053034 A1

Unique Topology



King-Pin for CO2 neutral AWD



Unique instantaneous center of motion

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(74) Agent: BJERKÉNS PATENTBYRÅ KB; Östermalmsgatan 58, S-114 50 Stockholm (SE).

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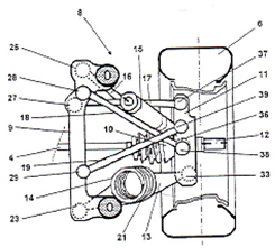
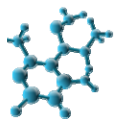
Published:
— *with international search report*

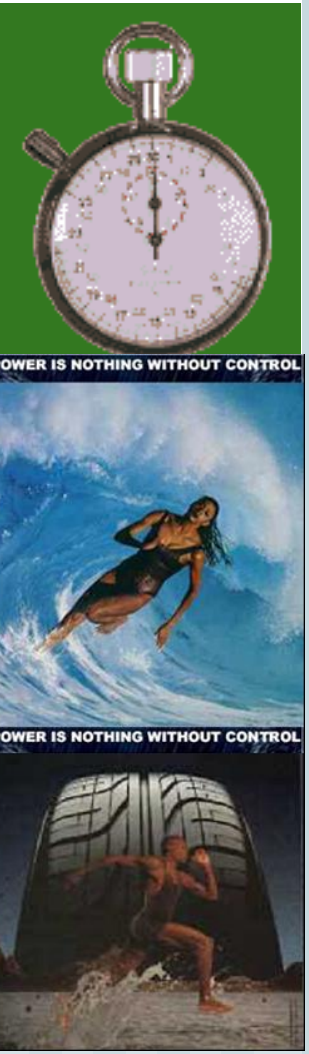
(54) Title: A WHEEL SUSPENSION ASSEMBLY, AND A MOTOR VEHICLE



(57) Abstract: The invention refers to a motor vehicle and wheel suspension assembly for a rear wheel of a motor vehicle. The assembly comprises wheel spindle housing (11) supporting a wheel spindle (12) carrying the rear wheel (6) and defining a wheel center. A frame structure (9) is adapted to be connected to a vehicle body or an engine-transmission assembly of the motor vehicle. A spring link (13) extends between the frame structure and the wheel spindle housing and carries a vehicle spring (14). First and second control links (16, 17) extend between the frame structure and the wheel spindle housing to control the wheel spindle housing to maintain the rear wheel substantially in parallel with a longitudinal direction (X). A first (18) and second (19) camber link extends between the frame structure and the wheel spindle housing, and intersect each other. An instantaneous center of motion is located at a position far outside the wheel and then rearward the wheel, or far inside the wheel and then forward the wheel.

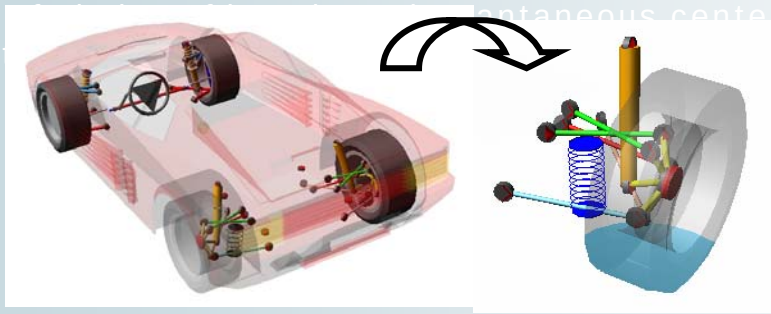
WO 2008/053034 A1





Patent Application WO 2008/053034 A1

The object of the topology....is to provide an instantaneous center of motion....as defined by the topology of the wheel suspension as connected to the vehicle body and thus defined in a body fixed coordinate system to coincide with the instantaneous center of motion for the around the wheel spindle rotating tire-wheel assembly with a road contact defined as a Homogeneous Contact Compression Interaction, where the tire-to-road contact is defined in a road fixed coordinate system.....which enables maximizing structural bonding over the entire contact patch during the extremely short time duration of Van der Waals forces..... From the freedom ... instantaneous center of upper camber links defining ... e to the center of the drive joint ... neous "traction power" from ... rence."



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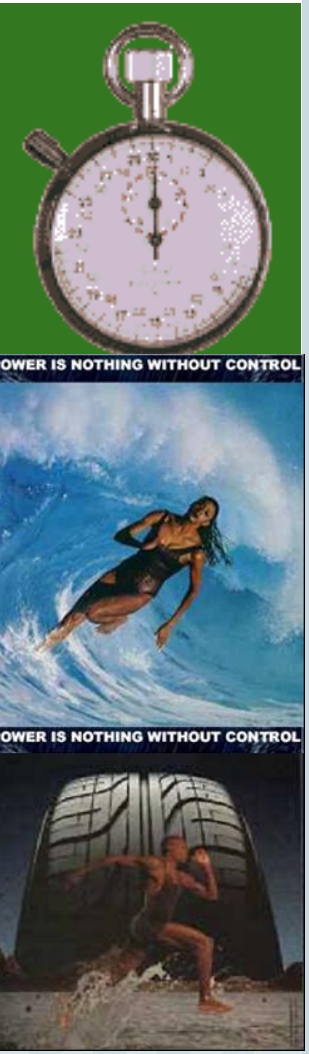

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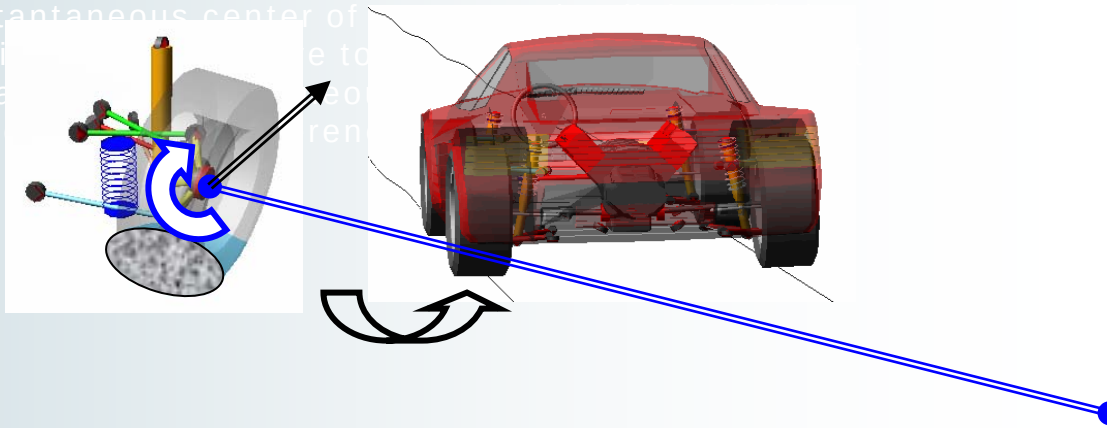

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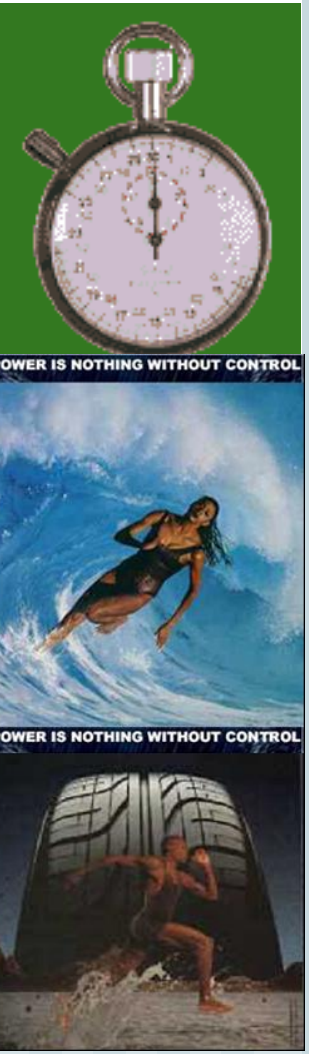

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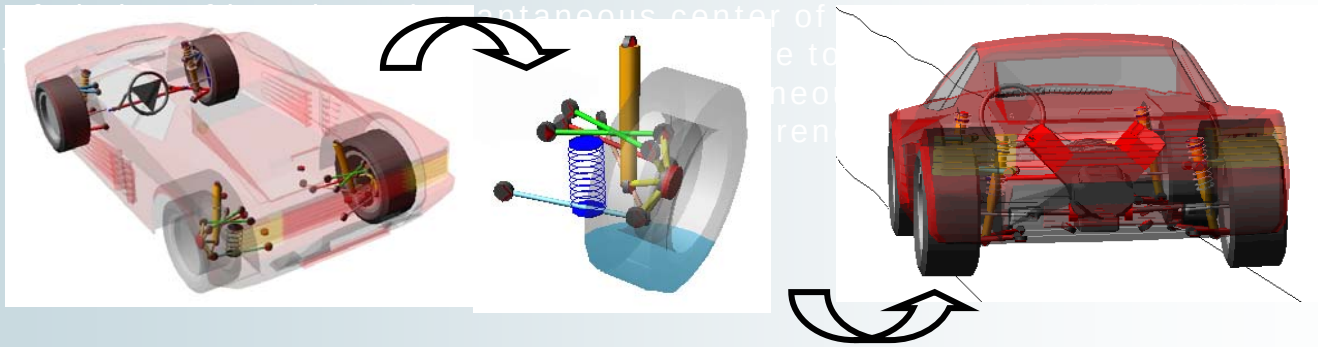

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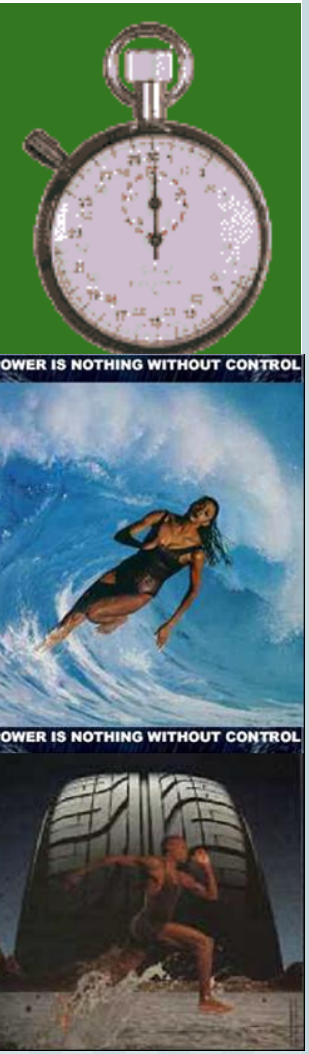

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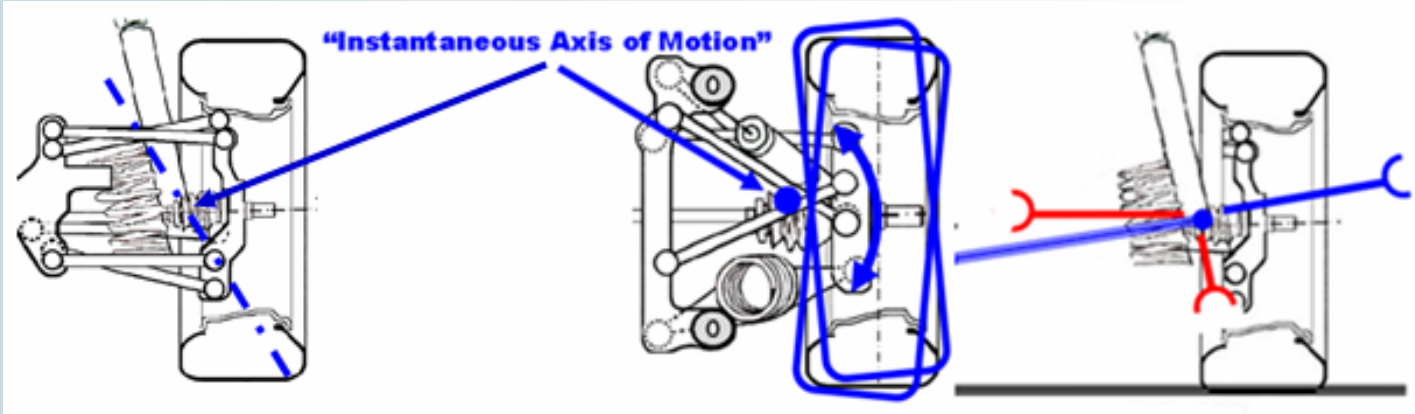
"destructive interference."



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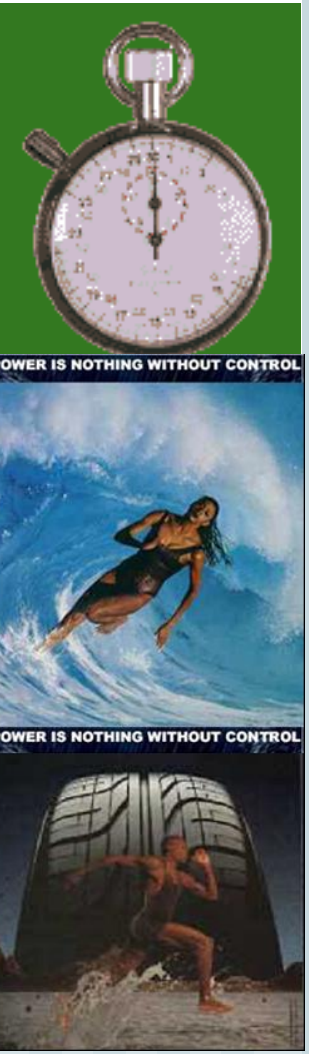
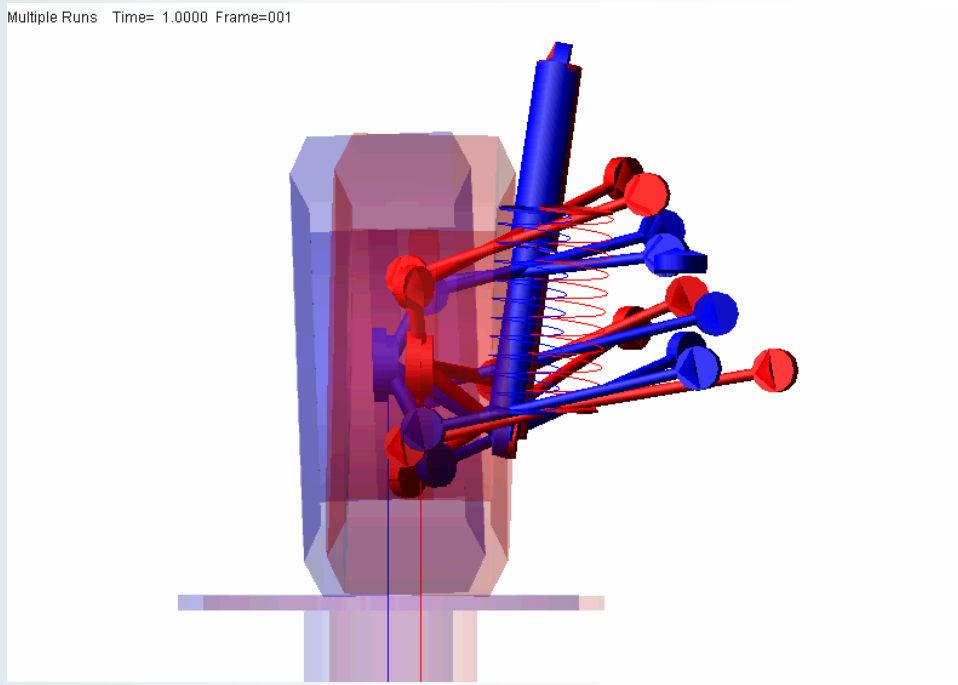
TGD as Topological GeometroDynamics extended to Tire to Ground Dynamics



Topology as the study or science of places in general includes “places in space” as well as “places in time”! Inertia used as a physical memory makes possible to define a suspension, which transforms chaos into order.

S2AB 5-Link

Competitor



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Advanced tools of simulation makes possible to visualize a pattern of propagating impulses [Quantum States].

Structural bonding of micro-effects to be controlled within microseconds with precision on molecular distance.

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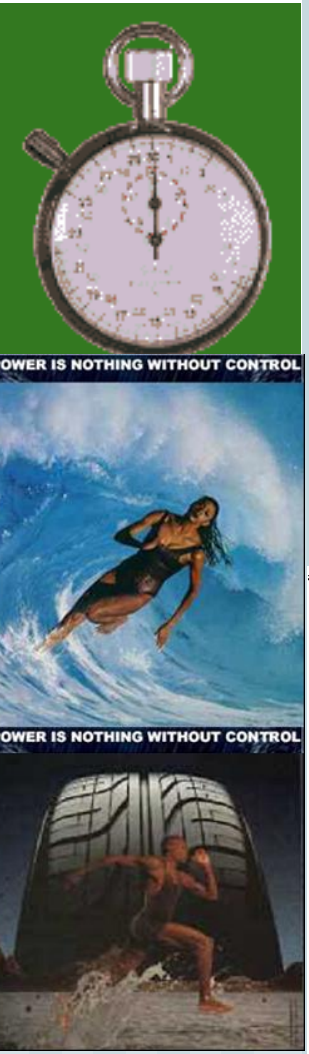
TGD as Topological GeometroDynamics extended to Tire to Ground Dynamics



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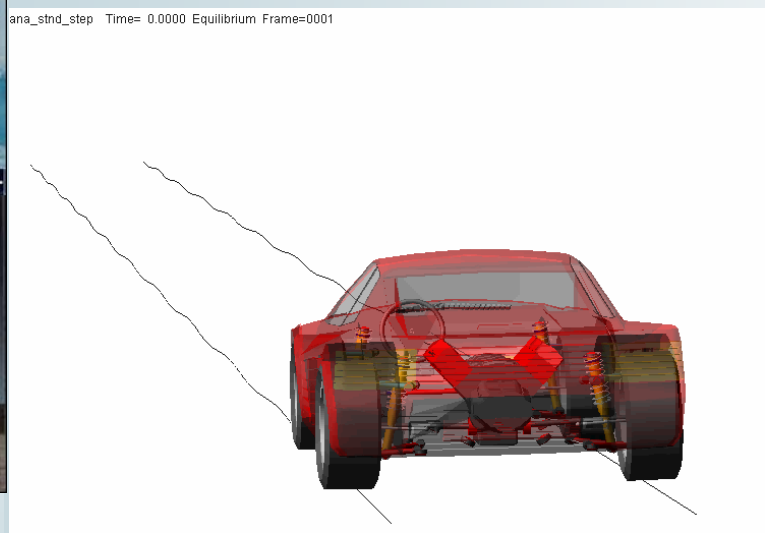

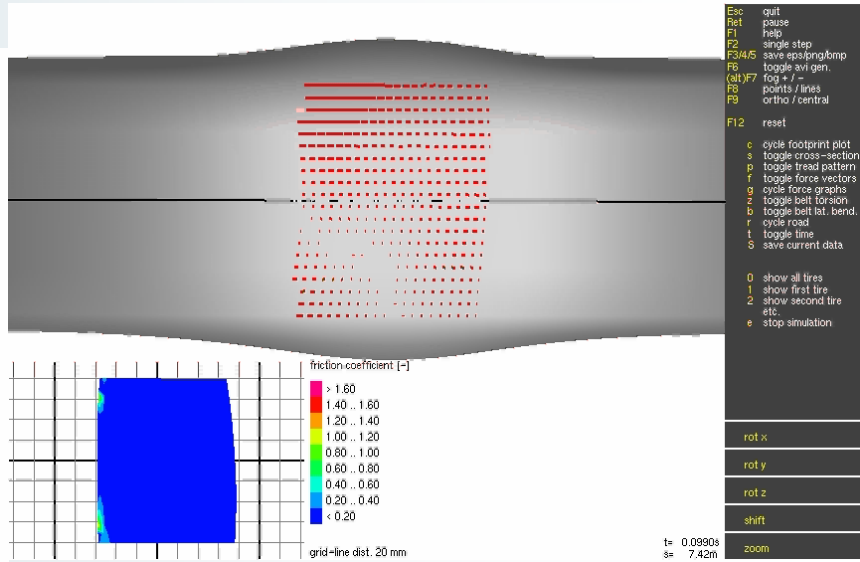

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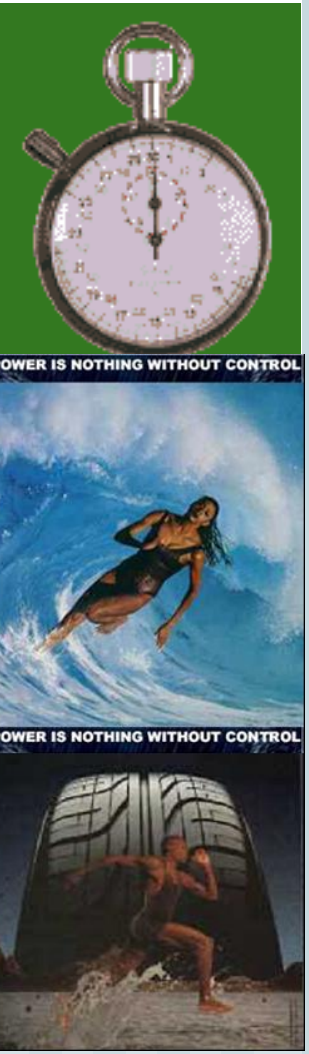
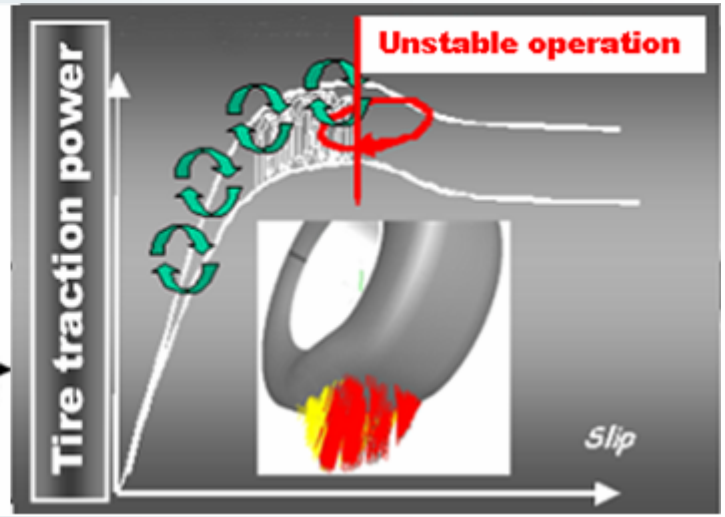
TGD as Topological GeometroDynamics extended to Tire to Ground Dynamics





"Quasi-steady-state" representations from tire test machines show tire characteristics as "lateral force" vs. "slip". [Newtonian mechanics.]

However, tire stresses are multi-directional (tensors) while tire forces and moments (vectors) are a simplification of a more complex dynamic pattern.

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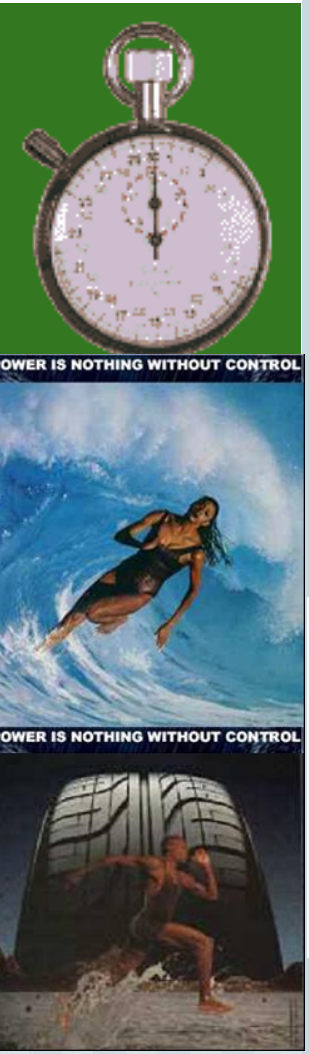
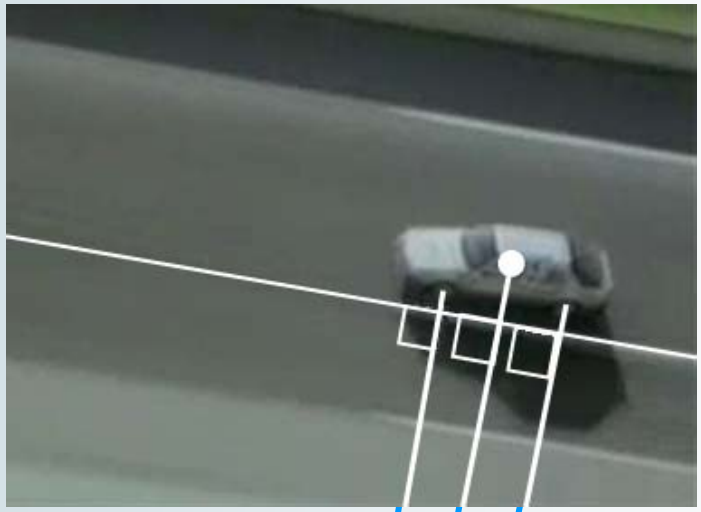
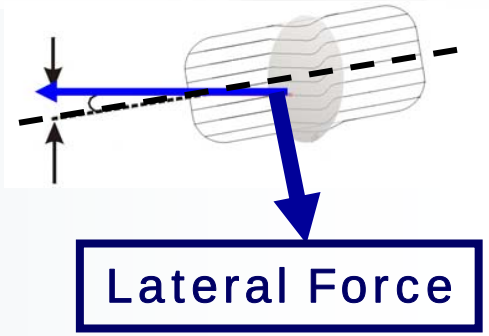
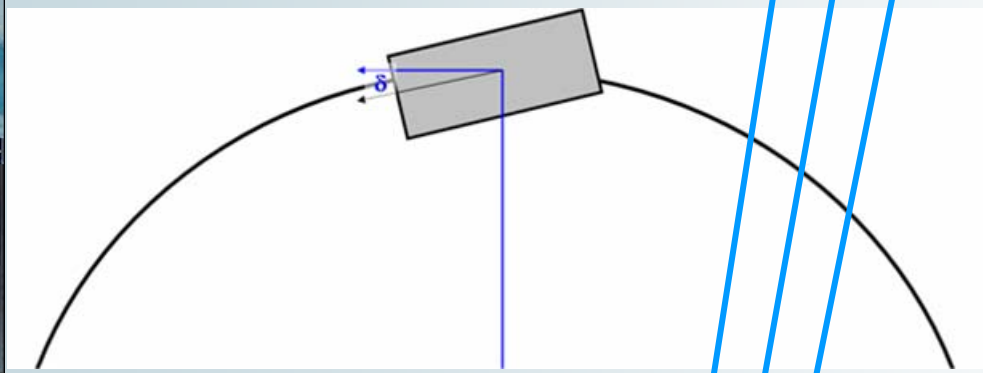
TGD as Topological GeometroDynamics extended to Tire to Ground Dynamics







Lateral Force



The above top view of real life cornering, with “free rolling” rear wheels shows that centripetal forces directed towards the instantaneous center of the curvature do not coincide with Newtonian “quasi-steady-state” forces.

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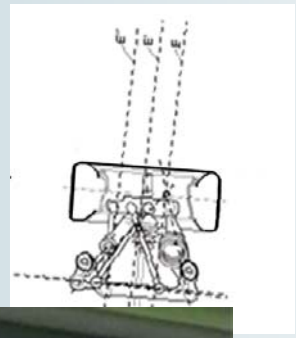
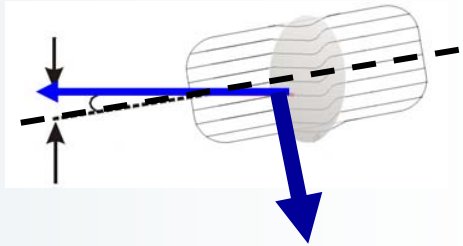
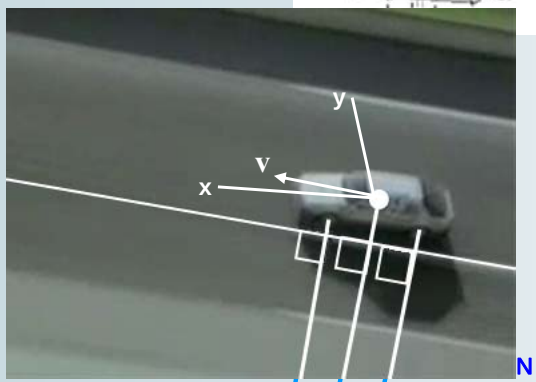
The 5-Link pending patent has defined topology from the location of the instantaneous center of motion, which in reality is a dynamic function.







Newton $F_z = m_x g = N \rightarrow F_y = \mu N$

Aerodynamic down force ~0.5G

Newtonian ground contact ~1.5G

Aerodynamic down force ~2.5G

Newtonian ground contact ~3.5G

vs.

Tire to Ground Dynamics of 3300g!

Patent Application WO 2008/053034 A1

<u>characterized in</u> that the instantaneous center of motion is located at a position far outside the wheel and then in the rear of the wheel spindle, or far inside the wheel and then in front of the wheel spindle, and in that the first control link (16) and the spring link (13) together form a virtual lower triangular link swingable about a lower swing axis (S1), wherein the first camber link (18) and the second camber link (19) together form a virtual upper link triangular link swingable about an upper swing axis (S2), wherein the lower swing axis (S1) and the upper swing axis (S2) are approximately parallel with each other.

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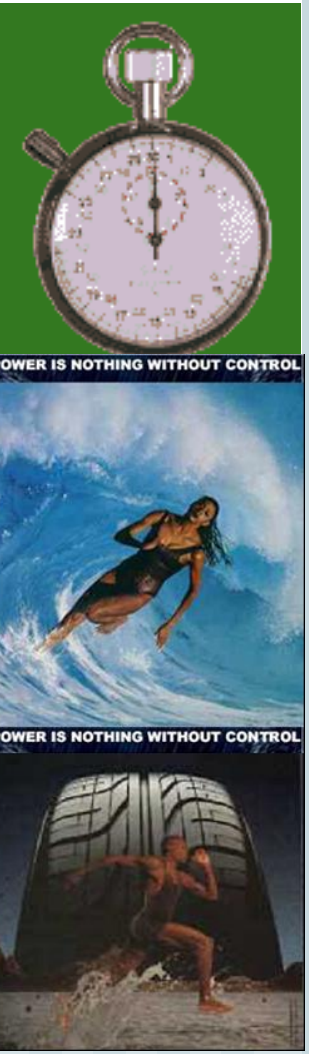
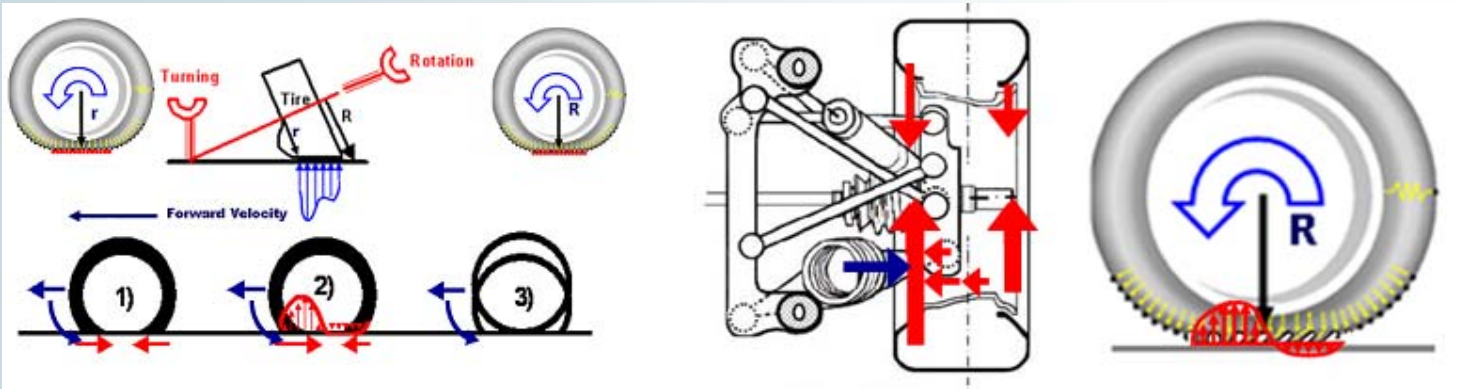


Vertical suspension motion from road topology cause stochastic impacts with dynamics of ~1Hz (sprung mass), ~10 Hz (un-sprung mass) and 400 Hz.



Dynamics at sub-levels are shear forces with transients of up to 400Hz.

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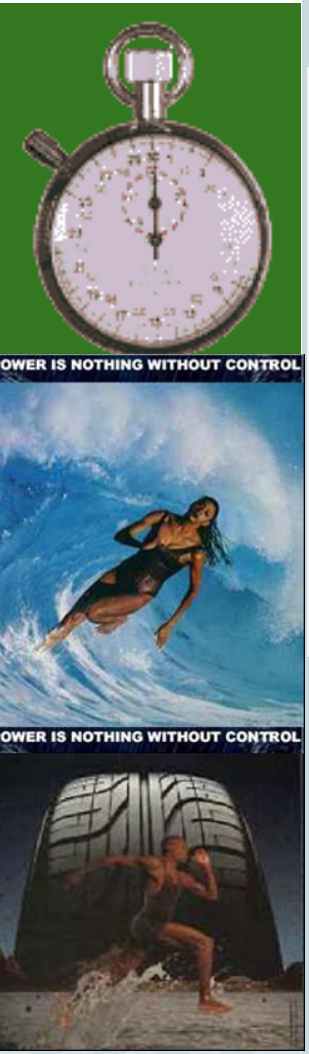
TGD as Topological GeometroDynamics extended to Tire to Ground Dynamics



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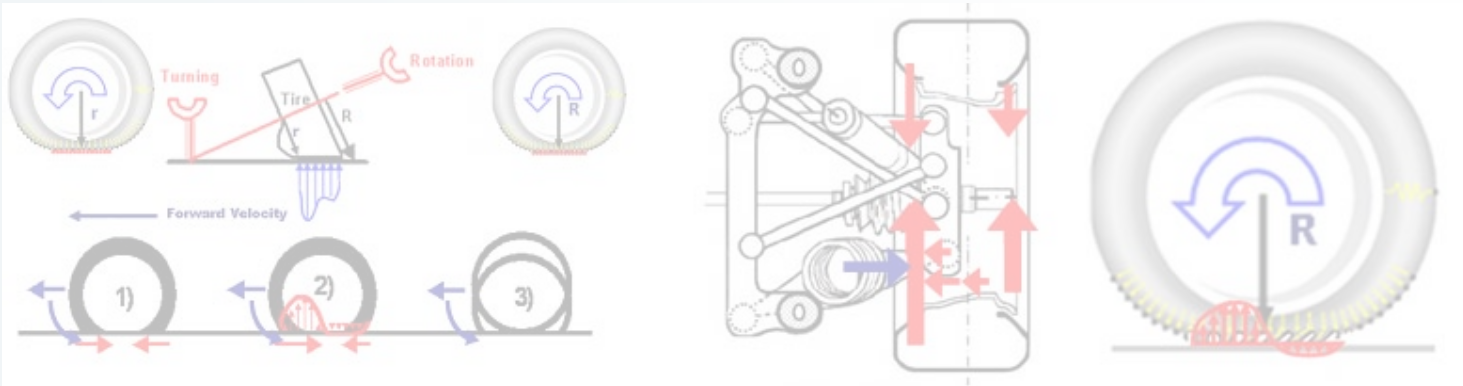
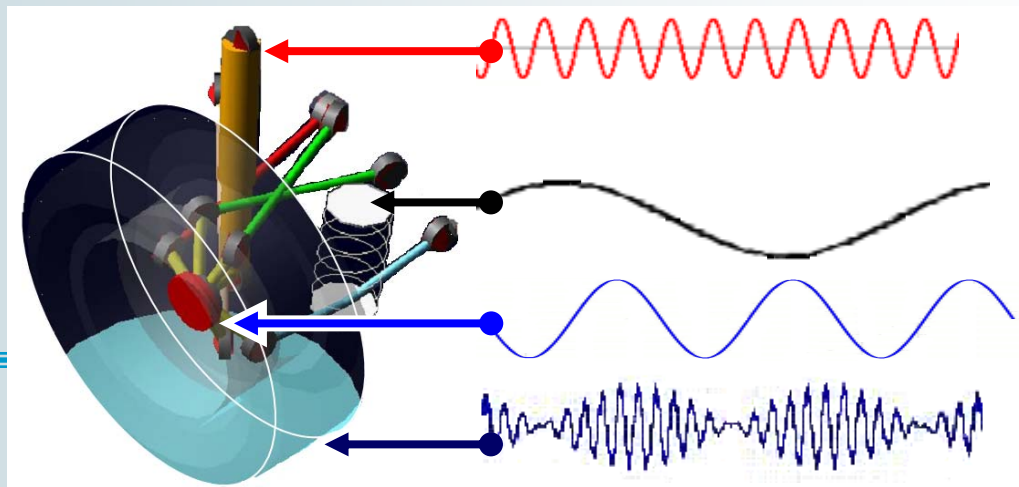


Dynamics at sub-levels are shear forces with transients of up to 400Hz.

The 400 Hz dynamics impact A) tire wear, B) rolling resistance, C) fuel economy and D) traction for asphalt as well as for snow and ice.

The engineering challenge is to find the combined kinematics and topology for minimum internal “power struggle” through destructive interference.



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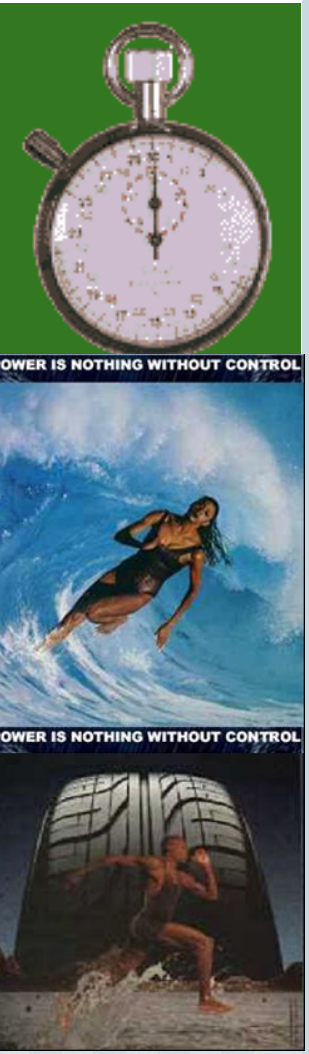

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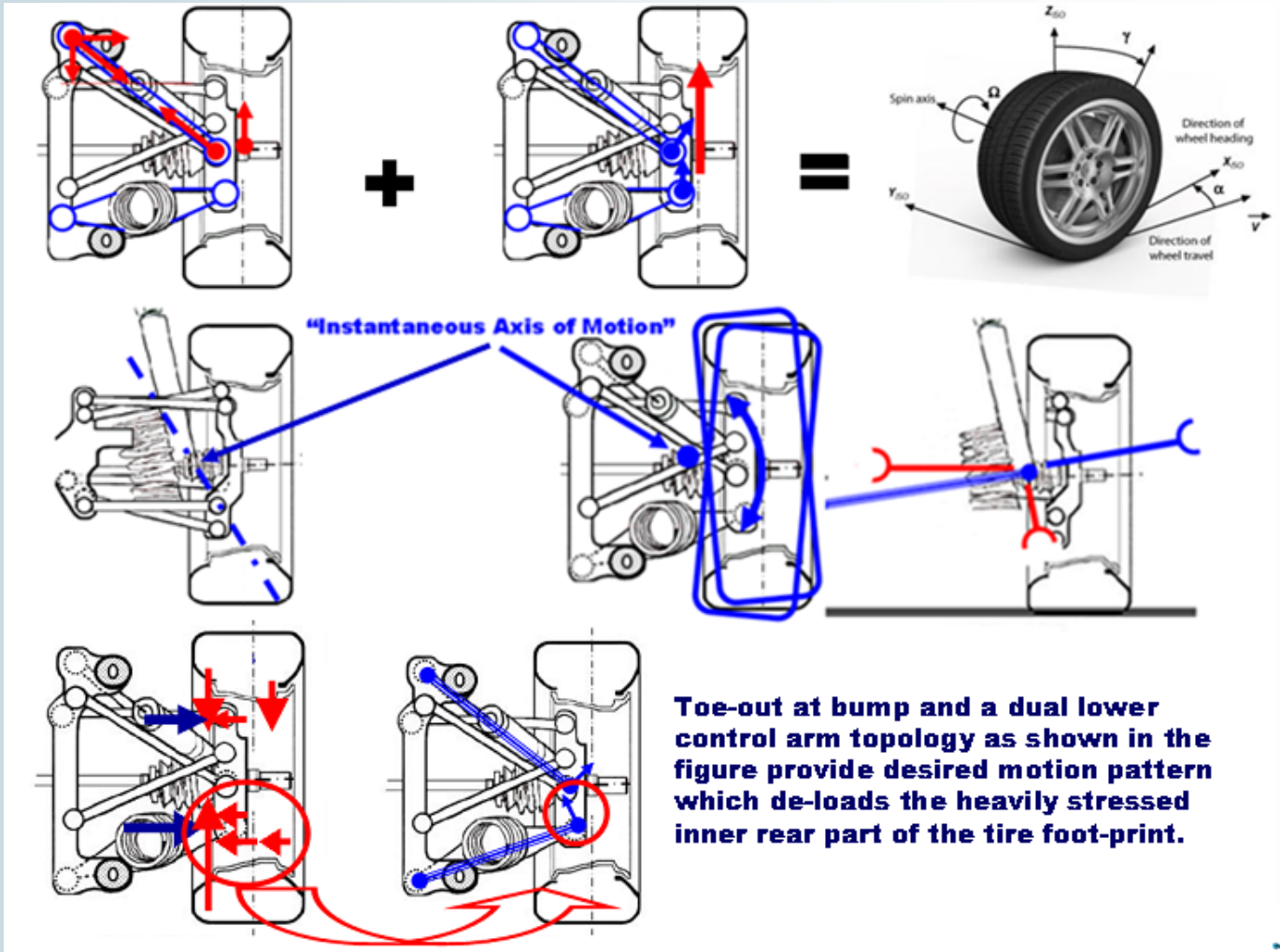

Toe-out at bump and a dual lower control arm topology as shown in the figure provide desired motion pattern which de-loads the heavily stressed inner rear part of the tire foot-print.

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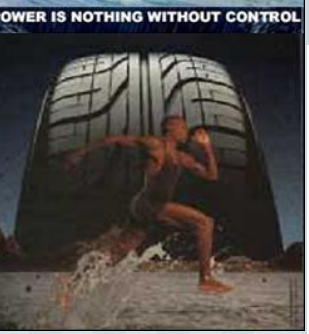
TGD as Topological GeometroDynamics extended to Tire to Ground Dynamics



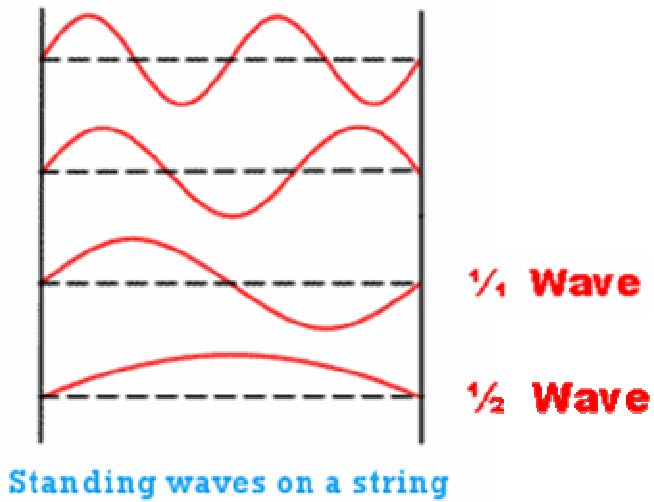
"Destructive interference" builds upon adaptively cancelling out any chaotic impact (all frequencies) in order to build dynamic structures of harmony.

Body frequency $f = 1/T = 1/2\pi \times \sqrt{c/m}$ → m = mass = 605 kg total → 150 kg per corner; c_{rear} = 128 N/mm → f = 4.65 Hz

Tire stiffness of 252 N/mm and spring stiffness of 128 N/mm between two stiff walls with un-sprung mass of 22.5 kg we get; $c_{tot} = [c_{tire} + c_{spring}]$ = 380 N/mm → f = 20.7 Hz The road has high mechanical impedance while the vehicle corner mass of 150 kg will reduce this ~10% → 18.6 Hz For the front un-sprung mass c_{front}=380 N/mm the resonance frequency would be 26 Hz.

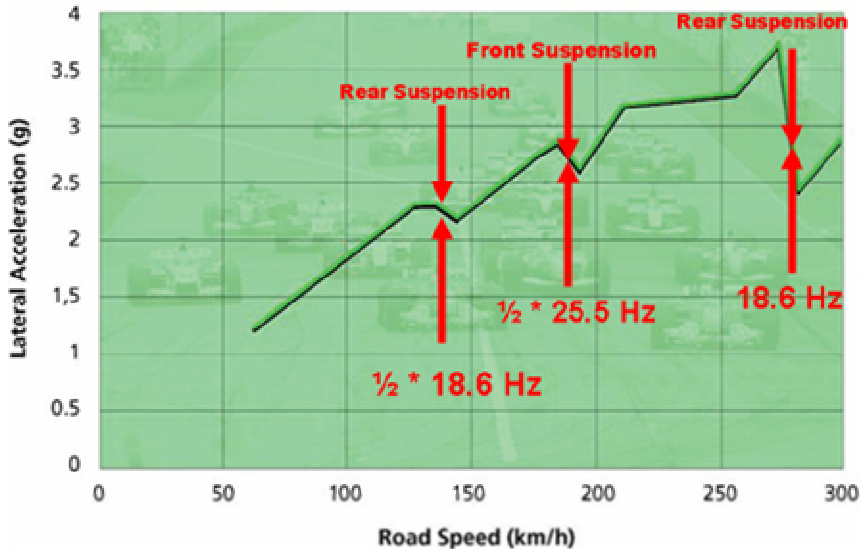
Tire diameter 660mm, Tire circumference 4.15 meter, Speed 278 km/h [77.2 m/s] → 18.6 Hz

Tire diameter 660mm, Tire circumference 4.15 meter, Speed 380 km/h [105.5 m/s] → 25.5 Hz



Standing waves on a string

Formula One



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