**Computational Mechanics of Interface Phenomena and Evolving Discontinuities**

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Two main approaches can be distinguished for resolving interfaces and evolving discontinuities. Within the class of discrete models, cohesive-surface approaches are probably the most versatile, in particular for heterogeneous materials. However, limitations exist, in particular related to stress triaxiality, which cannot be captured well in standard cohesive-surface models. In this lecture, we will present an elegant enhancement of the cohesive-surface model to include stress triaxiality, which still preserves the discrete character of cohesive-surface models. Subsequently, we will outline how the cohesive-surface approach to fracture can be extended to multi-phase media, in particular fluid-saturated porous media.

Whether a discontinuity is modelled via a continuum model, or in a discrete manner, advanced discretisation methods are needed to model the internal free boundary. A powerful method is isogeometric analysis. Examples will be given, including analyses, including delamination in layered shells.

Isogeometric analysis is also very suitable for the discretisation of higher-order continua by virtue of the smoothness of its basis functions, as will be demonstrated at the hand of a gradient-enhanced continuum damage model. In addition to approaches like NURBS that exploit tensor products for multi-dimensional generalisations, Powell-Sabin B-splines seem to be versatile, since they are defined on triangles, and thus share the ease and flexibility of mesh generation that characterises standard triangular finite elements.

Another recent development in continuum approaches is the phase-field theory for brittle fracture, and we will relate this to gradient damage models. We will also elaborate a phase-field approach for cohesive-surface models. We conclude with a concise discussion of the advantages of phase-field theories for damage and fracture.

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