



Department of  
Mechanical Engineering  
The University of Hong Kong



## SEMINAR

### Are Configurational Forces Real Forces?

**Date:** 9 January, 2024 (Tuesday)  
**Time:** 10:30 a.m.  
**Venue:** Tam Wing Fan Innovation Wing Two  
G/F, Run Run Shaw Building, HKU

**Speaker:** Professor Roberto Ballarini  
University of Houston  
USA

#### Abstract:

In the *Treatise on Natural Philosophy* of 1879, Thomson and Tait suggest that any attempt to supersede Newton's description of the laws of motion cannot but end in utter failure. A force is something that tends to alter a "body's" natural state of rest, or uniform motion along a straight line, with respect to an inertial observer. The structure of space as given to us in intuition is geometry; it is the possibility of visualizing forces with lines, and their geometrical composition, that facilitates the practical solution of most problems of mechanics. There are cases, however, for which the geometric visualization of such forces is not straightforward. A classical example is that of configurational forces, pioneered by Eshelby to describe the potential movement of defects within the solid state. From the variation of the free energy consequent to the movement of the defect, say an inclusion, an associated force can be inferred due to the natural tendency of the system to achieve lower potential states. However, as admitted by Eshelby himself, such a force is in some sense "fictitious": its existence is demonstrated starting from a consistent continuum theory of mechanics, but the same theory predicts that the resultant of the traction acting along the boundary of the inclusion is null. We show in paradigmatic examples amenable of generalization that a configurational force can be viewed as the resultant of the contact forces acting on the perturbed shape of an object of substance equivalent to the defect, and evaluated in the limit of the shape being restored to the primitive configuration. The expressions for the configurational forces on cracks and dislocations are in

agreement with those determined using classical variational arguments. It is hoped that this somewhat novel approach, which has been applied by Bigoni and coworkers to illustrate configurational forces in structural components, may open a new prospective in the use of configurational forces by permitting their physical and intuitive visualization.

**Biography:**

*Dr. Roberto Ballarini is Thomas and Laura Hsu Professor and Chair of the University of Houston's Civil and Environmental. His multidisciplinary research focuses on theoretical, computational and experimental techniques to characterize the response of materials to mechanical, thermal, and environmental loads. He is particularly interested in formulating models for characterizing fatigue and fracture of materials and structures. Ballarini's research has been applied to problems arising in civil engineering, mechanical and aerospace engineering, materials science, microelectromechanical systems, biological tissues and prosthetic design. He has published more than 120 papers in refereed journals, including Science and Nature, and several of his research projects have been featured in the popular press, including the New York Times Science Times, American Scientist, Business Week, Financial Times, and Geo. Ballarini is a Distinguished Member of ASCE, Fellow of ASME and of the Engineering Mechanics Institute, is Past-President of the ASCE Engineering Mechanics Institute, and served as Editor of the ASCE Journal of Engineering Mechanics. He is recipient of the 2019 ASCE Raymond D. Mindlin Medal in recognition of outstanding research contributions to applied solid mechanics.*

**ALL INTERESTED ARE WELCOME**

**For further information, please contact Prof. Y. Lu at 3910 2155.**