Foreword

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A mathematical mechanics mixed tape: Editor's foreword to special issue in honor of Alain Goriely

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1. Introduction

This special issue is dedicated to Professor Alain Goriely to mark his election as Fellow of The Royal Society of London in 2022. Founded on 28 November 1660, The Royal Society is the UK's national academy of sciences and the oldest scientific academy in continuous existence. Fellowship of The Royal Society (FRS) is the highest accolade that any scientist in the United Kingdom can achieve and has been awarded to eminent scholars throughout history, including Sir Isaac Newton (1672), Charles R. Darwin (1839), Srinivasa Ramanujan (1918), Albert Einstein (1921), Alan Turing (1951), Stephen Hawking (1974), Sir Andrew Wiles (1989), Sir John M. Ball (1989), Raymond W. Ogden (2006), and Andrew M. Stuart (2020), to name just a few.

Alain Goriely (Figure 1) has held the inaugural position of Statutory Professor of Mathematical Modelling and Fellow of St. Catherine's College at the University of Oxford, UK, since 2010. He earned his BSc in 1989 and a PhD in 1994 from the Université Libre de Bruxelles in Belgium, where he subsequently assumed the role of lecturer in the Mathematics Department. His academic journey continued at the University of Arizona, USA, where he steadily advanced from Research Associate (1994–1997) to Assistant Professor (1998–2002), then Associate Professor (2002–2007) and ultimately Professor (2007–2010). During this tenure, he established a renowned research group within the highly regarded Program of Applied Mathematics. Over the years, he also held distinguished Visiting Professorships in Europe and the United States.

He is perhaps best known for his contributions to fundamental and applied solid mechanics, in particular nonlinear elasticity and biological growth, which led him to coin the phrase "tendril perversion" [1] and later the term "morphoelasticity" [2]. His extensive published work and lectures cover a much wider range of topics and include, among others, plant tropism, seashells morphogenesis, brain multiphysics, power generation, and soft matter. He is the author of the pioneering book "The Mathematics and Mechanics of Biological Growth" [3] and the monographs "Integrability and Nonintegrability of Dynamical Systems" [4] and "Applied Mathematics: A Very Short Introduction" [5].

Passionate about scientific dissemination beyond the academic community, Alain Goriely has participated in several popular lectures on: Whip Cracking, Knot Theory, The Work of D'Arcy Thompson, The Mechanics of Handedness, and The Brain. In Oxford, he initiated the Clay Award for Dissemination of Mathematical Knowledges, which has been offered to mathematicians for their public engagement by the Clay Foundation since 2015. More recently, he chaired the judging panel for the Royal Society Trivedi Science Book Prize 2023, celebrating the best popular science writing from across the globe.

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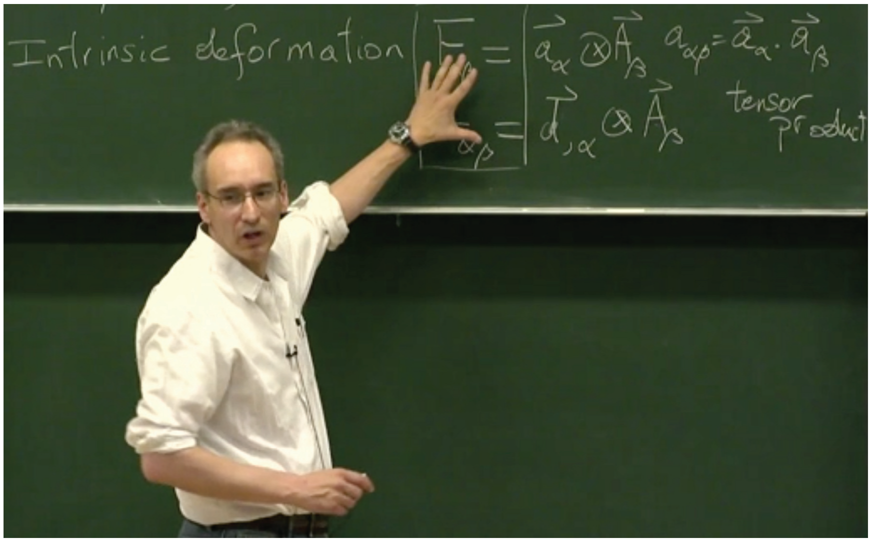

Figure 1. Professor Alain Goriely FRS.

His own editorial responsibilities include a number of book series (Applied Mathematical Sciences, Interdisciplinary Applied Mathematics, Texts in Applied Mathematics, Survey and Tutorials in the Applied Mathematical Sciences – Springer) and several scientific journals (Brain Multiphysics, Journal of Nonlinear Science, Transactions of Mathematics and Its Applications, SIAM Journal on Applied Mathematics, Nonlinearity, and more).

However, much of Alain Goriely's every day work involves training junior researchers and graduate students. A permanent student of science himself, the boundary between collaboration and training is hard to define in this case. His truly outstanding support for all his co-workers cannot be overstated and has been instrumental in helping many of them establish a scientific career or receive recognition in the form of honors and awards.

For those fortunate enough to know him more closely, there are many personal traits that make Alain Goriely unique. He is progressive and open-minded, idealistic, enthusiastic, and warm-hearted, wonderfully dependable, with an innate drive for communication and a delightful sense of humor that sets him apart.

Alain Goriely's election to the Royal Society is above of all his personal achievement and a well-deserved reward for his exceptional scientific work and dedication to the advancement of knowledge. It is also a notable achievement for our mathematics and mechanics community which makes us very proud.

Our special issue aims to reflect, in some way, his boundless curiosity and eclectic scientific taste. The collected articles are briefly reviewed below under different headings, reflecting Alain Goriely's main research interests.

2. Theories of rods and shells

"Anomalous curvature evolution and geometric regularization of energy focusing in the snapping dynamics of a flexible body" by Dehadrai and Hanna [6] examines theoretically and numerically the snapping motion of the free end of an inextensible string.

"Asymptotic theory for the inextensional flexure and twist of plastically deformed thin rods" by Shirani and Steigmann [7] presents a concise derivation of Kirchhoff's theory for naturally curved and twisted rods and further extends it to incorporate prior plastic deformations.

"The mathematics and mechanics of Tug of war" by Moulton and Oliveri [8] provides a simplified mechanical analysis for the ancient game of *tug of war* where two teams pull on opposite ends of a rope with the aim to shift the rope a certain distance against the force exerted by the opposing team. This paper focuses on two players modeled as structures of straight actuated rods.

"Stimuli-responsive shell theory" by Lee et al. [9] proposes a comprehensive theoretical model that accounts for non-mechanical stimuli that add mass, increase the area of a shell, or change its curvature. The modeling approach is tested on complex applications, such as the snapping of a Venus flytrap, leaf growth, and the buckling of electrically active polymeric plates.

3. Materials modeling

"Bespoke two-dimensional elasticity and the nonlinear analogue of Cauchy's relations" by Chenchiah [10] addresses the question whether it is possible to design a two-dimensional architectured material with the elastic energy arbitrarily close to a specified continuous function.

"Dispersive transverse waves for a strain-limiting continuum model" by Erbay et al. [11] analyzes transverse wave propagation in an isotropic homogeneous elastic medium with dispersion within the strain-limiting theory for incompressible solids.

"Tensor decomposition for modified quasi-linear viscoelastic models: Towards a fully non-linear theory" by Balby et al. [12] discusses the decomposition of the tensorial relaxation function for isotropic and transversely isotropic modified quasi-linear viscoelastic models and shows, for the first time, that the tensorial bases must be symmetrically additive, i.e., they must sum up to the fourth-order symmetric identity tensor. This is a fundamental property ensuring that the constitutive equation is consistent with the elastic limit.

"Flaw sensitivity of stochastic elastic materials" by Lavoie and Suo [13] studies how the fractocohesive length of a material is influenced by the stochasticity in its constituents. The study focuses on geometrically periodic lattices with linearly elastic constituents for which the strength varies stochastically.

4. Energy

"A theoretical model for power generation via liquid crystal elastomers" by Mihai [14] explores the theoretical modeling of a charge pump that can harness the chemical and mechanical properties of liquid crystal elastomers transitioning from a nematic to an isotropic phase when illuminated or heated.

5. Biomechanics

"Identifying composition-mechanics relations in human brain tissue based on neural-network-enhanced inverse parameter identification" by Hinrichsen et al. [15] employs neural networks to establish the correlation between human brain tissue components and material parameters obtained via an inverse parameter identification and multiaxial mechanical testing for different regions of the brain.

"Growth-induced delamination of an elastic film adhered to a cylinder" by Bevilacqua et al. [16] develops a theoretical analysis of the delamination induced by the growth of a compressible thin elastic sheet adhering to the outside of a cylindrical surface due to capillary adhesion.

6. Mathematical foundations of mechanics

"Universal displacements in inextensible fiber-reinforced linear elastic solids" by Yavari [17] characterizes the elastic deformations that can be maintained by the application of boundary tractions, without body forces, in compressible anisotropic linear elastic solids reinforced by a family of inextensible fibers.

"New mountain ridge modes in a film/substrate bilayer" by Yuxin et al. [18] provides a theoretical scenario in which a mountain ridge mode resembling a static solitary wave emerges as a first bifurcation when a film-substrate bilayer with a pre-stretched substrate is subjected to uniaxial compression.

"Localized necking and bulging of finitely deformed residually stressed solid cylinder" by Liu and Dorfmann [19] investigates the influence of residual stresses on the stability of elastic circular cylinders and focuses on stretch-induced localized bulging and necking.

"On the stochastic parametric resonance of a viscoelastic string of rate-type" by Farina et al. [20] analyzes small amplitude shearing motions superimposed on a harmonic extension of an isotropic rate-type viscoelastic string.

We hope that he will find this collection inspiring, and wish him many fruitful and happy researching years!

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