UNIVERSITA' DEGLI STUDI DI NAPOLI FEDERICO II

DIPARTIMENTO DI STRUTTURE PER L'INGEGNERIA E L'ARCHITETTURA
CORSO DI DOTTORATO DI RICERCA IN
INGEGNERIA STRUTTURALE GEOTECNICA E RISCHIO SISMICO

XXXIX CICLO

Il sottoscritto Dr. Mauro Palo

(PO □ PA □ RU □ RTD X)

afferente al Dipartimento di Fisica "Ettore Pancini" - S.S.D. FIS/06 Earth and Atmosphere Physics

CHIEDE

di essere inserito tra i possibili tutor di studenti di dottorato per il XXXIX ciclo.

1. Curriculum sintetico del proponente (max 500 parole)

Mauro Palo received his master's degree in physics in 2004 and PhD in Physics in 2008 from University of Salerno (Italy). He was post-doc at the same university from 2008 to 2012 where he studied and modelled the physical mechanisms of the Stromboli-like volcanoes by seismic observations adopting numerical methods from seismology, theory of nonlinear dynamic systems, unsupervised machine learning. From 2012 to 2016 he was associate researcher at the Seismology section of the GeoForschungsZentrum of Potsdam (Germany) where he investigated the fracture propagation during large earthquakes of the Chilean subduction zone and the small-scale physical rock properties by the differential arrival times of clusters of earthquakes. From 2017 to 2021 he was senior data scientist at GEIRI Research Institute of Berlin (Germany) where he developed advanced numerical solutions for the automatic monitoring of high-voltage power systems. Since 2022 he is senior Assistant Professor at the Department of Physics "Ettore Pancini" of University of Naples "Federico II" where he teaches Electromagnetism at the Faculty of Management Engineering. He investigates the spatiotemporal properties of the microseismicity and the segmentation of the fault networks combing machine-learning approaches and geophysical techniques with special focus on the Southern Apennine and the Irpinia region. He is member of the RISSC (Experimental and Computational Seismological Research Unit) Lab of the university "Federico II" and is involved in scientific and commercial projects on the seismic monitoring for risk mitigation and rapid response.

2. Dottorandi dei quali il proponente è stato tutor nell'ultimo triennio	
n. __1___ *2022-2024*	Maha Adil, dottoranda in fisica, 37° ciclo (co-tutor con il prof. A. Zollo): "Design, development and implementation of methodologies for monitoring and control of volumes affected by geothermal fields and/or CO2 storage".

3. Titolo della ricerca proposta
Inference of fault segmentation combining seismological methods and unsupervised machine learning approaches

4. Area tematica
Ingegneria Geotecnica □ Ingegneria Strutturale □ Rischio Sismico x

5. Tipologia di borsa per la quale si propone il progetto
Ateneo x DM 117 (Investimento 3.3) □ *(in questo caso indicare l'azienda co-finanziatrice)* DM 118 (Investimento 4.1 P.A.) □ DM 118 (Investimento 4.1 generici) □ DM 118 (Investimento 4.1 Patrimonio culturale) □

6. Sintesi del progetto di ricerca (max 500 parole. Stato dell'arte, obiettivi e breve programma previsto per le attività e)

The assessment of the seismic risk ideally needs the knowledge of the small-scale stress and interface coupling conditions. These conditions can be indirectly estimated by modelling of the seismic source and radiation, but their resolution suffers of the incomplete detection and analysis capability of the small-magnitude earthquakes. However, in this concern an improvement of the density and sensitivity of the modern seismic networks on one side, and the development of numerical techniques based on artificial intelligence on the other side, led to a lowering of the detection threshold of the seismic radiation allowing to map fault parameters even on scales of 10-100 meters.

One of the parameters sensitive to the interface coupling is the capability of a fault to generate repeating earthquakes, i.e. earthquakes nucleating on the same fault patch at different times. These earthquakes are especially powerful as they can be used to infer the local strain rate, i.e the coupling conditions. Recently these earthquakes have been used together with source and medium parameters to depict the boundaries of fault segments with similar stress and rheological conditions (e.g., Liu et al., 2022; Palo et al. 2023). The detection of these events needs a careful multi-station analysis of the seismic signals to identify clusters of earthquakes with similar waveforms.

Similarly, the proponent has recently proposed a new approach to identify spatial domains with similar temporal patterns of seismicity induced by water injection operations used for steam and energy production in geothermal areas (Palo et al., under review). The approach is based on large catalogs of earthquakes and unsupervised machine learning of the seismicity patterns and allows to map volumes with common stress fields and to differentiate the seismic risk assessment within segments of the fault network.

The project aims to integrate these approaches with seismological array-based techniques and methods to characterize nonlinear dynamic systems and eventually extend the application to areas with both natural and man-induced seismicity; the goal is the identification of segments of the fault systems with homogeneous interface conditions and eventually similar earthquake nucleation risk.

7. Eventuali pubblicazioni del tutor sul tema di ricerca (max 10)
Palo, M., & Cusano, P. (2013). Wavefield decomposition and phase space dynamics of the seismic noise at Volcàn de Colima, Mexico: Evidence of a two-state source process. *Nonlinear Processes in Geophysics*, *20*(1), 71–84. Palo, M., Tilmann, F., Krüger, F., Ehlert, L., & Lange, D. (2014). High-frequency seismic radiation from Maule earthquake (Mw 8.8, 2010 February 27) inferred from high-resolution backprojection analysis. *Geophysical Journal International*, *199*(2), 1058–1077. Palo, M., Tilmann, F., & Schurr, B. (2016). Applicability and Bias of Vp/ Vs Estimates by P and S Differential Arrival Times of Spatially Clustered Earthquakes. *Bulletin of the Seismological Society of America*, *106*(3), 1055–1063. Palo, M., Picozzi, M., De Landro, G, & Zollo, A. (2023). Microseismicity clustering and mechanic properties reveal fault segmentation in southern Italy. *Tectonophysics*, *856*, 229849. Palo M. Ogliari E., Sakwa M.. Spatial pattern of the seismicity induced by geothermal operations at the Geysers, 28th IUGG General Assembly, 11-20 July 2023, Berlin.

8. Eventuali progetti di ricerca finanziati in cui l'attività si inserisce

9. Eventuali fondi disponibili a supporto dell'attività del dottorando (escluso finanziamento borse)

10. Informazioni relative ad un periodo di ricerca all'estero (minimo tre mesi) previsto per il dottorando (*indicare Università/ente di ricerca e docente/ricercatore di riferimento* con indirizzo mail) (max 300 parole)
The PhD candidate will have the chance to spend 6 months at the GeoForschungsZentrum of Potsdam and cooperate with the Seismology section led by Prof. Frederik Tilmann.

11. Eventuali collaborazioni con imprese/aziende sul tema di ricerca (max 300 parole)

Napoli, 29/06/2023 FIRMA

Mauro Palo

Il presente modulo va compilato in ogni sua parte ed inviato all'indirizzo di posta elettronica phd.dist@unina.it entro e non oltre **il 30/06/2023.**