Summary of ISC6 Workshop

Gravitation workshop

"tide effects, Eötvös torsion balance"

Organizer: ISSMGE HNC

Gravitation workshop "tide effects, Eötvös torsion balance"

Date: 14h to 16h, October 1, 2021

Location: Hungarian Academy of Sciences, Budapest.

Chair : Péter Ván

Secretary: Nadaprapha Binsaaeteh, Emőke Imre

TOPICS :

- Space Mechanics – Controlled by The Symmetries in Physics
- Effect of Gravity : Tide in Tectonics and GWL

- Eötvös torsion balance measurements

This workshop aims to promote research dissemination of earlier and current research related to how gravitation effects the measurement of tectonic table motions, earthquakes, air pressure and Groundwater level.

SUMMARY

The ISC6- Academician of the Hungarian Academy of Sciences workshop was held in remote mode on October 1, 2021 at 2:00 p.m. to n 16:00. The main initiator and organizer of the event was Imre Emőke from the ISC6 Organizing Committee. The opening was made by János Józsa, Academician of the Hungarian Academy of Sciences, the chairman was Péter Ván. Roughly there were 20-25 participants in the workshop. 6 lectures were given, below titles. In 5 of the 6 cases, the slides of the lectures can be downloaded links.

"The gravity session was a bit an exotic topic which I had hardly been aware of.
Among other things, it came a bit a surprise how precipitation and its path through
the soil can even be measured in terms of gravitation, and how high the precision
of gravitation measurement had already been at the early 20th century."

PROGRAM

Opening on behalf of the Hungarian Academy of Sciences:

Prof. János Józsa

(a few words on Lóránd Eötvös)

Bruno Meurers, Gábor Papp, Hannu Ruotsalainen, Judit Benedek and Roman Leonhardt: Environmental effects in tilt and gravity residuals observed at Conrad Observatory (Austria)

Abstract: The superconducting gravimeter (SG) GWR C025 has monitored the time variation in gravity at the Conrad Observatory (Austria) since autumn 2007. Two tiltmeters have operated continuously since spring 2016, namely a 5.5m long interferometric water level tiltmeter and a Lippmanntype 2D pendulum tilt sensor. The co-located and co-oriented set up enables a wide range of investigations because the tilts are sensitive to both geometrical solid Earth deformations and to gravity potential changes. The tide-free residuals of the SG and both tiltmeters clearly reflect the gravity and/or deformation effects associated with short- and long-term environmental processes and reveal a complex water transport process at the observatory site. Water accumulation on the terrain surface causes short-term (a few hours) effects which are clearly imaged by the SG gravity and N–S tilt residuals. Long-term (>a few days/weeks) tilt and gravity variations occur frequently after long-lasting rain, heavy rain or rapid snowmelt. Gravity and tilt residuals are associated with the same hydrological process but have different physical causes. SG gravity residuals reveal the gravitational

effect of water mass transport, while modelling results exclude a purely gravitational source of the observed tilts. Tilt residuals show the response on surface loading instead. Tilts can be strongly affected by strain–tilt coupling (cavity effect). N–S tilt signals are much stronger than those of the E–W component, which is most probably due to the cavity effect of the 144m long tunnel being oriented in an E–W direction.

Peter Ván and Lajos Völgyesi: Development of the Eötvös balances: automatization and readout

Abstract: The improved sensitivity of the new equivalence principle measurements is based on the modernisation of an original instrument, a geophysical torsion balance. e survey the most important aspects of the technology, the automatisation of the rotation and the optical readout.

Szondy, György: Eötvös balance, the everythingmeter: environmental effects

Abstract: EPF-group is set up to repeat the famous Eötvös experiment with an original, high precision Eötvös torsion balance. The goal is to execute the measurements in fully automated way, using a state-of-the-art level of instrumentation and data processing. Instrumentation consists of executing several weeks of automated measurement program changing the orientation of the balance hourly, digital reading of the orientation and capturing and evaluating the scale of the balance, determining the equilibrium state from transient movements, the continuous measurement of the environment parameters (temperature, pressure, micro-seismic noise, tilt, magnetic field etc.) and detecting and logging human activity.

Peter Ván: The weak equivalence principle and the 5th force: the new Eötvös experiment

Abstract: The presentation surveys the history of the 5th force and gives the background and motivation the equivalence principle remeasurement with and original dipole type Eötvös instrument. The improved sensitivity lead to some interesting observations. Preliminary results are also shown.

György, Mező: Data collection and data processing: the example of Eötvös balance networks

Abstract: We are planning reorganizing the data collection of the Eötvös balance network using cloud based data collection. In the lecture we show examples how to collect environmental sensors data based on the MQTT protocol. The sensors publish data to the MQTT's broker and the cloud's instance server subscribed to the broker collect the measured data into database. The data collecting system can be scaled up and it is also possible real-time data analysis on the cloud's instances.

Gyula, Tóth: Outlier tolerant automated inversion of noisy data captured on the Eötvös torsion balance

Abstract: An original Eötvös-Pekár torsion balance is being used for the current re-measurement of the Eötvös-Pekár-Fekete (EPF) experiment. The double balance's arms are automatically rotated into different azimuths and two visual scales are read by analyzing the images captured at each second with two CCD cameras. For testing of the equivalence principle at each azimuth the scale reading of the damped position of the arms need to be determined from the time series of the readings. Since the arms initially bounce between delimiters and also an unknown number of readings are outliers, it is a challenge to get good fit for the last section with no bounces and with the rejection of a possibly high percent of outliers.

We present a RANSAC-based procedure and Python implementation that successfully solve this problem by using optionally four different damping models as well as the results of the fitting procedure at various azimuths. The process is fast, highly automated and robust, which is necessary, since for the EPF re-measurement we expect that about 1600 individual fits will be required for an input dataset of 6 million readings.

Presentations

https://mydrive.kfki.hu/f/69a097185cf44509bdaa/?dl=1

https://mydrive.kfki.hu/f/f2608d3857454fd0aa69/?dl=1

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