Sergio Conti

Academic career

1997	PhD, Scuola Normale Superiore di Pisa, Italy
1997 - 2004	Postdoctoral Associate, Max Planck Institute for Mathematics in the Sciences, Leipzig
2004	Habilitation in Mathematics, University of Leipzig
2004 - 2008	Professor (C4), University of Duisburg-Essen
Since 2008	Professor (W3), Institute for Applied Mathematics, University of Bonn

Invited Lectures

2008	79th Annual Meeting of GAMM, Bremen
2008	SIAM, Mathematical Aspects of Materials Science, Philadelphia, PA, USA
2011	ICIAM, Vancouver, BC, Canada
2016	European Congress of Mathematics, Berlin

Research Projects and Activities

HIM Trimester on "Mathematical challenges of materials science and condensed matter physics",
organizer, 2012
Project "From pair potentials to macroscopic plasticity"
within DFG Collaborative Research Center SFB 1060 "The Mathematics of Emergent Effects", jointly with Stefan Müller and Michael Ortiz
Project "Hysteresis and microstructure in shape memory alloys"
within DFG Collaborative Research Center SFB 1060 "The Mathematics of Emergent Effects", jointly with Barbara Zwicknagl
Project "Numerical optimization of shape microstructures"
within DFG Collaborative Research Center SFB 1060 "The Mathematics of Emergent Effects", jointly with Martin Rumpf

Research profile

My research activity focuses on variational problems with applications to materials science, in particular in elasticity and plasticity. One key theme is the elastic behavior of thin sheets. The starting point was a variational analysis of blistering in thin films [13], which contributed to a new understanding of the origin of microstructure in these systems. I then turned to the situation where compressive Dirichlet boundary conditions by confinement, as in an obstacle problem. The optimal scaling turned out to be different, being proportional to the thickness to the power $5/3$ [8]. A second line of thought focused on variational models in crystal plasticity and their relaxation. An explicit relaxation of a geometrically linear model in which finitely many slip systems are active was obtained in [12], and applied to simulate numerically an indentation test in [9]. At a finer scale, a line-tension model for dislocations was derived in [4, 7].
Future work will address interaction between different defects, such as damage and fracture, or density of interstitials and motion of dislocations. At the same time I intend to address microstructure formation in situations which cannot be addressed purely by energy minimization, such as plastic deformation under non-monotonous loadings, or fracture propagation, or cycling in phase transformation in shape-memory alloys. This will involve both the study of path-dependence in inelastic deformation and the study of hysteresis, and can be attacked by macroscopic rate-independent models or at a more microscopic level using transition-state theory.

Research Area B My research activity focuses on variational problems with applications to

materials science, in particular in elasticity and plasticity. One key theme is the elastic behavior of thin sheets. The starting point was a variational analysis of blistering in thin films [13], which contributed to a new understanding of the origin of microstructure in these systems. A simplification of the blistering model leads to the scalar Aviles-Giga functional, which was studied in [10]. I then turned to the situation where compressive Dirichlet boundary conditions by confinement, as in an obstacle problem. The optimal scaling turned out to be different, being proportional to the thickness to the power $5/3$ [8].
A second line of thought focused on variational models in crystal plasticity and their relaxation. An explicit relaxation of a geometrically linear model in which finitely many slip systems are active was obtained in [12], and applied to simulate numerically an indentation test in [9]. The situation in a geometrically nonlinear setting is considerably more subtle. The relaxation for an elastically rigid problem with one-slip-system was obtained in [11]. At a finer scale, self-similar dislocation microstructures have been related to Hall-Petch effect [12] and a line-tension model for dislocations was derived in [7]. The study of models of brittle fracture required a detailed analysis of the space SBD [2].
In the geometrically nonlinear setting, the microscopic significance of the multiplicative decomposition in crystal plasticity was discussed in [1].

Supervised theses

Master theses: 9
Diplom theses: 3
PhD theses: 3

Selected PhD students

Peter Gladbach (2016): “A phase-field model of dislocations on parallel slip planes”,
now Researcher, Mathematics Institute, University of Leipzig
Johannes Diermeier (2016): “Analysis of Martensitic Microstructures in Shape-Memory Alloys: A Low Volume-Fraction Limit”,
now Researcher, Institute for Applied Mathematics, University of Bonn

Selected publications

[1] Sergio Conti and Celia Reina. Incompressible inelasticity as an essential ingredient for the validity of the kinematic decomposition $F = F^e F^i$. *J. Mech. Phys. Solids*, 107:322–342, 2017.
[2] Sergio Conti, Matteo Focardi, and Flaviana Iurlano. Integral representation for functionals defined on SBD^p in dimension two. *Arch. Ration. Mech. Anal.*, 223(3):1337–1374, 2017.
[3] Sergio Conti, Adriana Garroni, and Stefan Müller. Dislocation microstructures and strain-gradient plasticity with one active slip plane. *J. Mech. Phys. Solids*, 93:240–251, 2016.
[4] Sergio Conti, Adriana Garroni, and Michael Ortiz. The line-tension approximation as the dilute limit of linear-elastic dislocations. *Arch. Ration. Mech. Anal.*, 218(2):699–755, 2015.
[5] Sergio Conti and Georg Dolzmann. On the theory of relaxation in nonlinear elasticity with constraints on the determinant. *Arch. Ration. Mech. Anal.*, 217(2):413–437, 2015.
[6] S. Conti and C. Reina. Kinematic description of crystal plasticity in the finite kinematic framework: a micromechanical understanding of $\mathbf{F} = \mathbf{F}^e\mathbf{F}^p$. *J. Mech. Phys. Solids*, 67:40–61, 2014.
[7] Sergio Conti, Adriana Garroni, and Stefan Müller. Singular kernels, multiscale decomposition of microstructure, and dislocation models. *Arch. Ration. Mech. Anal.*, 199(3):779–819, 2011.
[8] Sergio Conti and Francesco Maggi. Confining thin elastic sheets and folding paper. *Arch. Ration. Mech. Anal.*, 187(1):1–48, 2008.
[9] Sergio Conti, Patrice Hauret, and Michael Ortiz. Concurrent multiscale computing of deformation microstructure by relaxation and local enrichment with application to single-crystal plasticity. *Multiscale Model. Simul.*, 6(1):135–157, 2007.
[10] Sergio Conti and Camillo De Lellis. Sharp upper bounds for a variational problem with singular perturbation. *Math. Ann.*, 338(1):119–146, 2007.
[11] Sergio Conti and Florian Theil. Single-slip elastoplastic microstructures. *Arch. Ration. Mech. Anal.*, 178(1):125–148, 2005.
[12] Sergio Conti and Michael Ortiz. Dislocation microstructures and the effective behavior of single crystals. *Arch. Ration. Mech. Anal.*, 176(1):103–147, 2005.
[13] Hafedh Ben Belgacem, Sergio Conti, Antonio DeSimone, and Stefan Müller. Energy scaling of compressed elastic films—three-dimensional elasticity and reduced theories. *Arch. Ration. Mech. Anal.*, 164(1):1–37, 2002.