Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

The Catastrophic Failure of Plant Hydraulic Networks Examined in Leaves[1] PHILIPPE MARMOTTANT, DIANE BIENAIM, LIPhy CNRS and University Grenoble Alpes, TIMOTHY BRODRIBB, School of Biological Sciences, University of Tasmania, Hobart, Tasmania — Plants live a dangerous game: they have to facilitate water transport in their xylem conduits while minimizing the consequence of hydraulic failure. Indeed, as water flows under negative pressure inside these conduits, cavitation bubbles can spontaneously occur. By preventing the sap transport, they could lead to the plant death. This failure dynamics of this hydraulic network is poorly studied, while it has important ecological and bioengineering implications. Here, by using a simple optical method, we were able to directly visualize the spreading of cavitation bubbles within leaves. The air invasion also progresses by stop and go, from largest veins to smallest ones. In fact, in plants, conducts are linked by small valves called pits. By temporarily blocking bubbles they delay air invasion, until the pressure difference exceeds a threshold. To test the impact of these singular valves on the air invasion, we build a simulation based on the electrokinetic analogy. Taking in account the elasticity of the channel, each conduct becomes a hydraulic resistance coupled with a capacity. We show that we can reproduce the stop and go propagation in a variety of different network architectures.

[1]ERC Bubbleboost Grant number 614655

Philippe Marmottant
LIPhy CNRS and University Grenoble Alpes

Date submitted: 08 Nov 2016 Electronic form version 1.4