Studies on the circular hydraulic jump

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Structure formations in free surface flows remain a major source of complexity in hydrodynamics. One of the most well known and oldest problems is the hydraulic jump, where arise a sudden transition from a high speed, supercritical flow to a subcritical one, with a sudden jump of the fluid depth. Is possible to observe this phenomenon at very different scales: dam release flows, tidal bores on rivers, or in kitchen sinks when a vertical jet of liquid hits a horizontal surface. It's surprising that such a simple and common phenomena, which hides intriguing and a rich dynamics [1,2,3], remain still not well understood. We are investigating the problem from different point of view: experimentally we are using a Chromatic Confocal Pen to measure the profile thickness and detect the presence of capillary waves (first depicted in [4]). The experiments are compared with the numerical simulations, and all these measures are challenged with our model: Inertial Lubrication theory [5] to predict the thickness profile and non linear analysis to find an expression for jump position.

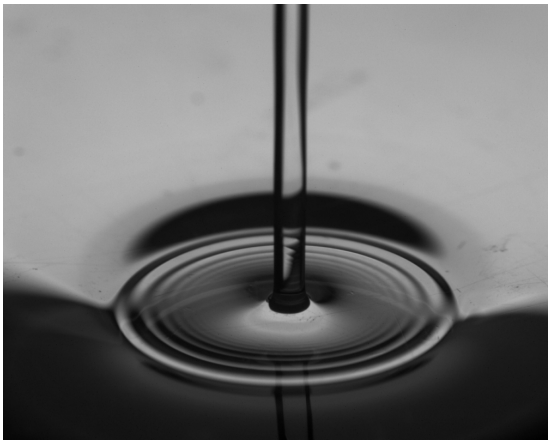

Figure 1. Circular hydraulic jump with ripples formation.

References

1. J. B. Bélanger , Notes sur l'hydraulique. Ecole Royale des Ponts et Chaussees, Paris, France session, 1842:223, 1841.
2. T. Bohr, V. Putkaradze &S. Watanabe, Averaging theory for the structure of hydraulic jumps and separation in laminar free-surface flows. Physical review letters, 79(6): 1038, 1997.
3. J. W. M. Bush, J. M. Aristoff &A. E. Hosoi, An experimental investigation of the stability of the circular hydraulic jump. J. Fluid Mech., 558 :33–52, 2006.
4. E. Rolley, C. Guthmann &M. S. Pettersen, The hydraulic jump and ripples in liquid helium. Physica B: Condensed Matter, 394(1): 46–55, 2007.
5. N. Rojas, M. Argentina, E. Cerda &E. Tirapegui, Inertial lubrication theory. Physical review letters, 104(18) :187801, 2010.