Measurement of wall-normal pressure gradient over the bed in a turbulent open channel flow

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Although the wall-normal pressure gradient appears to be an important quantity in the study of turbulence, not much attention has been given to this quantity so far. Jensen et al. (2014) were the first to study the wall-normal pressure gradient in a turbulent oscillatory boundary layer, calculating the wall-normal pressure gradient, using DNS simulations. It is believed that the wall-normal pressure gradient may have a significant role in the onset of turbulence. It is also believed that it may also have a significant role in the bursting process in a fully developed turbulent boundary layer. This quantity has been shown to be directly associated with the lift on sediment near/at the bed (Sumer and Fuhrman, 2020), and therefore has significant implications for sediment transport such as, e.g., for suspension of sediment from the bed, Jensen et al. (2014).

Experiments were conducted to measure the wall-normal pressure gradient over the bed of a turbulent open channel flow, utilizing neutrally-buoyant single particles, the size 1.0 mm. The equation of motion of the particle in the vertical direction (with the submerged weight, the drag force, and the apparent-mass force all being zero), leads to $(\pi d^3/6)\rho_p(dv_p/dt) = -(\pi d^3/6)(\partial p/\partial x_2)$ such that the wall-normal pressure gradient $(\partial p/\partial x_2)$ was calculated from the measured particle acceleration (dv_p/dt), using the particle trajectory data. Fig. 1 shows a particle trajectory corresponding to start of near-bed liftup.

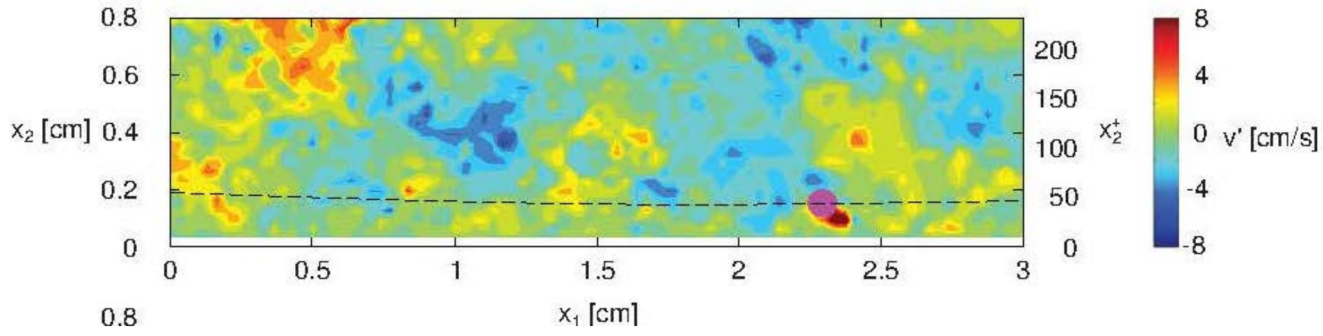

Figure 1: Particle (purple color) trajectory at start of upward motion. v': x_2 velocity.

References

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