Villari effect and earthquake prediction 00000

CREDO multidisciplinary: first thoughts on earthquake prediction

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Villari effect and earthquake prediction 00000



Overview



2 My main research area

- 3 Villari effect and earthquake prediction
 - Literature
 - Possible explanation
 - Methodology



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Structure and staff of Wigner RCP I.







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Structure and staff of Wigner RCP II.





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Theoretical Physics Department



Research Groups:

- Particle Physics and Field Theory Research Group
- Heavy-ion Physics Research Group
- MTA Momentum Holographic Quantum Field Theory Research Group
- Gravitational Physics Research Group

(particle astrophysics is basically non-existent in Hungary)

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Envisaged phase diagram of QCD

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Effective models helps revealing the rich phase structure at large μ_B . The success of an effective model depends on: d.o.f used, implemented resummation, parametrization of the model ...

Phase diagram in the $T - \mu_{\rm B} - \mu_{\rm I}$ space



- At $\mu_{\rm B} = 0 \ T_c = 153(3) \ {\rm MeV}$
- Is there a CEP?
- The *T*-dependence of thermodynamical quantities like pressure, interaction measure, quark density is known from lattice only at μ_B = 0.
- At which μ_B is there the phase boundary for T = 0?
- In medium changes of masses and widths

Details of the phase diagram are heavily studied theoretically (Lattice, EFT), and experimentally (RHIC, LHC, FAIR, NICA)

Wigner RCP

My main research area

Villari effect and earthquake prediction $\circ\circ\circ\circ\circ\circ$

Earthquake prediction

Villari effect and earthquake prediction $_{\odot \odot \odot \odot \odot}$

Experimental evidence





Figure: Increase in the low energy signal rate at least six hours before a $8.8M_L$ earthquake in 27.02.2010, 06:34:14 UTC at Chile [by A. Saleh]

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Literature

Relevant papers from the literature

• Visegrad Fund

- A. L. Morozova *et al.*, "Variations of the Cosmic Ray Fluxes as a Possible Earthquake Precursor", Phys. Chem. Earth (A), Vol. **25**, No. 3, pp. 321-324, 2000: Correlations between the annual number of earthquakes and air pressure, cosmic ray fluxes, interplanetary *B* are investigated. Some correlation was found.
- S. M. Korotaeva *et al.*, "The Effect and Forerunners of the Earthquake of August 28, 2008, in the Vertical Component of the Electric Field in Lake Baikal", ISSN 1028334X, Doklady Earth Sciences, 2011, Vol. **438**, Part 2, pp. 842–845: Changes of E_Z electric field component hours before an earthquake of $5.9 6.4M_L$
- Romanova, N. V. *et al.*, "On the magnetic precursor of the Chilean earthquake of February 27, 2010", Geomagnetism and Aeronomy, Volume 55, Issue 2, pp.219-222, 2014: Anomalous geomagnetic disturbance (three days before the event) was a mid-size substorm that was not related to seismic activity.

Basically no physical explanation

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Possible explanation

The Villari effect



The Villari or inverse magnetostrictive effect: change of magnetization of a magnetostrictive material due to mechanical stress. usage by engineers: magnetostrictive sensors (M. J. .Dapino *et al.*,

"A magnetoelastic model for Villari-effect magnetostrictive sensors", 2013)



geomagnetism:

(https://commons.wikimedia.org/w/index.php?curid=1712490)

Earthquake \longrightarrow stress wave in earth \longrightarrow deformation of magnetostrictive materials \longrightarrow changes of magnetic field \longrightarrow incoming particle flux changes

Methodology

Two-way approach



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Data analysis

- data on the strain tensor field and magnetic field are available from databases
- these should be analyzed to extract e.g. the orders of magnitudes of the effects, duration etc.
- analysis of correlations between deformation and magnetic field
- estimation of effects of the inhomogeneity of earth

Model building

- from simple to complex
- starting point: homogeneous magnetostrictive sphere
- next step: vibrating magnetostrictive sphere or shell, etc.
- orders of magnitudes of the possible effects can be deducted
- effect on a relativistic particle trajectory
- effect on the flux

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Methodology			
To sum up		Visegrad Fund •	

Highly interdisciplinary problem: in the intersection of geology (seismology, geophysics, tectonics), and physics (classical mechanics, classical electrodynamics, and astroparticle physics).

Important questions:

- Is it possible that the Villari effect is able to cause such a change in the incoming particle flux?
- How can the delay between the increased flux and the mechanical wave be explained?

For this project to be successful data on the incoming fluxes from all around the globe is needed, which can be done only with such a huge collaboration as CREDO. Wigner RCP

My main research area

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Methodology

Thank you for your attention!