On the use of the Weierstrass–Mandelbrot function to describe the fractal component of turbulent velocity

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It is shown that the Weierstrass–Mandelbrot function simulates the irregularity in a turbulent velocity record and yields correct forms for the energy and dissipation spectra. In particular, the universal properties of a corresponding multi-fractal function are demonstrated by showing its ability to reproduce and explain turbulent flow spectra measured near the walls of straight and curved channels and in the obstructed space between a pair of disks corotating in an axisymmetric enclosure. The simulation capabilities of the multi-fractal function strongly suggest that turbulence is fractal in the frequency range of the turbulent energy spectrum where the slope of the logarithm of the spectrum, G, is $-3<G<-1$. The scale-independent frequency range of the energy spectrum correctly represented by the multi-fractal function includes the isotropic dissipation subrange ($-3<G<-5/3$), the inertial subrange ($G=-5/3$), and the "inner" portion of the anisotropic large-scale subrange ($-5/3<G<-1$).

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