

## SOME REAL LIFE APPLICATIONS OF FRACTIONAL CALCULUS

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ABSTRACT. Three real life applications for fractional calculus are given. Nuclear (strong) interactions, earthquake prediction and epidemics.

### 1. NUCLEAR (STRONG) INTERACTIONS

Infinitesimally deformed oscillator algebra corresponds to a Heisenberg relation which may explain confinement. There is a correspondence between  $q$ -deformed oscillators and fractional order ones. This result has been confirmed experimentally by Herrmann [1], [2] who showed that  $\alpha = 2/3$  corresponds to hadrons and  $\alpha \cong 3/4, 4/5$  correspond to mesons. Using semi-simple Lie algebra [3] to model particle physics leads naturally to using the deformed  $SO_q(2, 3)$  group. Deformed algebra is naturally related to fractional calculus and to strong interactions.

Galilean group  $\Rightarrow$  (semisimple) Lorentz group.  
Poincare group  $\Rightarrow SO(2, 3)$   
Including  $SU(2) \times U(1)$  may  $\Rightarrow SO_q(2, 3)$ .

**The main conclusion** is that the algebra corresponding to strong interaction seems to be Hopf (deformed) algebra and that strong interactions are intrinsically related to fractional calculus.

### 2. EARTHQUAKE PREDICTION[4]

So far we have failed in earthquake prediction even for short range prediction. Earthquakes are known to occur on fractures which are fractals. Fractals, by definition are continuous nowhere differentiable functions hence only fractional calculus can be used to study them. Earthquakes are expected to increase hence studying them is quite important.

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### 3. EPIDEMICS

Studying epidemics is an important problem. It is known that the present state of a patient depends on his/her past history. Therefore mathematical models for epidemics need fractional calculus [5]. Several other engineering applications for fractional calculus are given in [6].

#### REFERENCES

- [1] Richard Herrmann: Fractional Calculus for Physicist, world scientific publ.2014.
- [2] Richard Herrmann (2010), Physica A Physica A 389 (2010) 4613 ,Common aspects of q-deformed Lie algebras and fractional calculus.
- [3] Niels G. Gresnigt and Adam B. Gillard, (2015), Electroweak symmetries from the topology of deformed space time with minimal length scale, arXiv 1512 04339.
- [4] Wikipedia, Earthquake prediction.
- [5] I.Obaya, H.El-Saka, E.Ahmed and A.I. Elmahdy (2018), JFCA 9, On Multi-Strain Fractional Order MERS-Cov Model. 196-201.
- [6] HongGuang Suna , , Yong Zhang , Dumitru Baleanua , Wen Chena , YangQuan, A new collection of real world applications of fractional calculus in science and engineering ,Commun Nonlinear Sci Numer Simulat (2018) To appear.

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