Abstract Submitted
for the DFD06 Meeting of
The American Physical Society

Pipe flow instability for the 'critical' Reynolds number in transition to turbulence GUY BEN-DOV, JACOB COHEN, Faculty of Aerospace Engineering, Technion - Israel Institute of Technology, Haifa, Israel, 32000 — Experimental results obtained over a century have shown that the flow in a circular pipe becomes 'naturally' turbulent at a 'critical' Reynolds number of ~ 2000. In this work a theoretical explanation, based on the minimum energy of an axisymmetric deviation, is suggested for this 'critical' value. For this purpose a temporal stability analysis is preformed for the pipe Poiseuille flow, which has been modified by a primary axially-independent axisymmetric and finite amplitude deviation (following the method by Gavarini, Bottaro and Nieustadt, *J. Fluid Mech.* **517**, 131, 2004, who analyzed the spatial case). The optimal modification is defined as the primary base-flow deviation, with a given additional energy density, that yields the maximum growth rate to the secondary disturbances. Optimal modifications are computed by a variational technique. It is found, that above the Reynolds number of ~ 2000 the minimum energy of the deviation, which is concentrated at the central part of the pipe, becomes a global minimum for triggering secondary instabilities. Below this critical number the minimum energy deviation, which is concentrated next to the pipe wall, is the one having a global minimum for instability. Previous experimental observations support these results.

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Date submitted: 04 Aug 2006 Electronic form version 1.4