# Plan and contribution from Hungarian groups

ET SPB Workshop

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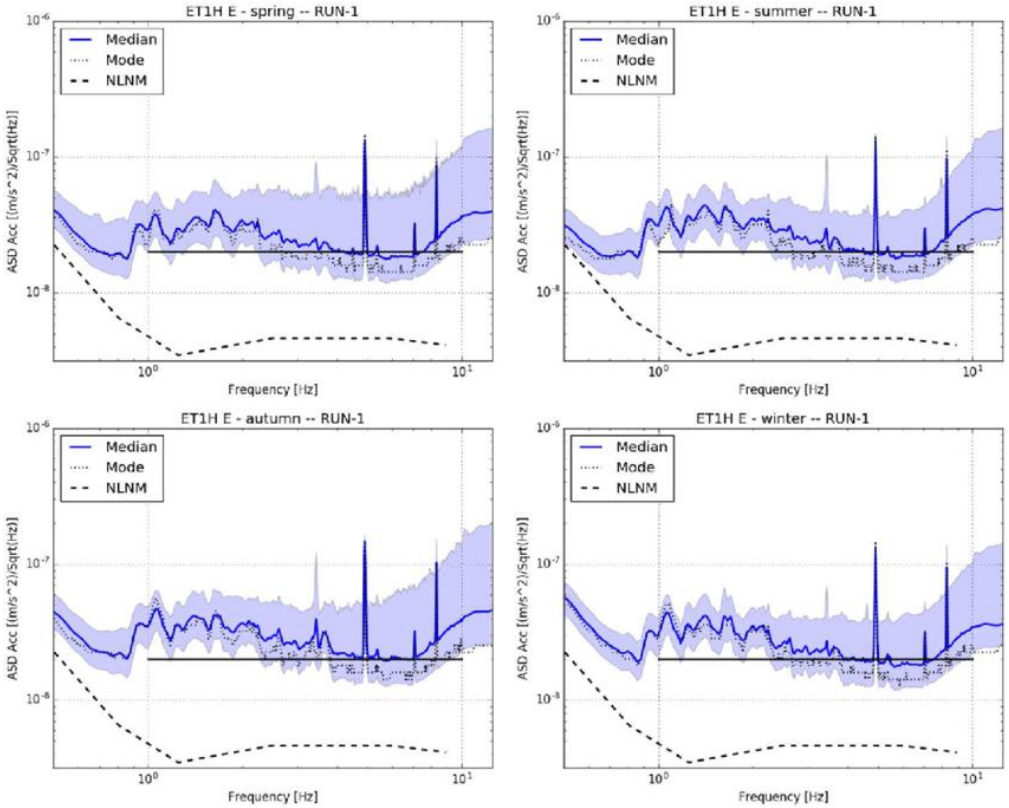
# Institutions

- Wigner Research Centre for Physics (Budapest)
- Atomki (Debrecen)
- Budapest University of Technology and Economics (Bp.)
- ...

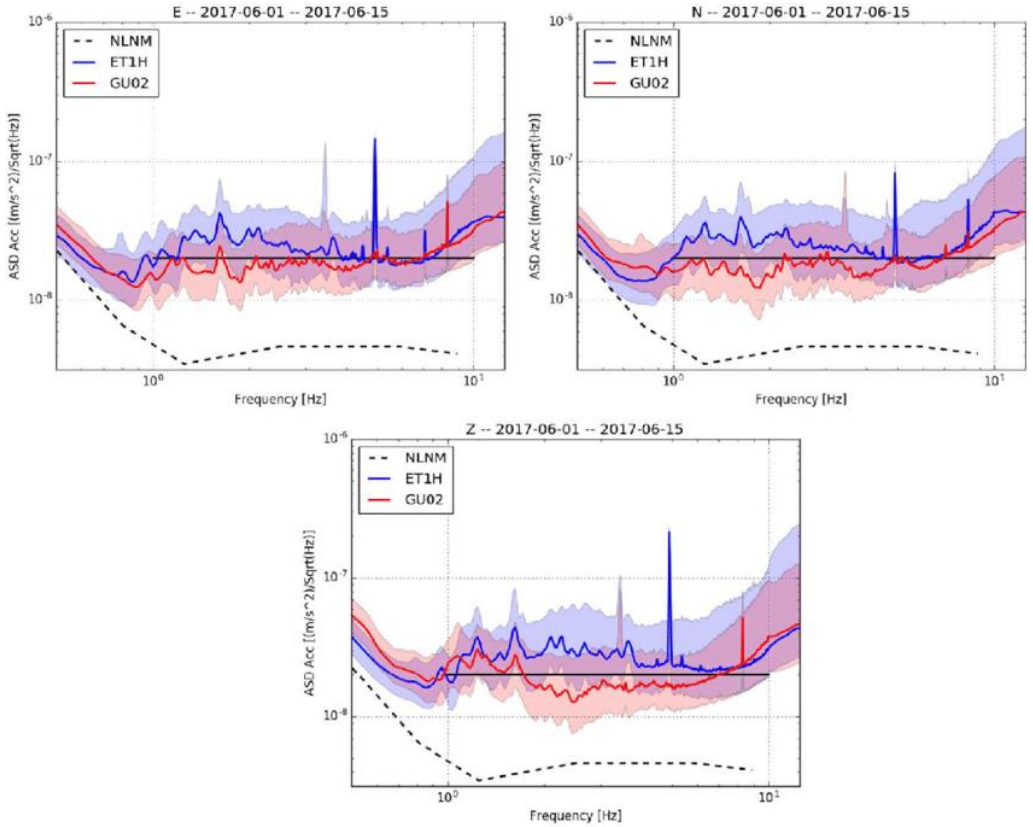


# Seismic measurements in Mátra




The acceleration ASD of the different seasons for a horizontal component calculated is shown here from whole-day periods. The solid blue and the dotted black lines indicate the median and the mode of the data, respectively. The borderlines of the blue colored area are the 10th and 90th percentiles. The Black Forest line is solid black and the dashed black lines are NLNM curves.

The percentiles of the ET1H −88 m and (red) the GU02, −404 m (blue) stations are shown together in the three directions. The Black Forest line is solid black and the dashed black lines are NLNM curves.




P. Ván et al. 2019 Eur. Phys. J. ST 228(8) 1693-1743, https://epjst.epj.org/articles/epjst/abs/2019/14/epjst1900153/epjst1900153.html
Somlai, L.Á., Gráczer, Z., Lévai, P. et al. Seismic noise measures for underground gravitational wave detectors. Acta Geod Geophys 54, 301–313 (2019). https://doi.org/10.1007/s40328-019-00257-5

# Jánossy Underground Research Laboratory

- 30m below the ground in Dachstein-type limestone
- The useful area of  the lab is 150 sqm on 3 levels
  - 20 sqm at level -1,
  - 2x20 sqm at level -2
  - 2x20 sqm + 50sqm at level -3.
- 40 cm thick walls made from concrete for nuclear reactors
- air conditioning, UPS, internet and service/rescue telephone availability
- The site is ideal for measurements that need low cosmic background
- Also appropriate for other measurements that require stable temperature and low environmental- and seismic noise level.
- Physical environment is monitored by temperature-, pressure- and humidity sensors together with a seismometer and an infrasound microphone.
- Full CAD model& density map is available
- **Contact:**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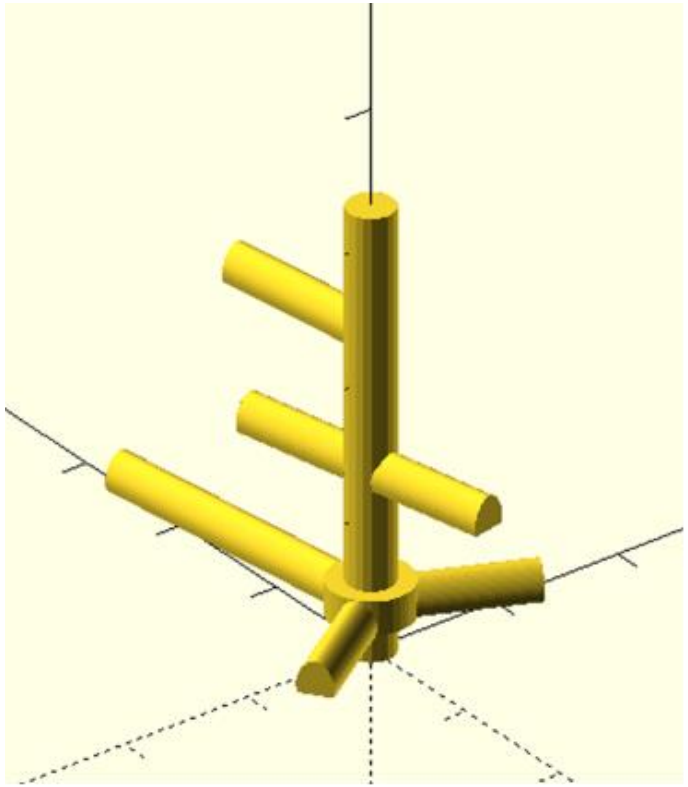
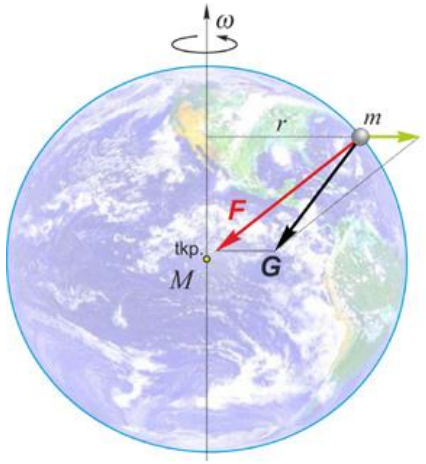
Gergely Gábor Barnaföldi: barnafoldi.gergely@wigner.hu

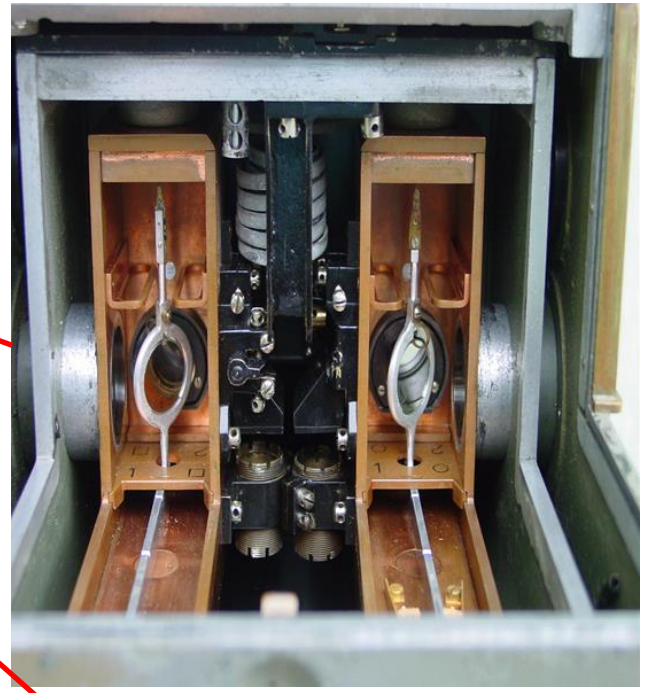



# Re-measurement of the Eötvös Experiment

- weak equivalence principle
- gravito-gradiometers
- gradient effect



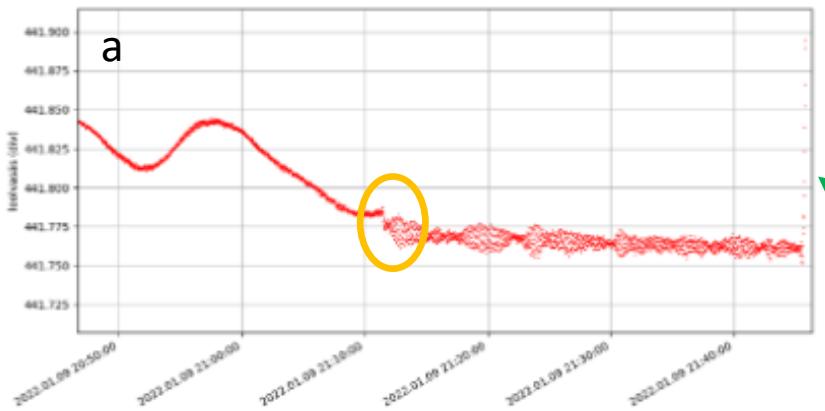




http://tudtor.kfki.hu/eotvos1/onehund.html

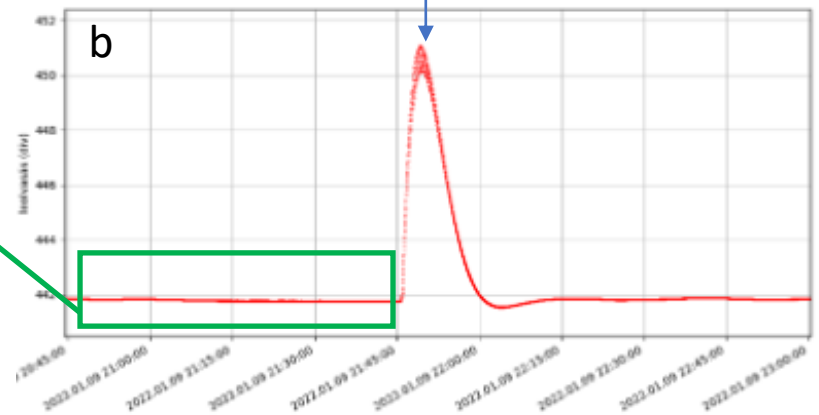
# Re-measurement of the Eötvös Experiment
# Seismic phenomenon (Florina earhquake Jan. 9th, 2022)

Eötvös-balance, strange signal before earthquake

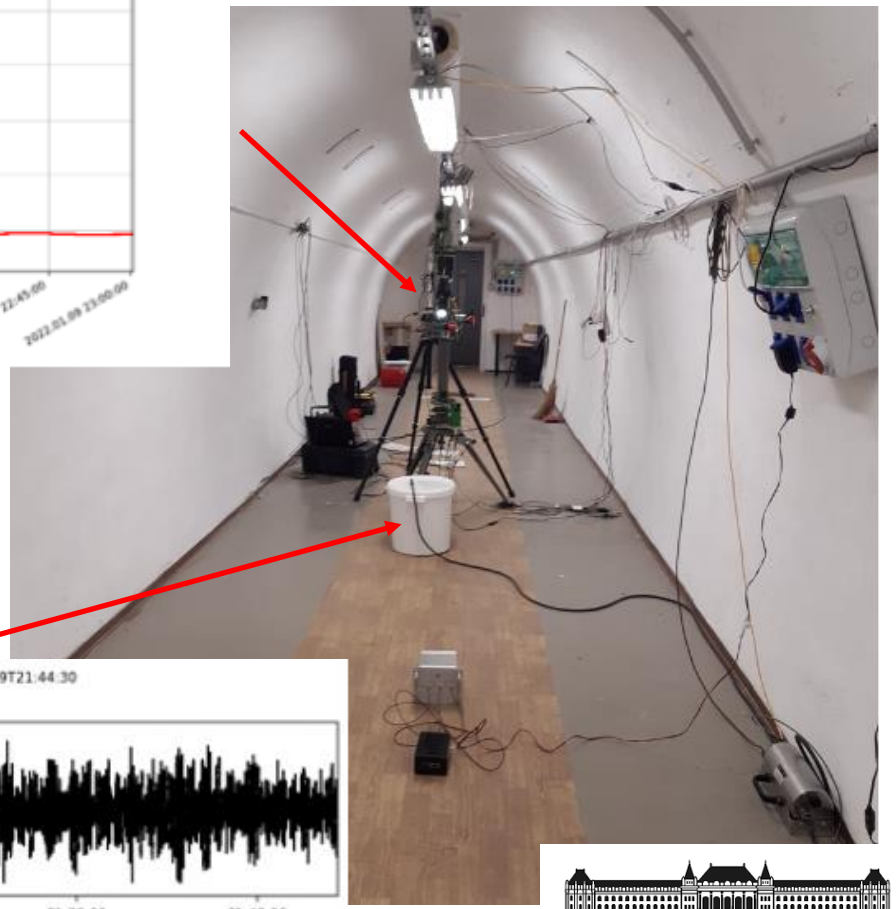



Time

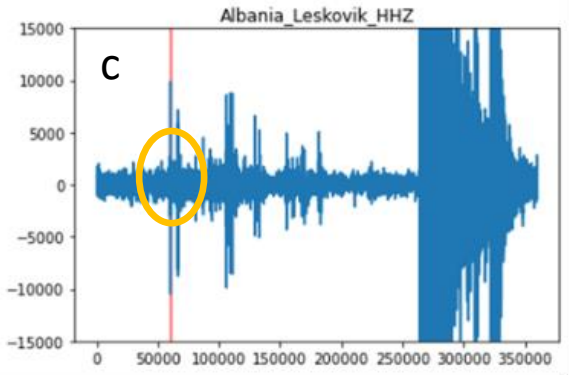
Earthquake




Time

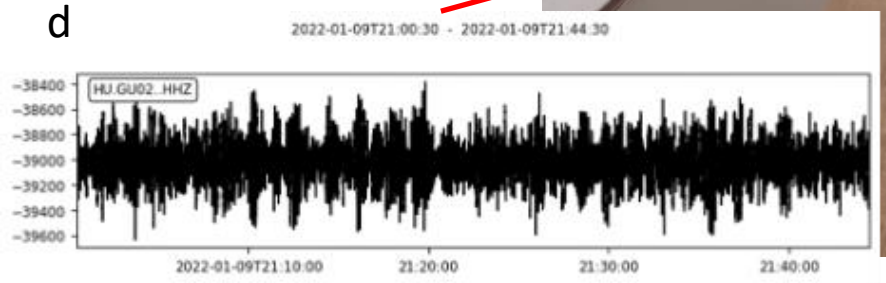


Signal of Leskovik seismic station (Albania)




Time [10 millisecs]

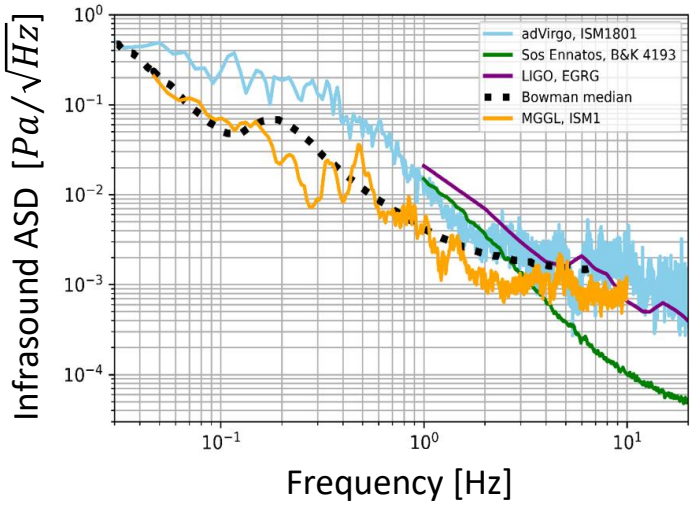
Güralp seismometer




Time

# Infrasound measurements

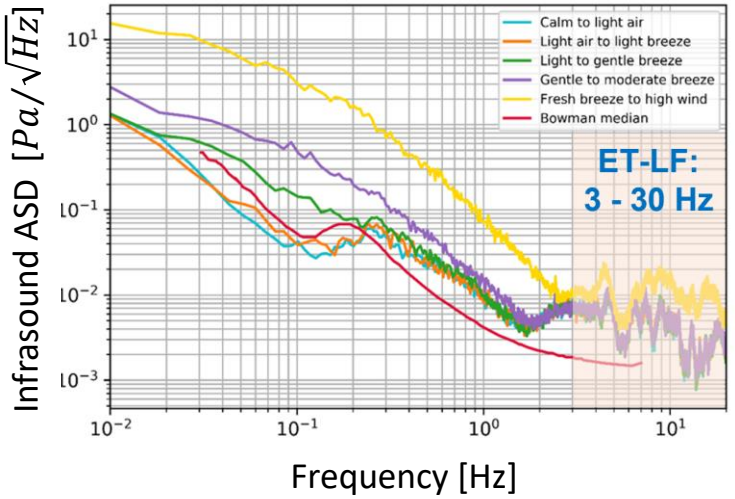
Mátra Gravitational and Geophysical Laboratory (MGGL) in Hungary

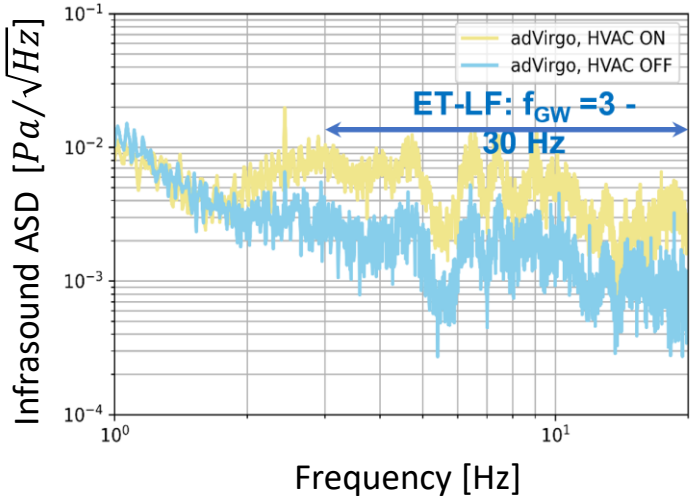



Fenyvesi E, Molnár J, Czellár S. Investigation of Infrasound Background Noise at Mátra Gravitational and Geophysical Laboratory (MGGL). Universe. 2020; 6(1):10. https://doi.org/10.3390/universe6010010




- Accelerometer
- Episensor
- Velocimeter
- Thermometer
- Comb. (temp.+press.+hum.)
- Microphone
- Infrasound microphone
- Magnetometer
- Voltage probe
- Current probe
- Radio frequency antenna




Planned activity: one week-long measurements at Sardinia with Atomki ISM and Earthdata EDR-209 digitizer.

# Theoretical investigations of the Gravitational Physics Research Group at Wigner RCP

- field theory
- numerical and post-Newtonian general relativity
- experimental gravitational wave data analysis
- fundamental research in algorithm optimization
- many-core computer science

https://wigner.hu/en/theoretical-physics/gravitational-physics-research-group

# Considering the Continuum PTZ Model while modelling Newtonian noise

Solids may be less “solid” than expected. Beyond elastic behaviour, they may exhibit damped and delayed response. This viscoelastic/rheological reaction may not be simply explained by a viscosity-related additional stress (the Kelvin–Voigt model of rheology), but the time derivative of stress may also be needed in the description, with the simplest such model being the so-called standard or **Poynting–Thomson–Zener (PTZ)** one.

- Consider a homogeneous and isotropic solid, in the small-deformation approximation.
- This will be the basis for a Newtonian noise calculation.
- The relationship between the symmetric strain tensor ε to the velocity field **v** is

$$\frac{\partial \varepsilon}{\partial t} = \frac{1}{2}\left(\vec{\nabla} \otimes \boldsymbol{v} + \boldsymbol{v} \otimes \overleftarrow{\nabla}\right)$$

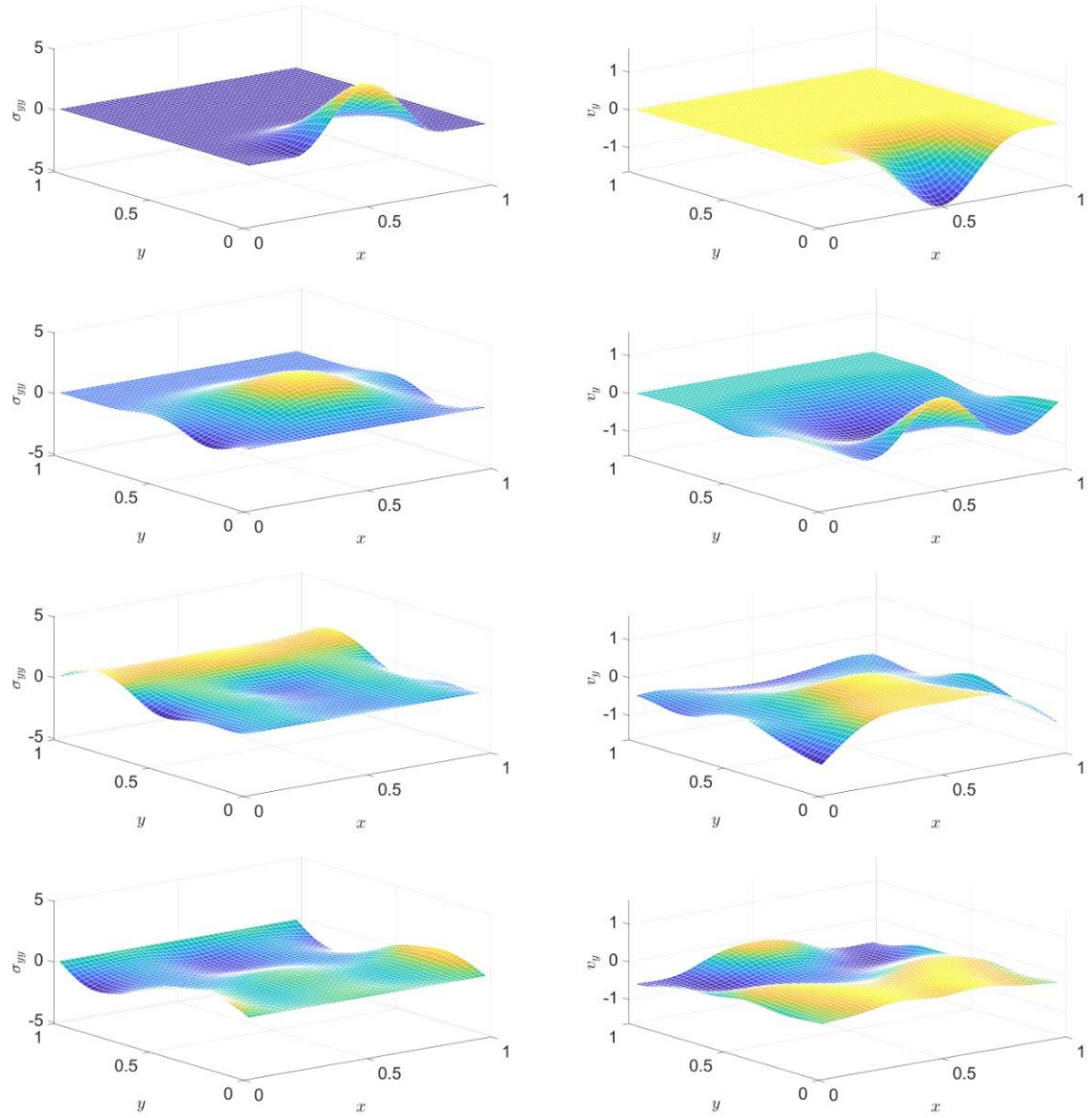
- The stress tensor $\sigma$ is also assumed to be symmetric, and it governs the time evolution according to

$$\rho \frac{\partial \boldsymbol{v}}{\partial t} = \sigma \cdot \overleftarrow{\nabla}$$

- With the deviatoric and spherical parts of tensors, the Hooke elasticity can be expressed, and its PTZ generalization:

$$\sigma^{dev} + \tau^{dev} \frac{\partial \sigma^{dev}}{\partial t} = E^{dev}\, \varepsilon^{dev} + \hat{E}^{dev} \frac{\partial \varepsilon^{dev}}{\partial t} \qquad \sigma^{sph} + \tau^{sph} \frac{\partial \sigma^{sph}}{\partial t} = E^{sph}\, \varepsilon^{sph} + \hat{E}^{sph} \frac{\partial \varepsilon^{sph}}{\partial t}$$

Pozsár Á, Szücs M, Kovács R, Fülöp T. Four Spacetime Dimensional Simulation of Rheological Waves in Solids and the Merits of Thermodynamics. Entropy. 2020; 22(12):1376. https://doi.org/10.3390/e22121376




Distribution of a stress component (left column) and of a velocity component (right column) at various instants, in the PTZ case. From top to bottom: snapshots at instants $(1/2)\tau_b$, $\tau_b$, $(3/2)\tau_b$, $2\tau_b$ respectively.

# TECHNOLOGICAL COMPETENCIES OF BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS

## MECHANICAL ENGINEERING

*CONTACT: CS. HŐS*
*(email: hos.csaba@gpk.bme.hu)*

- Fluid machinery
- Flow-generated noise
- CFD
- GPU programming
- Large pipe networks
- Nonlinear dynamics
- Micro machining
- Building service engineering
- Energy management
- Sustainability
- Design
- Materials science
- Time delayed systems
- Polymer and nanofiber technology
- Thermodynamic modeling
- 3D printing
- Tribology

## ELECTRICAL ENGINEERING

*CONTACT: T. KOVÁCSHÁZY*
*(email: khazy@mit.bme.hu)*

- Software technology
- Embedded systems
- High precision clock synchronization
- Real time communication
- Interconnection and packaging of microelectronics circuit modules
- Measurement and instrumentation
- Sensors and actuators
- Extremely high performance digital signal processing
- Component assembly
- Encapsulation techniques and thermal management
- Thin and thick films
- Hybrid circuits
- Lasers
- AI

## CIVIL ENGINEERING

*CONTACT: L. VÖLGYESI*
*(email: volgyesi@eik.bme.hu)*

- Geoinformatics
- Photogrammetry
- Land registry
- Regional gravity field modeling
- Geodynamics
- Rock rheology
- Deformation measurements mapping
- Structural engineering
- Hydraulic and water resources engineering
- Environmental engineering

MŰEGYETEM 1782

Thank you for your attention!