Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Cavitation and brain concussion JULIETTE AMAUGER, THIBAULT GUILLET, Ecole polytechnique, PHILIPPE DECQ, Arts et Metiers Paritech, DAVID QUERE, ESPCI, CHRISTOPHE CLANET, CAROLINE COHEN, Ecole polytechnique — A classical physics experiment consists in accelerating a closed container filled with water to form cavitation bubbles. Those bubbles nucleate in the area opposite to the point of impact and eventually, when they collapse, shatter the container. This situation mimics, to a certain end, a shock on the head of a sport player. We investigate the possibility that the collapse of cavitation bubbles in the cerebro-spinal fluid (CSF) is the underlying mechanism of mild Traumatic Brain Injury (mTBI). The occurrence of mTBI is dependent on the head acceleration a and the duration of the shock τ, as expressed by the empirical Wayne State Tolerance Curve (WSTC). We first observe the formation of cavitation bubbles in the contrecoup area following a shock on a water tank as a function of (a, τ) and show that Rayleigh-Plesset equation accurately predicts the time evolution of the bubble radius. We then explore the specificities of the system skull-CSF-brain (flow of the CSF in and out of the skull through the spinal cord, confinement of the CSF...). From there, we show that the energy stored in one bubble only depends on (a, τ) and build a phase diagram of the damaging capacity of the bubbles on the brain as a function of a, τ), in good agreement with the prediction of the WSTC.

Juliette Amauger
Ecole polytechnique

Date submitted: 30 Jul 2019 Electronic form version 1.4