Editorial: 20th International Workshop on Numerical Methods in Non-Newtonian Flows

This issue of the Journal of Non-Newtonian Fluid Mechanics includes a number of papers presented at the "XX International Workshop on Numerical Methods for Non-Newtonian Flows (IWNMNNF)" held from June 6 to June 11, 2021. Non-Newtonian materials are quite common in nature and in industrial contexts. These fluids are encountered in natural resource industries (e.g. mining, oil and gas among others), manufacturing industries (e.g. polymer processing, printing/layering, coating flows), and many bio-fluid applications (e.g. blood, mucus, semen, synovial fluids). This workshop brought together mathematically oriented scientists and engineers to work on these important concepts.

Casa Matemática Oaxaca (CMO) in Mexico hosted the workshop in Oaxaca. This edition of the IWNMNNF happened online, given the COVID-19 pandemics restrictions. The workshop was held in single sessions, with the contributions of colleagues around the globe, who shared together their latest findings and advances on numerical simulation of non-Newtonian fluids in simple and complex flows as well as experimental findings in attractive problems and applications.

CMO in Mexico and the Banff International Research Station for Mathematical Innovation and Discovery (BIRS) in Banff are collaborative Canada-US-Mexico ventures that provide an environment for creative interaction as well as the exchange of ideas, knowledge, and methods within the Mathematical Sciences, with related disciplines and with industry. The research station in Banff is supported by Canada's Natural Science and Engineering Research Council (NSERC), the U.S. National Science Foundation (NSF), Alberta's Advanced Education and Technology, and Mexico's Consejo Nacional de Ciencia y Tecnología (CONACYT). The research station in Oaxaca is funded by CONACYT.

The works collected in this special issue represent a sample of the breath of topics and the diversity of materials that numerical simulations in non-Newtonian fluid mechanics aim to describe in current times. Nowadays, the variety of modern numerical algorithms, in both Eulerian and Lagrangian formulations, and their robustness, permit the access to a first description of complex flows under more realistic scenarios. The combination of mixed deformations under strong flows and theories capable of describing the main aspects of complex fluid rheological response are central in non-Newtonian research actives. Such advances guide and signal one of the paths that computational rheology will follow in the forthcoming years, in which computational tools alongside innovative theories/experiments will complement each other to give answers to the main non-Newtonian fluid mechanics riddles.

The *topics* touched during the sessions spanned over many interesting areas of non-Newtonian fluid mechanics and computational rheology. The sessions were sectioned by generic topics covering some of the current interests of the community. The main contributions of the collected works in this special issue are as follow. On Numerical Solutions for benchmark flows of viscoelastic materials, Zografos *et al.* [1] shared their findings on the characterisation and flow of viscoelastic Boger fluids in planar contraction flow, using their Adaptive Length Scale (ALS-C) model. The area of Viscoplastic Fluids registered interesting inputs, for which Akbari & Taghavi [2] presented experimental results on the injection of viscoplastic materials into Newtonian fluids, reporting breakup, coiling, and buckling regimes, according to the relevant dimensionless group numbers (which may serve as a guidance for numerical experiments). Dealing with Viscoelastic Fluids and Interfaces, França *et al.* [3] provided numerical solutions for viscous and viscoelastic droplet collisions using an algorithm constructed on a finite difference discretisation and resolving droplet interphase evolution with Front-Tracking and Marker-And-Cell methods. Turbulence and Instabilities enjoyed a contribution from Varges *et al.* [4], in which instabilities were analysed when viscoelastic fluids were displaced by Newtonian ones in vertical annular ducts; here, the volume-of-fluid method was used to understand the role that rheology, inertia and buoyancy may have in the application of such flows. The section on Wormlike Micelles & Transient Networks witnessed the contribution of Varchanis *et al.* [5], who presented a comparison of some of the main constitutive equations describing the rheology of wormlike micellar solutions (WLMs) in simple and complex flows under banding conditions. In addition, López-Aguilar *et al.* [6] presented numerical solutions obtained with their finite-element/volume algorithm applied to the settling of spheres in WLMs using their BMP+_τ_p model, for which negative wake instabilities were predicted in the extensional Deborah-number range reported experimentally, alongside asymmetric yield-fronts under extreme solute-concentrations. Finally, in the Suspensions section of our workshop, Winters *et al.* [7] presented a study on the Folger–Tucker-Equation to account for the orientation of elongated particles in suspension and its implications in benchmark deformations. Relevant to the workshop, other interesting non-Newtonian flow problems [8-9] are also included in this special issue. Noteworthy is Prof. Ken Walters FRS passing in 2022, who was one of the first promoters of this workshop back in the day and who will be truly missed [10]. For further details and additional featured materials (videos), we invite the reader to visit the XX IWNMNNF website on: https://www.birs.ca/events/2021/5-day-workshops/21w5208.

A list of the participants to this workshop is provided in Table 1. The attendance to this meeting was remarkable, with over 90 participants listening to 34 talks during the workshop. In Fig.1, a group photo of the participants is provided.

Table 1. Participants to the XX International Workshop on Numerical Methods in Non- Newtonian Flows. Speakers in the workshop are highlighted in bold.

Alexandre Afonso	Julien Férec	Vipin Michael	Rudi Schuech
Jenil Agrawal	**Luís Ferrás**	Siamak Mirfendereski	Robert Secor
Soheil Akbari	Josep Ferré Torres	**Rishabh More**	**Eric Shaqfeh**
Manuel Alves	**Nikolas Fischer**	Alexander Morozov	Abhinendra Singh
Patrick Anderson	Hugo França	**Mônica Naccache**	John Stockie
Arezoo Ardekani	Ian Frigaard	**Matthias Niethammer**	**Seyed Mohammad Taghavi**
Kazem Bazesefidpar	**Alexei Gazca Orozco**	David Nieto Simavilla	Outi Tammisola
Pradeep Bhat	Natalie Germann	**Sooran Noroozi**	**Fernando Tavares de Pinho**
Dey Bikash	**Michael D. Graham**	**Cassio Oishi**	Jesse Taylor-West
Dieter Bothe	Shahriar Habibi	Monica Oliveira	**Becca Thomases**
Emad Chaparian	Richard Hommel,	Weston Ortiz	Roney Thompson
Pam Cook	**Martien Hulsen**	Ignacio Pagonabarraga	**Stylianos Varchanis**
Abdolrahman Dadvand	**Nick Jaensson**	Christina Papenfuss	Priscilla Varges
SeyedZia Daghighi	Soham Jariwala	Jae Sung Park	Travis Walker
Sujit Datta	Stephan Jefferis	Saeed Parvar	**Arturo Bjørklund Winters**
Tudur Davies	Krutarth Kamani	Alessandro Perego	**Li Xi**
Mahdi Davoodi	Masood Khabazian Esfahani	**Tim Phillips**	Fan Yang
Paul Dellar	Marion Krapez	Rob Poole	Lee Yi Wei
Morton Denn	Manish Kumar	**Lucas E. Quintero F.**	**Pengtao Yue**
Marco Ellero	Shivani Kumari	Hossein Rahmani	David Zamora
Elaheh Esmaeili	Gary Leal	**Rekha Rao**	Lin Zhou
Patrick Farrell	**J. Esteban López-Aguilar**	Alondra Renteria Ruiz	Konstantinos Zinelis
James J. Feng	**Octavio Manero**	**Kirti Chandra Sahu**	**Kostis Zografos**
Behrooz Ferdowsi	**Romain Mari**	**Pierre Saramito**	

Figure 1. Group picture of the participants of the XX International Workshop on Numerical Methods in Non-Newtonian Flow, Oaxaca, Mexico - June 6th to June 11th, 2021.

The presentations in the workshop and their sections are listed as follows:

Viscoplastic Fluids

Rekha Rao: Computational models and experimental studies of mold filling in thin channels with yield stress fluids.

Seyed Mohammad Taghavi: Dynamics of the buoyant injection of a viscoplastic fluid in a confined geometry.

Matthias Niethammer: The velocity jump discontinuity for single bubbles rising in a viscoelastic fluid – insights from direct numerical simulations.

Pierre Saramito: A new brittle-elastoviscoplastic fluid based on the Drucker-Prager plasticity.

Alexei Gazca Orozco: A Semismooth Newton Method for Bingham Flow.

Emad Chaparian: Yield-stress fluids in porous media: effect of complex rheological behaviours and recent advances.

Wormlike Micelles & Transient Networks

Martien Hulsen: Comparing the numerical stability of four positive (semi-)definite reformulations for viscoelastic constitutive models.

J. Esteban López-Aguilar: Flow past sphere simulations of wormlike micellar solutions.

Octavio Manero: Calculation of the structure factor in complex fluids.

Tim Phillips: Large amplitude oscillatory shear flow simulation of complex fluids using micro-macro approach with transient network dynamics.

Lucas E. Quintero F.: Computation of Transient networks of FENE dumbbells.

Stylianos Varchanis: Shear-banded flows and elastic instabilities of wormlike micellar solutions in microfluidic devices.

Viscoelastic Fluids and Interfaces

Cassio Oishi: Computational simulations of viscoelastic droplet collisions.

Sooran Noroozi: On the study of viscoelastic nanofiber formation through the centrifugal spinning method.

Arezoo Ardekani: Numerical simulation of viscoelastic fluids through porous media: flow instability and particle transport.

Eric Shaqfeh: The effect of swirl on swimming in elastic liquids.

Patrick Anderson: Computational Interfacial rheology.

Nick Jaensson: Drag on a spherical particle at the air-liquid interface: Interplay between compressibility, Marangoni flow and surface viscosities.

Turbulence and Instabilities

Fernando Tavares de Pinho: LES models for wall-free turbulent flows of viscoelastic FENE-P fluids.

Sujit Datta: Elastic turbulence in porous media.

Li Xi: Non-asymptotic elastoinertial turbulence for asymptotic drag reduction.

Michael D. Graham: Tollmien-Schlichting route to elastoinertial turbulence.

Mônica Naccache: Hydrodynamic instabilities in flow displacement through irregular annular ducts.

Luís Ferrás: Fractional Distributed-Order Derivatives and Viscoelasticity: Theory and Numerical Methods.

Suspensions

Romain Mari: Nonlocality in the transient rheology of non-Brownian suspensions.

Arturo Bjørklund Winters: A numerical approach to the alignment tensor in flow of fiber suspensions.

Rishabh More: Unifying disparate non-Newtonian regimes in suspensions: One model to unify them all.

Becca Thomases: JNNFM Complex Fluids Seminar - Quantifying fluid transitions for different strokes with applications to micro-organisms swimming in viscoelastic fluids.

Numerical Solutions

Kirti Chandra Sahu: A numerical study of pressure-driven two-layer channel flow involving a fluid with time-dependent viscosity.

Mahdi Davoodi: A coupling method for solving multiphase flow problems.

Pengtao Yue: Modeling and simulation of hydrogel interfacial dynamics.

Nikolas Fischer: Rinsing simulations of milk concentrates in spiral-wound membrane

modules using OpenFOAM.

Kostis Zografos: Numerical simulations using the closed from Adaptive Length Scale (ALS-C) model.

Patrick Farrell: Augmented Lagrangian preconditioners for anisothermal, implicitly-constituted flow.

References

[1] K. Zografos, A.M. Afonso, R.J. Poole, Viscoelastic simulations using the closed-form Adaptive Length Scale (ALS-C) model, J. Non-Newton. Fluid Mech. 304 (2022) 104776.

[2] S. Akbari, S.M. Taghavi, Immersed buoyant viscoplastic injections, J. Non-Newton. Fluid Mech. 306 (2022) 104836.

[3] H.L. França, C.M. Oishi, R.L. Thompson, Numerical investigation of shear-thinning and viscoelastic binary droplet collision, J. Non-Newton. Fluid Mech. 302 (2022) 104750.

[4] P.R. Varges, E.C. Rodrigues, L.C. Moraes, P.R. de Souza Mendes, M.F. Naccache, Flow instabilities in fluid displacement through enlarged regions in annular ducts, J. Non-Newton. Fluid Mech. 305 (2022) 104834.

[5] S. Varchanis, S.J. Haward, C.C. Hopkins, J. Tsamopoulos, A.Q. Shen, Evaluation of constitutive models for shear-banding wormlike micellar solutions in simple and complex flows, J. Non-Newton. Fluid Mech. 307 (2022) 104855.

[6] J.E. López-Aguilar, O. Resendiz-Tolentino, H.R. Tamaddon-Jahromi, M. Ellero, O. Manero, Flow past a sphere: Numerical predictions of thixo-viscoelastoplastic wormlike micellar solutions, J. Non-Newton. Fluid Mech. 309 (2022) 104902.

[7] A. Winters, C. Papenfuss, M. Karow, Benchmarking solutions of the Folgar–Tucker-Equation and its reduction to a linear problem for non-linear closure forms, J. Non-Newton. Fluid Mech. 310 (2022) 104922.

[8] B. Dietemann, C. Bierwisch, Predicting particle orientation: Is an accurate flow field more important than the actual orientation model?, J. Non-Newton. Fluid Mech. 310 (2022) 104927.

[9] H.-C. Tseng, Jeffery's orbit leading to the foundation of flow-induced orientation in modern fiber composite materials, J. Non-Newton. Fluid Mech. 309 (2022) 104926.

[10] I.A. Frigaard, R.J. Poole, In memory of Professor Kenneth Walters, J. Non-Newton. Fluid Mech. 304 (2022) 104809.

Ian Frigaard[a], Michael D. Graham[b], J. Esteban López-Aguilar[c,1], Seyed M. Taghavi[d], Lin Zhou[e]

[a]Departments of Mathematics and Mechanical Engineering, University of British Columbia, 1984 Mathematics Road, Vancouver, BC V6T 1Z2, Canada

[b]Department of Chemical and Biological Engineering, University of Wisconsin–Madison, Madison, Wisconsin 53706, USA

[c]Faculty of Chemistry, Chemical Engineering Department, Universidad Nacional Autónoma de México (UNAM), Ciudad Universitaria, Coyoacán, CDMX, 04510, Mexico

[d]Department of Chemical Engineering, Université Laval, Quebec, QC G1V 0A6, Canada

[e]Department of Mathematics, New York City College of Technology, CUNY, Brooklyn, NY 11201, USA

[1] Author for correspondence, email: jelopezaguilar@unam.mx