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Violation of Scale Invariance in the Laminar-Turbulent Transition in Gases[1] AMADOR MURIEL — For the past 150 years, it has been a tenet of the continuum model of hydrodynamics that the dimensionless critical Reynolds number is the sole discriminant of laminar-turbulent transition, irrespective of the hydrodynamic medium. So for the same apparatus, such as a pipe gas efflux apparatus, it is asserted that the critical Reynolds number, $Re_c = \rho v_c d/\eta$, where ρ is the density, v_c is the critical velocity, d is the diameter of a tube, and η is the dynamic viscosity, should be the same for all gases. This tenet is supported by (1) a re-scaling of the Navier-Stokes equation, and (2) experiments which have heretofore been accurate only to some 10-30%. New experiments using rapid pressure measurements with a sampling rate of every millisecond (S. Novopashin, A. Muriel., Phys. Letters A 335 (2005) 435), and vacuum technology equipment (L. Hinkle, A. Muriel, Phys. Letters A, to be published) show that this scale invariance is not true for the laminar-turbulent transition, thus questioning the basic assumption of continuum theory that the precise molecular nature of the gas used in the experiment is irrelevant. We will display results which are molecule-dependent, raising questions on the exclusive use the Navier-Stokes equation as the defining equation for the study of turbulence.

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