

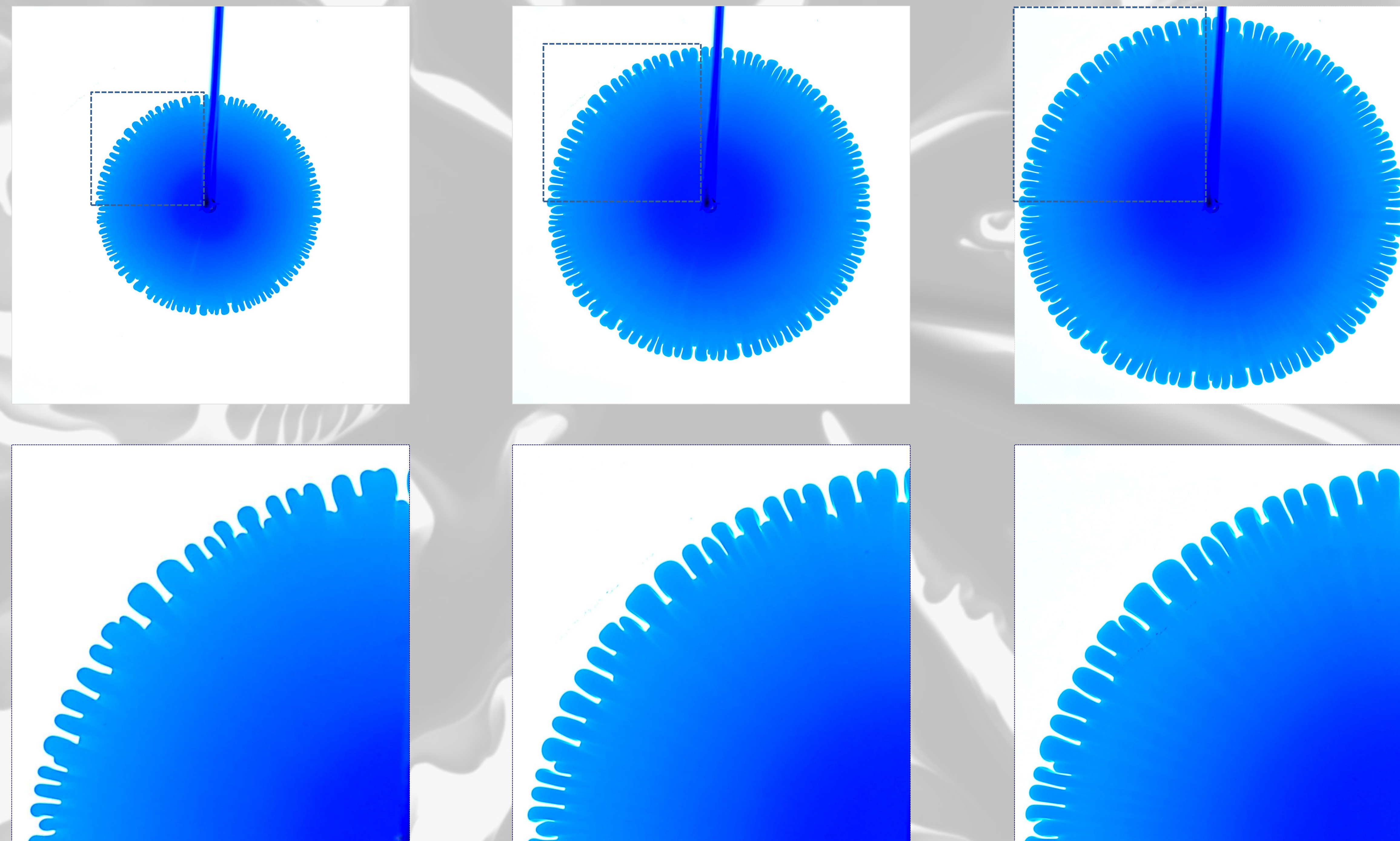
Fingers and toes in miscible flow instabilities

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A new type of physical growth: **Proportionate growth**

any length scale grows at nearly same rate; overall shape remains unchanged

$$3-10 \eta_{in} \approx \eta_{out}$$



Patterns created as a fluid (blue) displaces a more viscous miscible one in a Hele-Shaw cell. The viscosity ratio between the inner and outer fluid is $\eta_{in}/\eta_{out} = 0.2$.

Top row: temporal evolution of fingering patterns.

Bottom row: zoomed images of the patterns - the images are enlarged to have the same outer radius. The enlarged region is indicated by the squares. The zoomed images are essentially indistinguishable; the toes grow in direct proportion to the overall pattern.

Background: Fingering pattern for $\eta_{in}/\eta_{out} = 0.001$. Tip-splitting events during growth create new generations of fingers (no proportionate growth). The growth of the fingers leads to fractal-like patterns.