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Turbulent-like laminar flows sustained and controlled by multiscale electromagnetic forces ERWAN HASCOET, LIONEL ROSSI, JOHN CHRISTOS VASSILICOS, Imperial College London — We perform DNS of electromagnetically fractal-forced and Rayleigh-damped 2D flows and compare the results with a recent laboratory experiment of a similarly forced quais-2D thin layer of brine (JFM (2006) vol. 558 p. 207). We determine a range of DNS parameters where the multiscale streamline topology is the same as in the laboratory. It is possible to vary flow intensity whilst keeping multiscale flow topology constant. Our simulations show broad band power law energy spectra $E(k) \sim k^{-p}$. When the fractal distribution of magnets is as in the laboratory experiment then $p \approx 2.5$ in agreement with the experiment. When the fractal distribution of magnets is changed, then p is found to vary linearly with D_f, the fractal dimension of the magnet set up. Hence, fractal control of the energy spectrum is possible. The multiscale flow imposed by the fractal electromagnetic forcing resembles a deterministic β-model of turbulence which also predicts a linear relation between p and the fractal dimension of the multiscale flow. In both cases, p increases as the fractal dimension decreases. In the power-law range the Rayleigh damping balances the fractal forcing's energy input rate scale by scale. The small difference between the two equals the inter-scale energy transfer function which is severely depleted. The energy flux oscillates between positive and negative values and the wavenumbers where it cancels are a direct reflection of the multiscale stagnation point structure of the flow.

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