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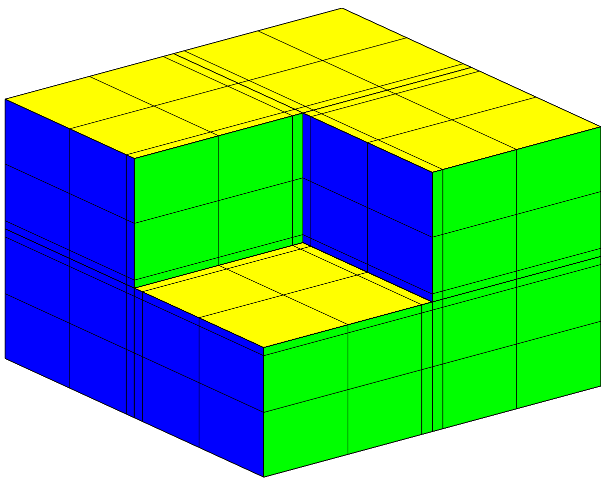

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Computation of 3D vertex singularities using the f.e.m.

The stress distribution at the top of a polyhedral corner or at a crack tip has the typical r^{α}-singularity. Mathematically, the exponent α is an eigenvalue of a quadratic operator eigenvalue problem. The finite element method is sufficiently flexible to solve the problem numerically, such that also anisotropic or composite materials can be treated. In the talk we present approximation results, strategies for the solution of the corresponding matrix eigenvalue problem and numerical tests.

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Approximation of Maxwell singularities by nodal finite elements

Near reentrant corners of a perfectly conducting boundary, electromagnetic fields have strong singularities that are not in H^1. The standard regularized variational formulation of the time-harmonic Maxwell equations, when discretized using nodal (C^0) finite elements, leads to non-convergent Galerkin methods. The weighted regularization method [1,2] is a simple modification of the variational formulation that leads to convergent nodal finite element methods.

In its hp version, the WRM is particularly efficient. For 2D problems, exponential convergence can be shown. The method works well for 3D problems, too.

In the talk, some points from the proof of exponential convergence in 2D will be presented. The convergence behavior will be illustrated by the the results of computations in 2D and in 3D. The results in 3D indicate that good approximation requires an extremely strong geometric mesh refinement.

References

[1] M. COSTABEL, M. DAUGE. Weighted regularization of Maxwell equations in polyhedral domains. *Numer. Math.* Online publication **DOI** 10.1007/s002110100388 (2002)

[2] M. COSTABEL, M. DAUGE, D. MARTIN, G. VIAL. Weighted regularization of Maxwell equations – computations in curvilinear polygons. *Proceedings of ENUMATH01*, Springer 2002.

[3] D. MARTIN. The finite element library MÉLINA.
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On nonlinear elastic material models of power-law type

This talk deals with nonlinear elastic materials where the constitutive equations are of power-law type. In fracture mechanics one investigates for such materials the corresponding HRR-fields (Hutchinson/Rice/Rosengren) [2,3] in order to describe the behavior of cracks under loading. HRR-fields are derived by the assumption that solutions can be decomposed as in the case of linear elliptic equations into a singular and a more regular part: $u = u_{\text{sing}} + u_{\text{reg}} = r^\alpha v_s + u_{\text{reg}}$, (α, v_s) an eigenpair of a nonlinear eigenvalue problem.

The aim of this talk is to present regularity results for weak solutions of the corresponding boundary value problem on polygonal or polyhedral domains. For the derivation of these results we apply the techniques of [1] to our BVP. One consequence of these results is that under the assumption that $u = r^\alpha v_s + u_{\text{reg}}$, the worst possible exponent α is exactly that exponent which is given by the HRR-theory.

References

[1] C. EBMEYER, Mixed boundary value problems for nonlinear elliptic systems with p-structure in polyhedral domains, *Math. Nachr.* **236** (2002), 91-108.

[2] J.R. RICE, G.F. ROSENGREN, Plane strain deformation near a crack tip in a power-law hardening material, *J. Mech. Phys. Solids* **16** (1968),1-12.

[3] J.W. HUTCHINSON, Singular behaviour at the end of a tensile crack in a hardening material, *J. Mech. Phys. Solids* **16** (1968),13-31.

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Density results for composite materials in electromagnetism

The propagation of electromagnetic waves in non-homogeneous materials with edges and corners is characterized by singularities at the exterior corners as well as at the interior ones.

For perfect conducting boundaries, it is well known that these singularities induce a lack of density of the subspace of regular fields in the involved functional space. In the case of an impedance boundary condition, however, a density result has been obtained for constant coefficients (i.e. homogeneous body). In our talk, we address the case of composite materials where the electromagnetic coefficients are piecewise constant functions. We show that we are in a hybrid situation where two cases may occur: either the coefficients satisfy special conditions and thus a density result similar to the homogeneous case does hold, or these conditions are violated and some singularities can not be approximated by regular fields.

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Regularity of the solution of some unilateral boundary value problems in polygonal and polyhedral domains

We consider some unilateral boundary value problems in polygonal and polyhedral domains with unilateral transmission conditions. Regularity results in terms of Sobolev spaces are obtained using a penalization technique, similar regularity results for the penalized problems and by showing uniform estimates with respect to the penalization parameter.

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Elastic junctions : Korn's inequalities, spaces with separated asymptotics and self-adjoint extensions

Elastic multi-structures are considered, i.e. junctions of thin elastic rods with plates and three-dimensional bodies. The main purpose is to indicate geometrical characteristics of junctions which govern asymptotic properties of physical fields. Such characteristics are reflected by forms of asymptotically precise inequalities of Korn's type and by asymptotics Ansätzen for solutions of stationary and oscillation problems.

Since the domains are degenerating, solutions to corresponding limit problems describing main asymptotic terms contain singular components and therefore weighted spaces with detached (separated) asymptotics are fit for a correct formulation of the limit problem. The technique of extensions of differential operators in weighted Hilbert spaces is described for realization of the limit problem as self-adjoint operators.

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Sparse approximation of singularity functions

We are concerned with the sparse approximation of singular functions which arise in decompositions of solutions to elliptic PDE due to corner singularities or the change of the type of boundary conditions. Due to their non-smoothness in the usual Sobolev scale, they deteriorate the rate of convergence of numerical algorithms to approximate these solutions. We show, that functions of this type can be approximated with respect to the H^1 norm by sparse grid wavelet spaces V_L (with $\dim(V_L) \leq C\, p^d\, L^{d-1}\, 2^L$) of biorthogonal spline wavelets of degree p with the rate p (up to logarithmic factors), i. e.

$$\|u - P_L u\|_{H^1([0,1]^d)} \leq C\, L^{d-1}\, 2^{-pL} \|u\|$$

with some weighted Sobolev norm $\|\cdot\|$. Here P_L is a certain projector onto V_L. This is in contrast to the optimal rate p/d for standard p-FEM and means, that one can overcome the curse of dimensionality for this type of singularities up to logarithmic factors.

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Extraction of Edge Flux Intensity Functions by p-FEM

The solution of an elliptic PDE in 3-d domains in the neighborhood of edges can be decomposed in an asymptotic series involving eigen-pairs and edge flux intensity functions (EFIF). In a recent paper by Costabel et al. [1], an explicit mathematical description of the "edge singular solution" is presented and an algorithm for extracting EFIF is proposed.

For the particular case of an elliptic equation (representing heat transfer) having one singular edge, the singular and dual-singular eigen-pairs have been computed, and used for extracting the EFIFs. The p-version of the finite elements method has been utilized in conjunction with the new algorithm presented in [1] for the extraction of the EFIFs. The steps followed for extracting EFIFs are presented.

References

[1] M. COSTABEL, M. DAUGE, Z. YOSIBASH, A quasidual function method for extracting edge stress intensity functions, *Preprint Université de Rennes 1* **02-26** (2002).

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Dynamical crack propagation in a 2D elastic body. The out-of-plane state

Already in 1920 Griffith has formulated an energy balance criterium for crack propagation in brittle elastic materials. A corresponding energy criterium can be also used in order to predict when a crack will grow dynamically [1,2]. We discuss this situation for the out-of plane state which is described by a two-dimensional scalar wave equation in a cracked bounded domain together with boundary and initial conditions:

$$\begin{array}{lll} \partial_t^2 u - c^2 \Delta u = f & \text{in} & Q, \\ \partial_n u = 0 & \text{on} & \Sigma := \cup_{t=0}^T (\Gamma \cup \sigma_t), \\ u(0) = u_0, \ \partial_t u(0) = u_1 & \text{in} & \Omega_0, \end{array}$$

where $Q = \cup_{t=0}^T \Omega_t$ is a noncylindrical domain, σ_t the running crack, Γ the remaining boundary part of $\partial\Omega_t$. We assume that $F_t(x) = x + h(t)\Theta(x)$ maps Ω_0 to Ω_t smoothly. Performing the change of variables we get a wave equation with time-dependent coefficients and lower order terms in Ω_0. The solvability of the transformed problem will be studied and the crack-tip singularities are derived under some assumptions on Θ and h. These results will be used in order to derive a formula for the energy release rate $\partial_t E(0)$, where

$$E(t) = \frac{1}{2} \int_{\Omega_t} \{ |\partial_t u(t,y)|^2 + |\nabla_y u(t,y)|^2 \} \, dy.$$

If $f = 0$ our formula coincides with a relation given in [2].

References

[1] L. B. FREUND, *Dynamic fracture mechanics*, Cambridge University Press, (1990).

[2] D. GROSS, *Bruchmechanik* , Springer Verlag (1996).

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Smooth domain method for crack problems

A new approach to the crack theory for linear elastic bodies with inequality type boundary conditions prescribed on the crack faces is proposed.

Let $\Omega \subset \mathbb{R}^2$ be a bounded domain with smooth boundary Γ, and $\Gamma_c \subset \Omega$ be a smooth curve without self-intersections. Denote by $n = (n_1, n_2)$ the unit external normal vector to Γ and by $\nu = (\nu_1, \nu_2)$ a unit normal vector to Γ_c, Γ_c defines a crack in an elastic body in the reference domain configuration. Let $\Omega_c = \Omega \setminus \bar{\Gamma}_c$. The equilibrium problem for a linear elastic body occupying the domain Ω_c with the interior crack Γ_c can be formulated as follows [1]. We have to find functions $u = (u_1, u_2)$, $\sigma = \{\sigma_{ij}\}$, $i, j = 1, 2$, such that

$$-\mathrm{div}\,\sigma = f \quad \text{in} \quad \Omega_c\,, \tag{1}$$

$$C\sigma - \varepsilon(u) = 0 \quad \text{in} \quad \Omega_c\,, \tag{2}$$

$$u = 0 \quad \text{on} \quad \Gamma\,, \tag{3}$$

$$[u]\nu \geq 0, \quad [\sigma_\nu] = 0, \quad \sigma_\nu \cdot [u]\nu = 0 \quad \text{on} \quad \Gamma_c\,, \tag{4}$$

$$\sigma_\nu \leq 0, \quad \sigma_\tau = 0 \quad \text{on} \quad \Gamma_c^\pm\,. \tag{5}$$

Here $[u] = u^+ - u^-$ is the jump of the displacement field across Γ_c, and the signs $\pm$ indicate the positive and negative directions of the normal ν.

Introduce notations for the space of stresses and the convex cone of admissible stresses in the smooth domain Ω,

$$\mathcal{H}(\mathrm{div}) = \left\{\sigma = \{\sigma_{ij}\} \mid \quad \sigma, \mathrm{div}\,\sigma \in L^2(\Omega)\right\}\,,$$
$$\mathcal{H}(\mathrm{div};\Gamma_c) = \left\{\sigma \in \mathcal{H}(\mathrm{div}) \mid \quad \sigma_\tau = 0\,, \quad \sigma_\nu \leq 0 \quad \text{on}\,\Gamma_c\right\}\,.$$

The weak formulation of (1)-(5) in smooth domain takes the form of the following problem in Ω [2]. *Find $u = (u_1, u_2)$, $\sigma = \{\sigma_{ij}\}$, $i, j = 1, 2$, such that*

$$u \in L^2(\Omega), \quad \sigma \in \mathcal{H}(\mathrm{div};\Gamma_c)\,, \tag{6}$$

$$-\mathrm{div}\,\sigma = f \quad \text{in}\,\Omega\,, \tag{7}$$

$$(C\sigma, \bar{\sigma} - \sigma)_\Omega + (u, \mathrm{div}\,\bar{\sigma} - \mathrm{div}\,\sigma)_\Omega \geq 0 \quad \forall \bar{\sigma} \in \mathcal{H}(\mathrm{div};\Gamma_c)\,. \tag{8}$$

Theorem 1. *There exists a solution to the problem (6)-(8).*

References

[1] A.M. KHLUDNEV, J. SOKOLOWSKI, *Modelling and control in solid mechanics*, Basel-Boston-Berlin, Birkhauser, 1997.

[2] A.M. KHLUDNEV, J. SOKOLOWSKI, Smooth domain method for crack problems, *Les prépublications de l'Institut Élie Cartan* **3/2002**.

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The pressure stabilization method for viscous flow problems

Let $\Omega \subset \mathbb{R}^3$ be a domain with smooth boundary $\partial\Omega$. We investigate a mixed boundary value problem for the following strongly elliptic system of second order differential equations

$$(\mathrm{S}_\varepsilon) \qquad \begin{array}{ll} S_\varepsilon u \ = (-\Delta v + \nabla p, -\varepsilon^2 \Delta p + \operatorname{div} v) = (f', f_4) & \text{in } \Omega, \\ \quad v \ = g', \qquad\qquad\qquad\qquad \partial_n p = g_4 & \text{on } \partial\Omega, \end{array}$$

where we focus our interest on asymptotically precise estimates for the solutions describing their behavior as $\varepsilon \searrow 0$. This system ought be considered as a singular perturbation of the Stokes system (S_0) which appears if we set $\varepsilon = 0$ and cancel the Neumann boundary condition for p, in particular the type of ellipticity is changed with $\varepsilon = 0$. With $f_4 = 0$ and vanishing boundary values, the above system appears in numerical schemes for the Navier-Stokes equations on bounded domains, namely, in the so-called *pressure-stabilization methods*.

If Ω is a bounded domain, the energy methods applied there to estimate the error between the solution $(v^\varepsilon, p^\varepsilon)$ of the system (S_ε) and the solution (v^0, p^0) to the Stokes system are of the form

$$\|v^\varepsilon - v^0; H^1(\Omega)\| + \|p^\varepsilon - p^0; L^2(\Omega)_\perp\| \leq C\,\varepsilon\,\|f'; L^2(\Omega)\|.$$

(the index $\perp$ stands for functions with vanishing mean value).

To obtain asymptotically precise estimates we introduce Sobolev norms depending on the small parameter $\varepsilon > 0$. It turns out that for bounded domains, under the additional smoothness assumption $f' \in H^1(\Omega)$, these estimates can be improved up to convergence of v^ε in $H^2(\Omega)$ and p^ε in $H^1(\Omega)_\perp$.

Apparently up to now the corresponding nonlinear problems as well as the case of unbounded domains were not yet considered. In this lecture the interest is focussed on the exterior Dirichlet problem for the linear systems. The appropriate function spaces for our investigations are step weighted, parameter dependent Sobolev spaces. This leads to asymptotically precise estimates as $\varepsilon \searrow 0$, and enables us to derive the complete asymptotics of the solutions to (S_ε) as $|x| \to \infty$. The latter is remarkable insofar as this system itself for $\varepsilon > 0$ can not be handled with the usual arguments of Kondratiev theory, the differential operator S_ε is not admissible.

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Neumann problem in a perforated layer - Sieving ad infinitum

We consider the Neumann boundary value problem for an elliptic self-adjoint operator in a domain Ω which is characterized by the property, that outside a finite ball there is a certain 3d-pattern (which may contain a hole in its interior), called periodic cell S, which infinitely often is repeated along two axial directions.

We derive a variant of the Hardy inequality which in the standard way leads us to the right energy space and related solvability results.

Nonetheless, our main interest is to characterize the asymptotic behaviour of solutions more precisely than done by the weight index of the space to which they belong to. Namely, we derive an asymptotic representation which is in accordance with the formally derived behaviour. It turns out that standard Sobolev or Kondratiev spaces are not appropriate but we must introduce *step-weighted* spaces.

Our main tools are:

1) Reduction to problems in S and $\mathbb{R}^2\backslash 0$,

2) An auxiliary Lemma about the solvability of the problem

$$\mathcal{L}\, u + \vartheta(1+r^2)^{-1}u = f \quad \text{in } \Omega, \qquad \mathcal{B}\, u = g \quad \text{on } \partial\Omega \tag{9}$$

for $(f, g) \in \mathcal{V}^1_{-\beta}(\Omega)^*$.

3) Asymptotic representation of solutions to the problem in $\mathbb{R}^2\backslash 0$ in negative spaces,

4) Splitting of the solution into its mean-value function and a decaying remainder.

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Approximate boundary conditions for a problem with thin layer in a non-smooth domain

Approximate boundary conditions appear in many applications in electromagnetism: anechoïd chambers, wave absorption by dielectric layers. In such situations, in order to determine the field, we need to solve a transmission problem in a domain – bounded or not – with a thin dielectric layer of thickness $\varepsilon \ll 1$. For the numerical treatment, a fine mesh is needed, the elements being of size ε: the computation becomes very long and may not be accurate. That leads us to replace the thin layer by a boundary condition, called *approximate boundary condition* or *impedance condition*. In the new problem – which is close to the original one –, the thin layer does not appear anymore and we can use a coarser mesh.

The obtention of such boundary conditions is well known in the case of smooth domains (see [1]): it is based on the construction of an asymptotic expansion of the solution as $\varepsilon \to 0$, obtained via a dilatation of the thin layer in the normal direction. We are here interested in a two-dimensional situation of a corner domain. Singularities appear near the corner and we cannot perform the same technic as in the smooth case.

Our method consists in a decomposition of the solution into regular and singular parts; the first one can be studied via the "smooth techniques". But the second one requires tools coming from the theory of singularities in corner domains (Mellin transform, see [2]). We introduce an auxiliary problem in an infinite sector, which allows the construction of *profiles* which are the basis of the structure of the expansion of the singular part near the corner. The complete expansion involves non integer exponents of ε, depending on the opening of the corner. The impedance conditions are not as efficient as in the smooth case: the nearest the angle is from 2π, the less precise is the approximation of the thin layer by the impedance condition.

Numerical tests have been performed with the library MÉLINA. The illustration of the asymptotic expansion needs very accurate results, allowed by high order elements. The $p-$ version is particularly adapted to our case because we can use anisotropic elements in the layer.

References

[1] B. ENGQUIST, J. C. NEDELEC. Effective boundary conditions for electromagnetic scattering in thin layers. Rapport interne 278, CMAP 1993.

[2] M. COSTABEL, M. DAUGE. A singularly perturbed mixed boundary value problem. *Comm. Partial Differential Equations* **21** (1996) 1919–1949.

[3] D. MARTIN. The finite element library MÉLINA. http://www.maths.univ-rennes1.fr/~dmartin/melina/www/homepage.html

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Steady flows of Jeffrey-Hamel type in a Navier-Stokes fluid

This work is the second part of our investigation on two-dimensional aperture like problems for the Navier-Stokes equations. Here, we consider the steady flow of a viscous incompressible fluid in a two-dimensional asymmetric unbounded domain $\widetilde{\Omega}$ having two outlets to infinity, the outlets being a half-plane K and a semi-infinite channel Π_-, and assume that $\widetilde{\Omega}$ differs from a symmetric domain Ω only by a small perturbation. In the first part, cf. [3], we studied the Navier-Stokes flow in an asymmetric domain similar to $\widetilde{\Omega}$ but where the perturbation from a symmetric domain was not necessarily small. Having made a hypothesis that the antisymmetric part of the fluid flow dominates over the symmetric one, we showed that there exists a unique solution having the required (physically reasonable) asymptotic behaviour. Curiously, the data of the problem in [3] did not allow, as is usually the case in domains with outlets to infinity, the prescription of the flux. In fact, the flux became uniquely determined at infinity in K.

Here, we reduce the problem back to a symmetric domain and consider a linearization around a symmetric solution of the Navier-Stokes problem with a prescribed flux. Ultimately, we prove the existence of a unique solution in $\widetilde{\Omega}$ and show that the solution takes asymptotically, at large distances in K, the Jeffrey-Hamel form. Curiously, the results are valid only if the flux Φ, besides being small, is directed from the half-plane towards the semi-infinite channel, i.e. Φ is negative.

Our proofs are based on estimates in weighted spaces with detached asymptotics, cf. [2], and on the study of a model problem resulting from the linearization around the symmetric solution which, for non-zero flux, leads, in contrast to the linearization around the zero solution, to the absence of compatibility conditions for the convective term and, for $\Phi < 0$, to the domination of nonlinear terms by the linear ones.

The main conclusion is that if, as opposed to [3], it is the symmetric Jeffrey-Hamel flow that dominates the antisymmetric one in K, then the problem is well-posed at least if the prescribed flux is small and negative. The well-posedness and even existence of physically reasonable solutions in a non-symmetric domain with a prescribed positive flux remains still an open question. It should be noted that solving this last problem would finally lead to solving the two-dimensional asymmetric aperture problem, see [1] for the symmetric case.

This is a joint work with S. Nazarov (St. Petersburg) and A. Sequeira (Lisbon). For a detailed version, see [4].

References

[1] S.A. NAZAROV, On the two–dimensional aperture problem for Navier–Stokes equations, *C.R. Acad. Sci. Paris*, Ser.1, **323**, 699–703 (1996).

[2] S.A. NAZAROV, Weighted spaces with detached asymptotics in application to the Navier-Stokes equations, in: *Advances in Mathematical Fluid Mechanics*, Malek et al. (eds.), Springer-Verlag, pp. 159-191 (2000).

[3] S.A. NAZAROV, A. SEQUEIRA, J.H. VIDEMAN, Steady flows of Jeffrey-Hamel type from the half-plane into an infinite channel. 1. Linearization on an antisymmetric solution, *J. Math. Pures Appl.* **80**, 1069–1098 (2001).

[4] S.A. NAZAROV, A. SEQUEIRA, J.H. VIDEMAN, Steady flows of Jeffrey-Hamel type from the half-plane into an infinite channel. 2. Linearization on a symmetric solution, *J. Math. Pures Appl.*, (to appear).

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Failure initiation criteria in linear elasticity

Several failure initiation criteria for 2-D singular points in brittle elastic materials are studied and correlated to experimental observations. We consider four criteria, by Novoshilov, Leguillon, the generalized stress intensity factors, and a newly proposed one based on the strain energy density in the neighborhood of the singular point. A series of experiments have been conducted on different materials, and the correlation between the experimental observation and criteria prediction is illustrated. The influence of the V-notch tip radius on the failure initiation is also presented.

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