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Geometry of Valley Growth

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(Submitted on 11 Nov 2010)

Although amphitheater-shaped valley heads can be cut by groundwater flows emerging from springs, recent geological evidence suggests that other processes may also produce similar features, thus confounding the interpretations of such valley heads on Earth and Mars. To better understand the origin of this topographic form we combine field observations, laboratory experiments, analysis of a high-resolution topographic map, and mathematical theory to quantitatively characterize a class of physical phenomena that produce amphitheater-shaped heads. The resulting geometric growth equation accurately predicts the shape of decimeter-wide channels in laboratory experiments, 100-meter wide valleys in Florida and Idaho, and kilometer wide valleys on Mars. We find that whenever the processes shaping a landscape favor the growth of sharply protruding features, channels develop amphitheater-shaped heads with an aspect ratio of pi.

Subjects: **Fluid Dynamics (physics.flu-dyn)**
Cite as: **arXiv:1011.2782v1 [physics.flu-dyn]**

Submission history

From: Alexander Petroff [view email]
[v1] Thu, 11 Nov 2010 21:51:16 GMT (3567kb,D)

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