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Buoyancy-driven exchange flows in inclined ducts ADRIEN LEFAUVE, PAUL LINDEN, DAMTP, U. of Cambridge — We tackle buoyancy-driven exchange flows, which naturally occur whenever bodies of fluids at different densities are connected by a narrow constriction. To do so, we employ the canonical stratified inclined duct experiment, which sustains an exchange flow in an inclined duct of rectangular cross-section over long time periods. We present the first extensive, unified set of experimental data, in which the five non-dimensional independent parameters of the experiment (the Reynolds number, tilt angle, duct aspect ratios, and Prandtl number) were systematically varied. This allowed us to make progress on the scaling laws of three dependent variables of particular interest: (i) the qualitative flow regime (laminar, wavy, intermittently turbulent, or fully turbulent), (ii) the mass flux (net transport of buoyancy between reservoirs), and (iii) the interfacial thickness (thickness of the layer of intermediate density between the two counter-flowing layers). We also provide physical insight into these exchange flows, and explain some of their scaling laws by three classes of theoretical models: volume-average energetics, two-layer frictional hydraulics, and turbulent mixing. Finally we highlight areas in which future progress is needed.

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