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A Simple Model for Biological Valves AARON WINN, ELENI KATIFORI, University of Pennsylvania — Valves play an important role in promoting unidirectional transport of biological fluids in the venous and lymphatic systems, yet the complex nonlinear fluid-structure interaction makes them challenging to model. The current simplest treatment of valves assumes that the valves behave as diodes preventing backflow when the pressure drop is unfavorable, but it is unclear how this electronic analogue arises from local pressure and flow rules at the valves. Thus, there is a need to construct a general valve theory, universal enough to capture the function of valves in a variety of systems yet simple enough to incorporate them into large-scale network models. By employing a one-dimensional model for pulsatile flow in compliant vessels, this work shows how diode-like pressure-flow relationships can arise from valve mechanics and fluid dynamics near the valves. When the time the valves spend open is comparable to the time spent closed, the effective resistance depends on the properties of the pressure wave as well as the location of the valves. In this regime, resonances caused by reflections off valves near the pumping source play an important role in determining the flow.

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