Solving the Couette inverse problem by using a wavelet-vaguelette decomposition

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This paper develops a new approach to computing the shear rate from the torque and rotational-velocity measurements in a Couette rheometer. It is based on the wavelet-vaguelette decomposition (WVD) proposed by Donoho [Appl. Comput. Harmonic Anal. 2 (1995) 101]. This decomposition consists in expanding the shear rate into a truncated wavelet series, whose coefficients can be determined by computing the inner products of the wavelet functions with dual functions (vaguelette). Compared to other strategies used for recovering shear rate such as Tikhonov regularization, the WVD method exhibits greater accuracy and faster convergence. Because of the spatial adaptivity of wavelets, it still performs well when the flow curve is irregular (yield stress, sudden behavior change, etc.) and thus no prior knowledge of the shear rate characteristics (e.g., existence of a yield stress, smoothness) is needed. Its efficiency is demonstrated by applying the method to two fluids (a polymeric gel and a granular suspension).