Order and Randomness in Branched Channel Networks

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The branched structure of channel networks has a primary impact on the spatial distribution of elevation, water, and life across Earth's surface from the hillslope to the continental scale and is also observed on other planets. However, the link between this dendritic, multiscale structure and the erosional processes that sculpt it has remained elusive for more than six decades. In fact, many topologic measures fail to distinguish natural networks from those generated by random walks. Here we show that a fundamental plan-view geometry is ingrained into the structure of these networks that reflects the equal elevation drop spanned by flows that split at the drainage divide and meet again downslope. We demonstrate that this symmetry distinguishes random-walk networks from natural ones, captures the temporal evolution of these networks, and divulges information about the processes that shape them.