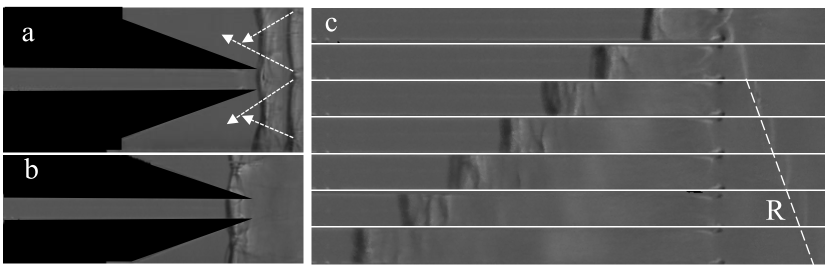
# Do two-dimensional detonation waves exist?

T. Song[1,2], Y. Poroshyna[1], L. Ding[2], G. Ciccarelli[1]
[1]Queen's University, Kingston, Ontario Canada
[2]Chongqing University, Chongqing, China

Experiments were carried out to generate a detonation wave with transverse waves in only one lateral direction, i.e., a two-dimensional detonation wave. Strehlow et al. [1] studied detonation propagation in a very narrow channel and observed that in general one transverse wave was always present even in the narrow dimension that was smaller than the average cell size but claimed that in one test such a two-dimensional wave occurred. Strehlow referred to such detonations in a narrow channel as "marginal," characterized by a large CJ velocity deficit and an average cell size significantly larger than that measured in a large diameter tube. Numerical simulations show that detonations can propagate in two-dimensions, but three-dimensional simulations have only been performed where at least one transverse wave propagates in both lateral dimensions [2]. The objective of this experimental study is to determine if a two-dimensional detonation wave can be generated.

A detonation was generated in a square 76 mm channel, with a mixture of $2H_2$+$O_2$+2Ar at a pressure of 6.5 kPa that resulted in a detonation with 2-3 cells in each lateral dimension. A "cookie cutter" consisting of two sharp corner wedges, see Fig. 1a, was used to reduce one of the lateral dimensions to 12.7 mm. High-speed schlieren was used to determine if the detonation in the narrow section could propagate with lateral transverse waves in only the wide dimension. The schlieren image in Fig. 1a shows the detonation front at two times (consecutive video images recorded at 120 kfps) approaching the cookie cutter at close to the CJ velocity. The trajectory of the 4 triple lines (see dotted lines) do not enter the narrow channel. The next image in Fig. 1b shows that the portion of the detonation front that enters the narrow channel is roughly planar and there are no up/down propagating transverse waves; however, there are four transverse waves propagating in the side-to-side horizontal direction. A reflected wave R forms and the detonation decelerates slightly upon entering the narrow channel but then propagates at a constant velocity of 1704 m/s (10% CJ velocity deficit). A transverse wave develops spontaneously that is difficult to see in the image sequence. The evidence for the transverse wave is the wobble in the lead shock front and the trailing unburned gas pockets that form every time it reflects off the top and bottom wall pinching off the unburned gas adjacent to the shear layer. These pockets burn out in the time for 3-4 images. Soot foils will be used to confirm the formation of the transverse wave, and more importantly the source of the transverse wave in the narrow channel. One possible source is the reflected waves that form at the wedge tips (see Fig 1b).




**References**

R.A. Strehlow, Astron. Acta 15 (1970) 345–357.

V. Deledicque and M. V. Papalexandris, Combust. Flame 144 (2006) 821–837.