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The Molecular Origin of Turbulence in a Flowing Gas According to James Clerk Maxwell ALBERT DE GRAFFENRIED, North American Digital Company — James Clerk Maxwell was an eminent physicist who operated out of the University of Edinburgh in the early 1800's. He is internationally famous for his derivation of the laws governing the propagation of electro-magnetic waves. He also derived an equation for the Viscosity of a gas (μ) in terms of its **molecular** parameters. This derivation established clearly and unequivocably that a real (viscous) flowing gas was a **molecular fluid**, that is, a flow of molecules which obeys the Kinetic Theory of Gases. Maxwell's derivation of the Viscosity of a gas takes place in a zone of a flowing gas which (1) is remote from any solid surface, and (2) is in a region having a linear velocity-gradient dv_x/dy . The derivation which I will present today takes place in a zone of the flowing gas which is (1) immediately adjacent a solid surface, and (2) where the velocity gradient is unknown. My analytical approach, the parameters I use, and the theoretical concepts are all taken from Maxwell's derivation. I have simply re-arranged some of his equations in order to solve the 1-dimensional case of boundary-layer growth over an infinite flat plate, starting with a step-function of flow velocity, namely: $v_x(y,t)$ for the initial condition $v_x(y=0+,t=0+) = U_0$,viz: rectilinear flow as an initial condition. Using Maxwell's approach, we write the equation for Net Stream-Momentum Flux flowing through an element of area, da_y . This quantity is shown to be the difference between two Convolution integrals which Laplace transform readily into an equation in the s-plane which equation has the same form as a positive-feedback, single closed-loop amplifier gain equation, viz: Output = (input)x(transfer function). The solution in the Real plane shows $v_x(y,t)$ equal to the sum of two exponentials. The coefficients of the two exponents, r_1 and r_2 . are found by using the binomial equation which contains a square-root radical. If the argument under the radical (the radicand) is positive, the two roots are real, and turbulence does not occur. If the radicand is negative, the two roots are complex conjugates and turbulence will develop. The physical reality of the transfer function's feedback-loop format may be clarified by tracing backwards through the derivation to the earliest occurrence of $v_x(y,t)$. Maxwell's derivation of Viscosity, adapted to solve for the boundary-layer growth over an infinite flat plate, is shown to be a nice application of the Kinetic Theory of Gases, and is well suited to revealing the molecular mechanisms at work in such a flowing pattern.

Albert de Graffenried
North American Digital Company

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