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Exact Navier-Stokes solutions linear in one coordinate JONATHAN MESTEL, Mathematics Dept, Imperial College London — If a 3D flow is independent of one coordinate it naturally reduces to a 2D flow. Similar simplification can occur if a flow varies *linearly* with a coordinate. For example, the advection-diffusion equation $\mathbf{u}\cdot\nabla c = \kappa\nabla^2 c$ has solutions of the form $c = xf(y,z)$ when the velocity has the form $\mathbf{u} = (xu(y,z), v(y,z), w(y,z))$ with $\nabla\cdot\mathbf{u} = 0$. The resulting system is essentially two-dimensional, but retains some 3D aspects. This talk employs similar reductions in axisymmetry to derive several previously unknown solutions to the full Navier-Stokes equtions. As they extend to infinity, in some cases these similarity solutions exist without additional forcing. A family of 3D boundary layer flows is also derived, demonstrating for example that the Falkner-Skan solutions are nonunique in 3D. Finally, it is shown that these flows can coexist with other fields of advection-diffusion type. In particular, it is shown that these flows can act as dynamos, spontaneously generating magnetic fields with a related spatial structure.

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