Modulated waves in the Couette-Taylor system submitted to a high radial temperature gradient

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This experimental work focus on the study of the flow induced by the coupling between the centrifugal force and thermal effects in a Couette-Taylor system submitted to a high radial temperature gradient [1-3]. For this purpose, we have developed a non-intrusive velocity and temperature fields measurement technique using thermochromic liquid crystals [4, 5]. It allows us to fully characterize the flow produced in a narrow gap and large aspect ratio Couette-Taylor system with aspect ratio and radius ratio respectively equal to 112 and 0.8. For such a system, the control parameters are the Grashof number Gr, related to the radial temperature gradient, and the Taylor number Ta, related to the rotation of the inner cylinder. Here, Gr is fixed and Ta is gradually increased.

For small values of the Taylor number, the base flow is composed of the circular Couette flow and a vertical flow corresponding to a convective cell induced by the radial temperature gradient. Above a critical value of the Taylor number, the base flow becomes unstable. For small values of the Grashof number, it is replaced by an inclined co-rotating vortex flow pattern present on the bottom of the system [3]. For large values of the Grashof number, the base flow is replaced by a modulated wave present along the entire length of the system and rotating at the mean angular velocity of the flow. The pattern takes the form of wave packets we have studied the envelope. It can be modeled as $A(t) = A_{max}.cosh^{-1}[(t - tmax)/T_{mod}]$ where A_{max} is the maximum value of the amplitude of a packet, t_{max} the time at which this maximum is reached and T_{mod} the period of the modulation which also corresponds to the length of a packet.

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