

15th International Symposium on Flow Visualization, June 25-28, 2012, Minsk, Belarus



15th International Symposium on Flow Visualization
ISFV15

Book of Abstracts

Minsk, Belarus

June 25-28, 2012



Luikov Heat and Mass Transfer Institute of National Academy of Science of Belarus

Hosted by: Luikov Heat and Mass Transfer Institute of the National Academy of Science of Belarus.
15, P. Brovki, Minsk, 220072, Belarus
<http://www.itmo.by/>

This book contains the contributions accepted for presentation at the 15th International Symposium on Flow Visualization by decision of the ISFV15 Symposium's Organizing committee upon the peer-review procedure performed by the members of the Program Board and Scientific Review Committee.

ISFV15 Sponsors: We wish to thank the following institutions for their contribution to the symposium



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The cover contains fragments of flow visualization patterns from contributions of Prof. I. Znamenskaya and coauthors, Academician V. Levin and coauthors, Dr. Oleg Penyazkov and coauthors and Dr. J.M. Desse and P. Picart

ISBN 978-985-6456-76-6



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UNSTEADY PHENOMENA IN SEPARATED AND REATTACHING FLOWS: FROM STATISTICAL CHARACTERISTICS TO INSTANTANEOUS SPACE-TIME FIELDS

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KEYWORDS:

Main subjects: fluid mechanics, flow visualization

Fluid: incompressible flows, boundary layer

Visualization method(s): direct numerical simulation

Other keywords: turbulence, separation, reattachment

ABSTRACT: Existence of the quasi-periodic pulsation of the instantaneous reattachment point in various separated flows is a well-known experimental fact. Understanding of the phenomenon is essential, for instance, for developing of separation control methods. An important tool for statistical description of unsteady phenomena is the technique of conditional sampling and averaging. The criterion of early/late reattachment is often used for the skin friction in the reattachment region of a separated flow (for example, [1]). The criterion fixes the statistical correlation between the instantaneous reattachment position and other overall characteristics of the separated region, but the physical meaning of the late reattachment is still unclear. Using results from DNS and LES of the separated and reattaching flat-plate boundary layer under an adverse pressure gradient [2] the unsteady phenomena are visualized and analyzed ($x=0$ is the location where $Re^* = \delta_0^* U_0 / \nu = 550$; δ_0^* – local displacement thickness, U_0 – free stream velocity, ν – kinematic viscosity). The late reattachment criterion is described in terms of instantaneous space-time flow images (fig.1). Some recommendations for local (e.g., hot-wire) measurements of the instantaneous reattachment point pulsation are proposed.

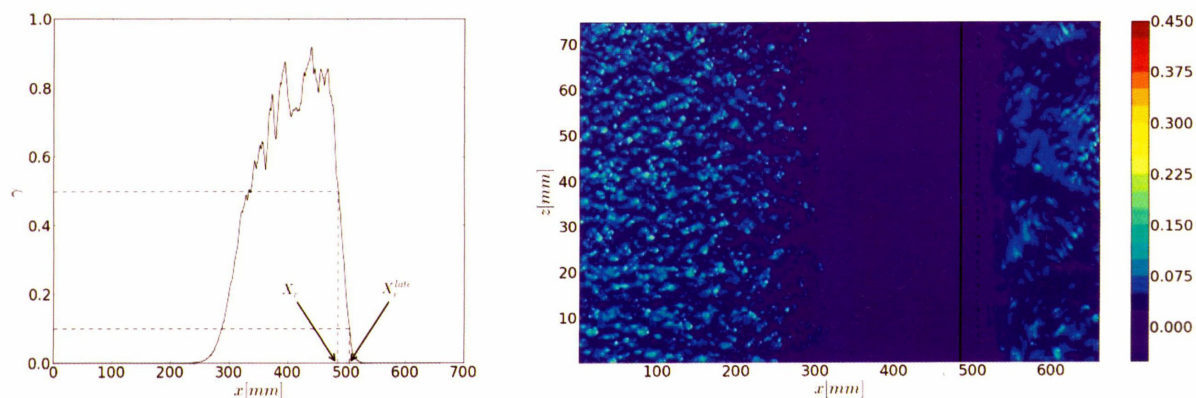


Fig. 1. Probability of reverse flow γ (left; X_r – mean reattachment line, X_r^{late} corresponds to late reattachment criterion), and instantaneous skin friction field corresponding to late reattachment criterion (right; solid black line – mean reattachment line, dashed black line corresponds to late reattachment criterion)

References

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