# 中国留德学人迎圣诞学术交流会及
# 数学与应用数学学会2010年年会
# (GCMA Weihnachtsworkshop 2010)

Karlsruhe，周六 4.12.2010

## 学术报告概要

在上午进行的 "**数学与应用数学学术报告及研讨**" 模块中，我们采用专题讨论的形式，集中讨论 *数值计算* 和 *优化方法* 在工程计算和科研领域中的一些实际应用和成果，包含四个学术报告。

**Numerical simulation of turbulent combustion processes**
**[9:10-9:55]**

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The CFD (computational fluid dynamics) simulation of combustion systems becomes meanwhile an important and reliable tool in designing and optimizing combustion devices like combustion engines or gas turbines. For such industrial flows with high Reynolds number (*Re*), the resolution of all turbulent scales and the computation of all reaction species is not possible due to computational costs. For this reason, modeling is needed to simplify the underlying physics, namely: turbulence and combustion. On one hand, the classical RANS (Reynold's averaged Navier Stokes approach) method provides only information about the time mean variables of the flow and lack detailed transient characteristics; on the other hand, the LES (Large Eddy Simulation) offers the possibility to resolve the 'large' unsteady flow structures and it seems as a good compromise between computational costs and additional accuracy.

In the current work, a Unified Turbulent Flame Speed Closure or UTFC model for turbulent combustion modeling is presented, where the turbulent flame speed $S_t$ is used to describe the turbulence/chemistry interaction, e.g. the finite rate chemistry effect. It is based on a 2-variable approach (mixture fraction $\xi$ and progress variable $\theta$) and the presumption that the entire turbulent flame can be handled as a collection of premixed reaction zones with different stoichiometries. A PDF for the mixture fraction $\xi$ is used to account for turbulencce effect. The fluctuation of $\theta$ is implicitly included by the formulation of the source term of $\theta$ using $S_t$. Detailed chemistry can be used in the model as well. The UTFC model can be applied to simulate different flame types and it is appropriate for use in the context of RANS and LES. In the actual work, the applicability of the model is tested by means of simulations of a premixed, a non-premixed, a partially premixed and a industry-oriented swirl flame using RANS and LES approaches, and at a wide range of Damköhler number (Da). The results of all simulations showed good agreement with the measured data.

## 医学影像学中的数学

**[9:55-10:40]**

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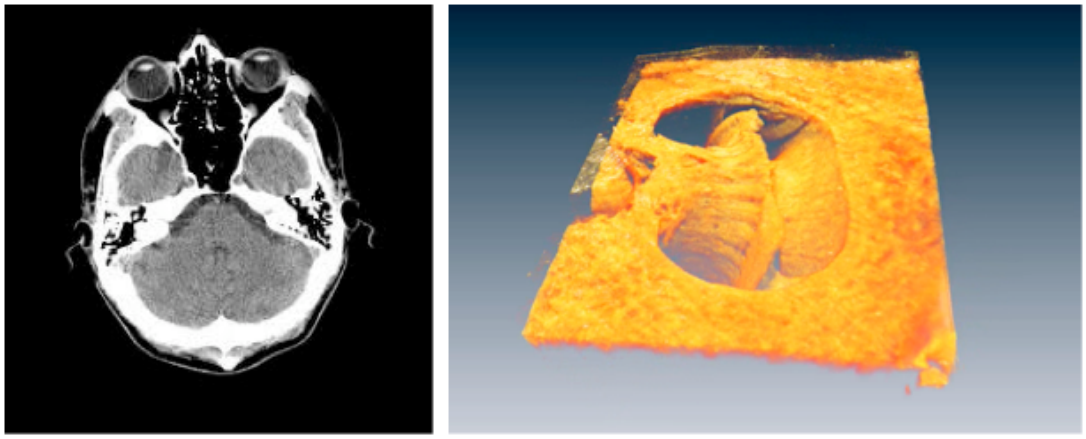
在现代临床医学中，医学影像学为医生提供了人体内部的直观影像，在疾病的诊断、治疗中起着不可替代的作用。在新兴的计算机辅助外科手术(computer assisted surgery)中，各种断层扫描技术为术前计划(preoperative planning)提供了依据，并在手术中为医生导航(intraoperative navigation)。本报告将以两种断层扫描技术CT (Computerized Tomography)以及OCT (Optical Coherence Tomography)为例，介绍医学影像学中常用到的数学工具。报告将分为如下部分：

1. CT及OCT的成像原理和算法
2. 图像增强及器官识别
3. 基于CT及OCT的耳蜗骨穿孔手术(cochlea osteotomy)



*图片：人类头部横断面的CT断层图（左），人类耳蜗的OCT三维重构（右）*

## Homogenization of the thermoelastic properties of pyrolytic carbon by using image processing technology

**[11:00-11:45]**

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First- and second-order bounds of the thermoelastic properties of pyrolytic carbon on the submicron scale are derived explicitly in terms of the one- and two-point correlation functions [1][2]. The necessary statistical information is obtained based on image processing techniques applied to micrographs [4].

The segmentation technique, which segments the micrograph into regions with approximately coherent orientations, uses the distribution of Local Binary Patterns (LBPs) [3] for determining the similarity of adjacent image regions. This region-based algorithm yields a first coarse image segmentation. By means of a pixelwise classification scheme, the localization of region boundaries is improved in a second step.

Within the identified regions with homogeneous orientations, a texture analysis based on the evaluation of Fourier spectra is applied to determine the orientations and distances between the layers. With the region boundaries and the corresponding orientations, the one- and the two-point correlation functions of domain orientation are determined which are necessary for computing bounds of the thermo-elastic properties of PyC.

**References**

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[3] Ojala, T., Pietikäinen, M.: Unsupervised Texture Segmentation Using Feature Distributions. Pattern Recognition, 32 (3), 477–486, 1999

[4] Böhlke, T., Jöchen, K., Piat, R., Langhoff, T.-A., Tsukrov, I., Reznik, B.: Elastic properties of pyrolytic carbon with axisymmetric textures,. Technische Mechanik, 30,4, 343-353, 2010

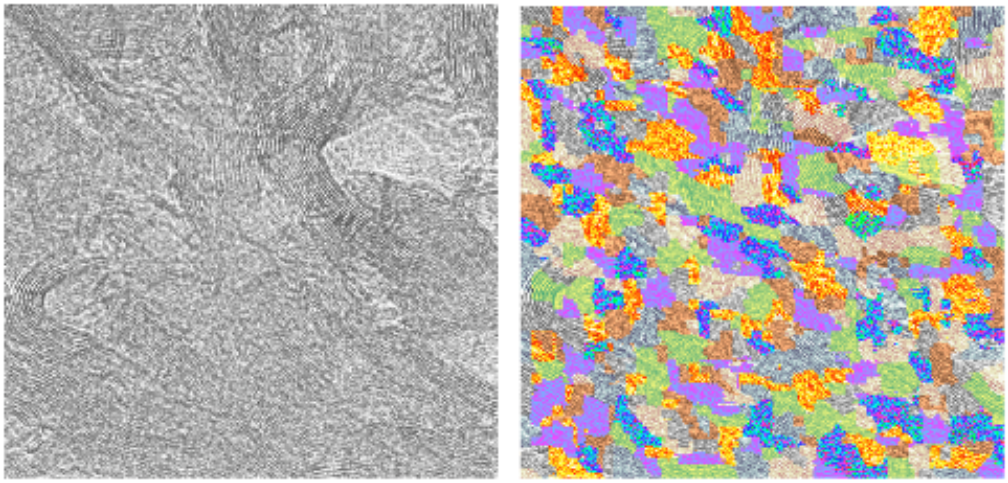

***Figure**: Polarized light micrograph of a polished section of an infiltrated carbon fiber composite (left);Segmented image showing the domains with approximately coherent orientations (right)*

## Interpolation of curves using variational subdivision surfaces

## （曲面重构——用变分细分的方法生成插值曲线的曲面）

**[11:45-12:30]**

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We introduce a variational method to interpolate or approximate given curves on a surface by subdivision within a given tolerance. In every subdivision step some new points are determined by the interpolation constraint and the other new points are varied by solving an optimization problem to minimize some surface energies such that the resulting surfaces have high quality. This method is simple to implement and can flexibly meet different quality requests.

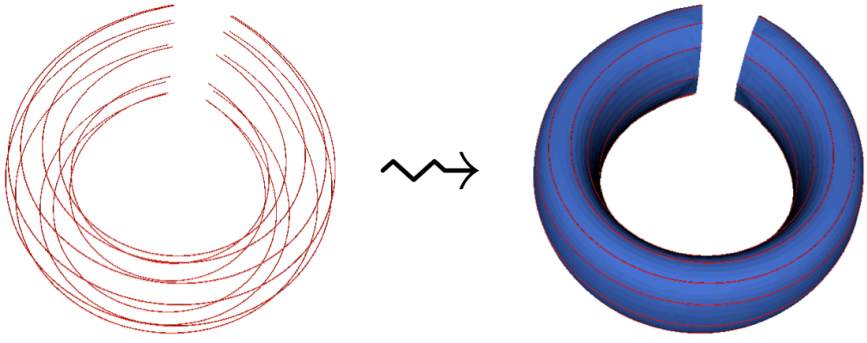

***Figure**: Reconstructed surfaces (right) of a part of a torus after 2 subdivision steps from 10 curves (left).*