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2D multiple-scale flow generated by fractal electromagnetic forcing LIONEL ROSSI, JOHN CHRISTOS VASSILICOS, YANNIS HARDALUPAS, Imperial College London — We generate a class of multi-scale quasi-steady laminar flows in the laboratory by controlling a quasi-two-dimensional shallow layer brine flow by multi-scale Lorentz body forcing. The flows' multi-scale topology is invariant over a broad range of Reynolds numbers, Re_{2D} from 600 to 9900. Our multi-scale flows have a power-law energy spectrum $E(k) \sim k^{-p}$ with $p = 2.5$ in agreement with the formula $p + D_s = 3$ of Davila & Vassilicos (PRL, 2003) where $D_s \approx 0.5$ is the fractal dimension of the set of stagnation points. The exponents D_s and p are controlled by the multi-scale electromagnetic forcing over the entire range of scales. The pair dispersion properties are also controlled by their multi-scale hyperbolic stagnation point topology which generates a sequence of exponential separation processes starting from the smaller scale hyperbolic points and ending with the larger ones. The average mean square separation $\overline{\Delta^2}$ has an approximate power law behaviour $\sim t^{\gamma}$ with "Richardson exponent" $\gamma \approx 2.45$ in the range of time scales controlled by the hyperbolic stagnation points. This exponent $\gamma = 3 - D_s$ is itself controlled by the multi-scale quasi-steady hyperbolic stagnation point topology of the flow.

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