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ROUGHNESS-BASED LAMINAR-FLOW CONTROL FOR BOUNDARY LAYERS WITH A CROSS-FLOW COMPONENT

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We discuss results of a numerical study conducted as part of our programme investigating the feasibility of designing energetically optimal surface roughness for transition delay of boundary-layer flow for laminar-flow control and drag reduction [1,2]. The particular type of boundary-layer considered is that over a rotating disk. This represents the paradigm for studying boundary layers with a cross-flow component as occurring in similar form over, for instance, highly swept wings of aircraft or in connection with turbomachinery. We briefly summarize our results of Refs. [1,2] which indicate energetically beneficial effects together with the possibility for a theory-led strategy for their optimisation. In connections with our concurrent experimental programme we then compare roughness-induced effects on the steady boundary-layer base flow to geometry-induced effects as occurring in typical applications encountered in association with turbomachinery. The results discussed show that roughness-induced and geometry-induced effects on the boundary-layer base flow can be very similar in both nature and magnitude [3] indicating that it may be difficult to experimentally distinguish between both for some typical flow geometries. Due to the generic nature of the types of flow considered here we expect that a similar competition between roughness and geometry effects will be relevant to applications related to those addressed here.

References:

[1] Cooper, A.J. et al. 2015 Phys. Fluids vol. 27, 014107

[2] Garrett, S.J. et al. 2016 Phys. Fluids vol. 28, 014104

[3] Özkan, M. et al. 2016, Eng. Appl. Comp. Fluid Mech., under review.