Linearized no-slip boundary conditions at a rough surface

Thursday, November 21, 2013, 3:30P.M.

Engineering Boardroom,

257 Fitzpatrick Hall

Refreshments served at 3:00 p.m. in 257 Fitzpatrick Hall

Linearized boundary conditions are a common numerical tool in any flow problems where the solid wall is nominally flat but the effects of small roughness of height epsilon are being investigated. Typical are receptivity problems in aerodynamic transition prediction or turbulent flow control.

However, two distinguished mathematical limits have to be considered: a “shallow-roughness” limit, where the linearized boundary condition properly applies, involving a family of surfaces that become smoother and smoother as epsilon tends to 0, and a “small-roughness” limit, more closely representative of usually encountered roughness, whose family of surfaces remain geometrically similar to themselves (in particular, retain their slope) as epsilon tends to 0.

A connection between the two limits can be established through an analysis of their asymptotic behaviour. As a result, the correct effect of the surface in the small-roughness limit, obtained through a numerical solution of the Stokes equation, can be recast as an equivalent linearized boundary condition modified by a suitable “protrusion coefficient” (related to the “protrusion height” used years ago in the study of riblets). Quantitative numerical examples of such protrusion coefficients will be provided.

Dr. Paolo Luchini
Department of Industrial Engineering
Universita` di Salerno
Salerno, Italy

If you are interested in meeting individually with Dr. Luchini, please contact Linda at 631-5431.