Reynolds number, used to characterize the flow of viscous incompressible fluids, was referred to as the most famous of the dimensionless numbers. In magnetohydrodynamics, the study of electrically conducting fluids, another Reynolds number arises, the magnetic Reynolds number. It is defined as $R_m = UL/\eta$, where U and L are the characteristic velocity and length, and η is the magnetic diffusivity.

It is often stated in the literature that the magnetic Reynolds number is a measure of the relative importance of magnetic convection to magnetic diffusion.[1] That is not the case.[2]

Consider a conducting disk rotating between the poles of a magnet, as found in some residential electricity meters. Currents induced in the disk by the magnet distort the magnetic field. The magnetic lines of force are dragged in the direction of rotation, but the disturbance is localized since the electrical conductivity is finite. The diffusion and convection processes must be equal in the steady state, irrespective of the value of the electrical conductivity of the disk and the value of the magnetic Reynolds number. This does not mean that the magnetic Reynolds number is meaningless; it is a measure of the distortion of the magnetic field due to the motion of the conductor.

References

1. See, for example, T. G. Cowling, *Magnetohydrodynamics*, Hilger, Bristol, UK (1976), p. 7.
2. J. E. Allen, *J. Phys. D: Appl. Phys.* **19**, L133 (1986).

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■ **I read with interest** the feature article "Dynamic similarity, the dimensionless science" by Diogo Bolster, Robert Hershberger, and Russell Donnelly. The authors give a simple example of dimensional analysis of the deflection of a light beam passing through a star's gravitational field. But the example stretches the possibilities of dimensional analysis beyond its true limits. In fact, the deflection angle could be any nontrivial function of the dimensionless fraction Gm/c^2r. Thus at least one more assumption outside dimensional reasoning must be made—the simplest solution, as the authors imply in the given example.

A nontrivial solution may be demonstrated by performing the same exercise with the Planck law, which gives the radiation spectrum emitted by a blackbody. The relevant quantities are wavelength λ, temperature T, spectral emittance B_λ, speed of light c, Planck's constant h, and Boltzmann's constant k. According to the Buckingham Pi theorem, two independent dimensionless quantities can be formed using this list of quantities. An example of a solution is

$$\frac{B_\lambda \lambda^5}{2hc^2} = \frac{1}{\exp\left(\frac{hc}{\lambda kT}\right) - 1}.$$

One dimensionless quantity forms the left-hand side of the equation; the second, independent one occurs in the exponent of the denominator of the Planck law. Such a result could not be found by dimensional reasoning alone.

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■ **The intriguing article** on dimensional analysis gives rise to a more profound question than the authors explicitly pose: Why should dimensionally nonhomogeneous equations, such as the Manning and Hazen–Williams formulas, be used in hydraulics, or anywhere, when such equations purport to equate apples and oranges?

Do our primitive dimensions of mass, space, and time reflect physical reality, or are they biologically adaptive artifacts arising from sensory perceptions? Historically, the sensory perceptions have dominated, beginning with the Greek "elements" of earth, air, fire, and water. That could be making nature seem more complex, and even bizarre, than it truly is, and not just in the case of hydraulics. While some will surely say, "Shut up and calculate," the question may be worth addressing at a time when many struggle to understand quantum mechanics and the modern cosmological mysteries.

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Corrections

August 2011, page 80—The photograph was taken by Eric Brown.

September 2011, pages 44, 46—In box 2, the first of the Boussinesq equations should be

$$\frac{\partial \mathbf{u}}{\partial t} + (\mathbf{u}\cdot\nabla)\mathbf{u} = -(\nabla p)/\rho + \nu\nabla^2\mathbf{u} + \alpha\Delta T\mathbf{g},$$

and the Rayleigh number should be $Ra \equiv g\alpha L^3\Delta T/\kappa\nu$. In the text on page 46 the Ekman number should be $E \equiv \nu(2\Omega L^2)^{-1}$. We thank Paul Asimow for pointing these out. ■