Effect of the Reynolds number on the segregation of non-axisymmetric fibres in turbulent shear flows

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In a variety of industrial and environmental problems, fibers suspensions are transported through different geometries at high speeds, and the resulting configuration consists of a turbulent wall-bounded flow. Experiments and simulations have shown that, in this flow configuration, fibres tend to agglomerate into streamwise, near-wall streaks (Hakansson et al., 2013). Motivated by this physical problem, we investigate the fibre distribution and segregation in a turbulent channel flow. We study the preferential distribution of long non-axisymmetric fibres (length-to-dimater ratio of 120) in the TU Wien Turbulent Water Channel, a closed water channel with aspect ratio 10, and we vary the shear Reynolds number, from 180 to 720. With the aid of four high-speed cameras, we track the fibres and we are also able to provide information about their rotation rates. The three-dimensional location, shape and orientation of the fibres are obtained by multiplicative algebraic reconstruction techniques (Alipour et al., 2021). We investigate the behaviour of the fibres, from the near-wall region to the channel centre, and we analyse the effect of the Reynolds number and fibres shape on the segregation patterns formed. Finally, we measure the rotation rates of the fibres (tumbling and spinning), and we clearly link the dynamics observed to the segregation patterns in correspondence of the near-wall streaks.

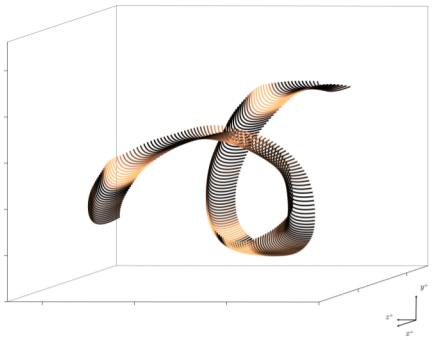

Figure 1: Experimental measurement of the trajectory of a non-axisymmetric fibre. The colour indicates the tumbling rate, from low (black) to high (yellow). *Courtesy of Alipour et al. (2021).*

References

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