EUROPEAN MECHANICS SOCIETY

Colloquium n. 643 – Advances in peridynamic material modeling

Dates and location

25 September — 27 September 2024, Venice, Italy

Chairperson

Vito Diana

Co-chairperson

Florin Bobaru, Mirco Zaccariotto and Arman Shojaei

Conference fees

- Regular registration: **530.00 €**

What other funding was obtained?

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What were the participants offered?

The welcome aperitif
Three lunches
Two dinners;
Six coffee breaks;
The book of abstracts;
An exclusive evening visit to Scuola Grande di San Rocco

Applicants (members)

1. Florin Bobaru
2. Vito Diana
3. Ugo Galvanetto
4. Erdogan Madenci
5. Erkan Oterkus
6. LORENZO SANAVIA
7. Bernhard Schrefler
8. HongGuang Sun
9. Christian Willberg
10. Mirco Zaccariotto
11. Lorenzo Zoboli

Applicants (non members)

1. José Carlos Bellido
2. Ziguang Chen
3. Federico Dalla Barba
4. Marco Enea
5. Anton Evgrafov
6. Samuele Faggionato
7. Soheil Firooz
8. John Foster
9. Alexander Hermann
10. Subrata Mondal
11. Farshid Mossaiby
12. Tao Ni
13. Kai Partmann
14. Anna Pernatii
15. Francesco Scabbia
16. Zahra Shafiei
17. Shucheta Shegufta
18. Arman Shojaei
19. Yongkang Shu
20. Olha Sukhanova

21. Luca Vecchiato
22. Francisco Vieira

Scientific report

Peridynamics is a non-local continuum theory that has shown significant promise in modeling the behavior of materials subjected to extreme deformation and complex material phenomena. Unlike classical continuum mechanics, peridynamics is based on integro-differential equations without partial derivatives in space, and postulates that material points interact through pair-potentials (bond-based formulations) or multi-body potentials (state-based formulations). This non-local nature makes peridynamics particularly well-suited for modeling modern mechanical problems, such as the spontaneous formation of cracks or damage, as the governing equations remain valid at points or surfaces of discontinuity.
In the last decade, peridynamic equations have been extended to address diffusion-based problems and have been successfully applied to model coupled phenomena involving different physical processes, including corrosion damage, electrodeposition, and more. During this colloquium, recent advances in peridynamics research were discussed, including the development of new constitutive models for complex materials such as soft tissues, porous media, and composites. A significant focus was placed on recent developments and open questions in the peridynamic modeling of material degradation and size-dependent behaviors.
Additionally, we discussed advancements in the numerical implementation of peridynamic models, such as the use of meshfree methods and other discretization techniques. This included the development of GPU-based and parallel algorithms for large-scale simulations, as well as the integration of machine learning techniques to improve the computational efficiency of peridynamic simulations.
Finally, potential future directions for peridynamics research were explored, including its applicability in areas such as biomechanics and materials design. We also examined the connections between peridynamics and other modeling approaches based on continuum mechanics.
Overall, this colloquium provided a comprehensive overview of recent advances in peridynamics, highlighting its potential to address fundamental challenges in materials science and engineering, while fostering collaboration and the exchange of ideas among researchers in this field.

Specific topics addressed in the talks and discussed included:

- Advances in peridynamic constitutive modeling
- Pair-potentials and multi-body potentials formulations
- Analytical solutions of peridynamic governing equations
- Brittle and ductile fracture, material degradation
- Local to nonlocal coupling
- Heat transfer and diffusion problems
- Multiphysics/coupled problems
- Modeling of soft tissues, porous media and composites
- Impact and fragmentation problems, hypervelocity
- Machine learning for nonlocal models, connections to atomistic modeling
- Size-dependent behaviors and multiscale analysis
- Peridynamic models for micropolar elasticity
- Wave propagation and dispersion properties
- Discretization methods, computer codes, and fast algorithms

Keynote Speakers:

- Stewart A. Silling, Sandia National Laboratories, USA
- Erdogan Madenci, University of Arizona, USA
- John T. Foster, University of Texas at Austin, USA
- Ugo Galvanetto, University of Padua, Italy
- Erkan Oterkus, University of Strathclyde, UK
- Ziguang Chen, Huazhong University of Science and Technology, China

Number of participants from each

country

Country	Participants
Italy	13
Germany	9
China	3
United States	3
Denmark	1
Spain	1
Portugal	1
United Kingdom	1
India	1
Total	**33**