DiSTAR Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse
UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II
SCUOLA POLITECNICA E DELLE SCIENZE DI BASE

PhD programme in Earth, Environmental and Resources Sciences

Instructor(s)	Umberto Riccardi, DISTAR-UNINA; Tommaso Pivetta, INGV-OV
Course Title	Time-lapse hybrid and super-hybrid Gravimetry: Concept & Applications in volcano & geothermal monitoring
Total Number of Hours	12
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Course Description

The course introduces the PhD students to the concept of time-lapse hybrid and super-hybrid gravimetry. According to the hybrid concept, the students will understand the benefit of jointly using absolute and relative gravity measurements repeated over time in different operating modes. New technologies (such as quantum and superconducting) applied to gravity sensors will also be presented, to raise awareness on the performance that each sensor involved in the hybrid approach can offer. Two applications will be presented: a) for energy transition (monitoring of a geothermal plant) and b) monitoring of active volcanic areas. Examples of forward and inverse modeling of underground mass redistribution processes will be shown.

Course Contents

1. Module / Topic 1 – description
Hybrid & Super-hybrid Gravimetry (The Concept), Modern terrestrial relative and absolute gravity sensors based on superconducting, quantum and laser interferometry technology. Quantitative assessment of underground mass redistribution by means of forward and inverse modelling.
2. Module / Topic 2 – description
Gravity Monitoring of Geothermal Systems: Mass budget and exploitation scenarios. Gravity and geodetic monitoring of active volcanoes; detecting the mass redistribution and density changes in the shallow crust during volcanic unrests.
3. Module / Topic 3 – description
Calculus laboratory: Processing and analysis of time-lapse gravity data:
Analysis of Continuous Gravity Record collected with SG gravimeter and survey relative Gravity measurements collected on monitoring networks

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Learning Outcomes

By the end of the course, doctoral students will be able to:
• Understanding the benefit of jointly using absolute and relative gravity measurements repeated over time in different operating modes.

• Learning how the new technologies (such as quantum and superconducting) are involved in the gravity measurements

• Analize both relative gravity measurements and continuous gravity recordings

• Produce simple forward and inverse modeling of underground mass redistribution processes

Teaching Format

Lectures, seminars, and practical exercises.

Essential Bibliography

- Riccardi, U., Pivetta, T., Fedele, A., Ricciardi, G., & Carlino, S. (2025). Continuous gravity observations at Campi Flegrei caldera: An accurate assessment of tidal and non-tidal signals and implications for volcano monitoring. *Pure and Applied Geophysics*, *182*(3), 1047-1074.
- Giuliante, B., Riccardi, U., Hinderer, J., Jousset, P., Pivetta, T., Mortensen, A. K., ... & Krawczyk, C. M. (2026). Subsurface mass monitoring at Theistareykir geothermal field, Iceland, using hybrid gravimetry. Journal of Volcanology and Geothermal Research, 108539.

Assessment Method

Active participation, in-class discussion & Laboratory Report