数学与系统科学研究院

计算数学所学术报告

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报告题目：

Adaptive coupling between damage mechanics and Peridynamics: A route for objective simulation of material degradation up to complete failure

邀请人：　崔俊芝 院士

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报告地点：　数学院南楼九层

902 教室

Abstract:

The objective (mesh-independent) simulation of evolving discontinuities, such as cracks, is still today a challenging task. Indeed, current available techniques are highly complex and very often involve outrageous computational costs, thereby making simulations up to complete failure quite difficult. In order to circumvent this problem, we propose herein a new hybrid computational framework in which local continuum damage mechanics is adaptively coupled with peridynamics to achieve the objective simulation of all the steps related to material failure, i.e. damage nucleation, crack formation and propagation. Local continuum damage mechanics successfully describes the degradation related to distributed microscopic defects before the formation of a macroscopic crack. However, when damage localization occurs, spurious mesh dependency arises, making the simulation of crack propagation challenging. On the other hand, the peridynamic theory is very promising for the simulation of fracture, as it naturally allows to embed discontinuities within the displacement field. Here, we present a hybrid local-continuum damage/peridynamic model. Local-continuum damage mechanics is used to describe “volume" damage before localization. Once localization is detected at a point, the remaining part of the energy is dissipated through an adaptive peridynamic model capable of the transition to a “surface" degradation, typically a crack. We believe that this framework, which actually mimics the real physical process of crack formation, is the first bridge between continuum damage theories and peridynamics. Two-dimensional numerical examples are used to illustrate that an objective simulation of material failure can be achieved by this method.

References

[1] G. Lubineau, Y. Azdoud, F. Han, Ch. Rey and A. Askari. A morphing strategy to couple non-local to local continuum mechanics. Journal of the Mechanics and Physics of Solids, 60(6):1088–1102, 2012.

[2] F. Han, G. Lubineau, Y. Azdoud and A. Askari. A morphing approach to couple state-based peridynamics and classical continuum mechanics. Computer Methods in Applied Mechanics and Engineering, 301:336-358, 2016.

[3] F. Han, G. Lubineau and Y. Azdoud, Adaptive coupling between damage mechanics and peri-dynamics: a route for objective simulation of material degradation up to complete failure. Journal of the Mechanics and Physics of Solids, 94: 453:472, 2016.

报告人简介:

Pr. Gilles Lubineau is professor of Mechanical Engineering

and Chair of the Mechanical Engineering program at KAUST. He is principal investigator for COHMAS (COmposite and Heterogeneous Materials Analysis and Simulation, an integrated environment for composite engineering that he created in 2009 when joining KAUST). Current research interests include: integrity at short and/or long-term of composite materials and structures, inverse problems for the identification of constitutive parameters, multi-scale coupling technique, multi-functional materials and modeling, nano and multifunctional materials and devices.

Before joining KAUST, Pr. Lubineau was a faculty member at the École Normale Supérieure of Cachan, and a non-resident faculty member at the École Polytechnique, France. He also served as a visiting researcher at UC-Berkeley.

Pr. Lubineau earned a PhD degree in Mechanical Engineering from École Normale Supérieure de Cachan (ENS-Cachan), France.

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