The Australian Society of Rheology, Inc.

2022-23 Rheology Seminar Series

CAV Reg. No. A0055806E

The Australian Society of Rheology is presenting a national series of lectures, which is open to anyone interested in the flow and deformation of matter. The next event in the series will be held online.

Calendar details

Date:	**Monday, January 23, 2023**
Time:	4:00 to 5:00 PM
Eventbrite Link:	https://www.eventbrite.com/e/australian-society-of-rheology-seminar-23-january-2023-registration-514451346827
Venue:	Level 5, Electrical Engineering Building, University of Melbourne

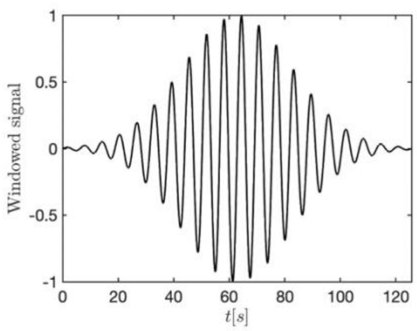
Invited lecture 1

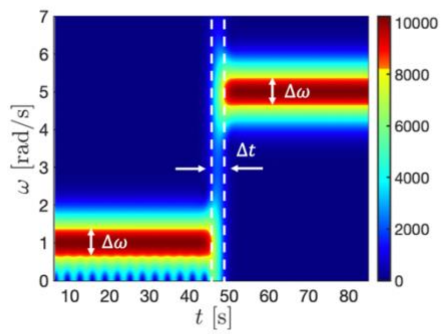
Prof Gareth H. McKinley (Department of Mechanical Engineering, MIT)

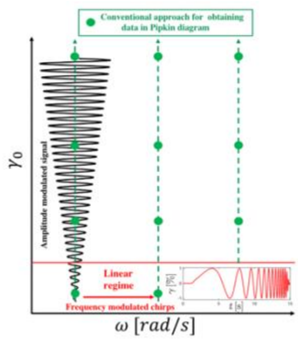
Presentation Title

***Gaborheometry*: Applications of the Gabor Transform to Time-Resolved Oscillatory Rheometry**

Abstract: Oscillatory rheometric techniques are widely used for rheological characterization of the viscoelastic properties of complex fluids. However, in a *mutating material* the evolution of microstructure is commonly both time– and shear-rate–dependent, and thixotropic phenomena are observed in many complex fluids. Application of the Fourier transform for analyzing oscillatory data implicitly assumes the signals are *time-translation invariant* which constrains the mutation number of the sample to be extremely small. This constraint makes it difficult to accurately quantify shear-induced rheological changes in materials that are gelling or crystallizing or exhibiting thixotropic effects. In this work, we explore applications of the *Gabor transform* (a Short Time Fourier Transform (STFT) combined with a Gaussian window) for providing optimal time-frequency resolution of the viscoelastic properties of a mutating material. First, we show using simple models that application of the STFT enables extraction of useful data from the initial transient response following the inception of oscillatory flow. Secondly, using measurements on a Bentonite clay, we show that a Gabor transform enables us to measure more accurately rapid changes in the complex modulus and also extract a characteristic thixotropic/aging time scale for the material. We also consider application to a thixotropic silica suspension that is restructuring following a strong preshearing (or *letherization*) and illustrate how parallel superposition can be used to arrest aging in this colloidal gel. Finally we consider extension of the Gabor transform to non-linear oscillatory deformations using an amplitude-modulated input signal, to track the evolution of the Fourier-Tschebyshev coefficients characterizing a thixotropic viscoelastic material. We refer to the resulting test protocol as *Gaborheometry* and construct an operability diagram in terms of the imposed ramp rate and the mutation time of the material. By considering the shapes of Gabor spectrograms we show that there is a trade-off between frequency and time resolution (effectively a rheological uncertainty principle!). This unconventional, but easily implemented,







rheometric approach facilitates both SAOS and LAOS studies of time-evolving materials, reducing the number of experiments and the data post-processing time significantly.

Speaker's biography

Gareth H. McKinley
Professor

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Gareth H. McKinley is the School of Engineering Professor of Teaching Innovation within the Department of Mechanical Engineering at MIT. He received his BA (1985) and M.Eng (1986) degrees from the University of Cambridge and his Ph.D (1991) from the Chemical Engineering department at MIT. He taught in the Division of Engineering and Applied Science at Harvard from 1991-1997 and was an NSF Presidential Faculty Fellow from 1995-1997.

He won the Annual Award of the British Society of Rheology in 1995 and the Frenkiel Award (with J. Rothstein) from the APS Division of Fluid Dynamics in 2001. He served as Executive Editor of the *Journal of Non-Newtonian Fluid Mechanics* from 1999-2009 and as Associate Editor of *Journal of Fluid Mechanics* from 2007-2009. He is presently a member of the Editorial Board of *Rheologica Acta*, the *Journal of Rheology* and *Applied Rheology*. He is currently the Associate Head for Research of the Mechanical Engineering Department at MIT, a Fellow of the *American Physical Society* and a Member-at-Large of the US *National Committee of Theoretical and Applied Mechanics* (USNC/TAM). He is also a co-founder and member of the Board of Directors of Cambridge Polymer Group. His current research interests include extensional rheology of complex fluids, non-Newtonian fluid dynamics, microrheology & microfluidics, field-responsive fluids, superhydrophobicity and the development of nanocomposite materials.

Enquiries may be directed to Dr Zakiya Shireen, zakiya.shireen@unimelb.edu.au

Invited lecture 2

Prof Ronald G. Larson
(Department of Chemical Engineering, University of Michigan)

Presentation Title
New Simulation Tools to Understand Rheology and Crystallization of Polyethylene Melts

Abstract: New simulation methods are contributing to solving an old problem: how molecular weight and branching distribution, and rheology and processing conditions control properties such as modulus and toughness, of polyethylene film. In one part of this talk, a practical method is presented that accounts for the effects of short- and long-chain branching on rheological properties of commercial polyethylene through use of an "optimal ensemble" of chains, that can be used to predict chain orientation in a processing flow such as film blowing. In a second part, molecular dynamics simulations are used show that both primary and secondary nucleation proceed through a nematic-like intermediate. We show that short-chain branches are partially expelled from the growing crystal to an extent dependent on branch length and by measuring the degree of expulsion, and we can infer the "defect energy" induced by trapping of branches of various lengths in the crystal. Future work will apply these insights to the development of a film blowing model that includes new insights into both rheology and crystallization.

Speaker's biography

Ronald G. Larson
George Granger Brown Professor

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Ronald G. Larson is George G. Brown Professor of Chemical Engineering and Alfred H. White Distinguished University Professor at the University of Michigan. Prof Larson holds joint appointments in Macromolecular Science and Engineering, Biomedical Engineering, Mechanical Engineering and Chemical Engineering. He is internationally recognized for his significant research contributions to the fields of polymer physics and complex fluid rheology, especially in the development of theory and computational simulations. Notably, Prof Larson and colleagues discovered new types of viscoelastic instabilities for polymer molecules and developed predictive theories for their flow behaviour. He has written numerous scientific papers and multiple books on these subjects, "The Structure and Rheology of Complex Fluids".

He is a fellow of the American Physical Society, the American Institute of Chemical Engineers, Bingham medalist and the Society of Rheology. He was also elected a member of the National Academy of Engineering (2003) for elucidating the flow properties of complex fluids at the molecular and continuum levels through theory and experiment.

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