An experimental and numerical investigation of polygonal converging shock waves.

Veronica Eliasson[1,2] Daniel Appelö[3] W. D. Henshaw[3]

19 December 2006

[1] KTH Mechanics, KTH, SE-100 44 Stockholm, Sweden
[2] University of California, Department of Mechanical Engineering, Berkeley, CA 94720, USA
[3] Lawrence Livermore National Laboratory, Livermore, CA 94551 USA

Abstract submitted to EE250

Converging shock waves can be found in a broad range of situations, from huge events like supernova collapse to tiny bubbles that collapse so strongly that they produce sonoluminescence. The ability to use shock waves to generate high temperatures and pressures has resulted in continuing research in this area. The present work compare experimental results and numerical solutions of the Euler equations for strong converging shock waves of different geometrical shapes.

It is well known that a cylindrical converging shock wave is unstable and easy to perturb. A challenging problem is thus to find shapes that are stable, in the sense that their deformation during the focusing process is well determined. Converging shock waves in different polygonal shapes have been shown to remain stable during the focusing process, see [1]. Parts of the shock wave with high curvature, such as corners, travels faster than plane parts and this leads to a reconfiguring of the shape of the shock wave, during the focusing process. For example, a heptagonally shaped shock wave will transform into a double heptagon and then back to a heptagon again, see Figure 1. This procedure continues during the whole convergence process if there are no other disturbances present that interrupts it. In this work, the method to produce converging polygonal shock waves is simply to introduce disturbances in a cylindrical shock wave, see Figure 1 and [2].

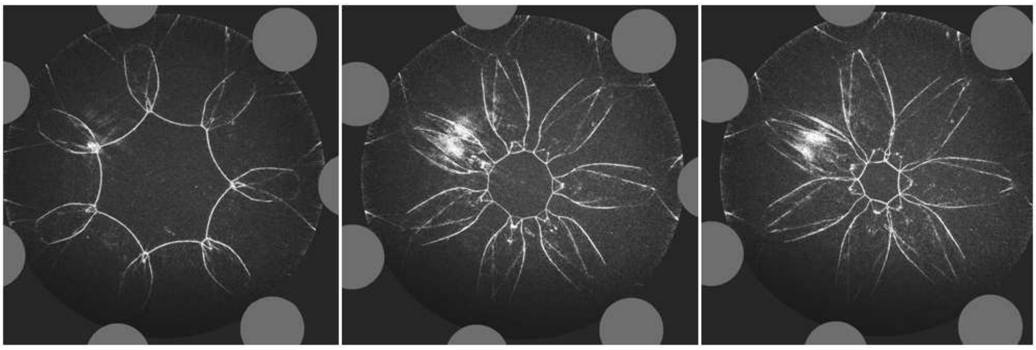

Figure 1: Schlieren photographs from the experimental tests showing a heptagonally shaped converging shock wave that transforms into a double heptagon and then back to a heptagonal shape again.

The complex geometry of the experimental setup requires a numerical solver that handles geometries well. Here, we use the Overture suit, [3], which is a code for solving partial differential equations on curvilinear overlapping grids using AMR. In particular we use the Overblown solver to solve the Euler equations.

From the numerical solutions the kinetic energy, shock speed and other physical quantities are computed, these quantities are then compared for different experimental setups. In particular we compare the experimentally measured dynamics of the intensity with the dynamics of the kinetic energy of the shock during the focusing.

References

[1] V. Eliasson N., Apazidis N. & Tillmark, *Focusing of strong shocks in an annular shock tube.*, Shock Waves **15** (2006), 205–217.

[2] V. Eliasson N., Apazidis N. & Tillmark, *Controlling the form of strong converging shocks by means of disturbances*, to appear in Shock Waves.

[3] W. D. Henshaw *http://www.llnl.gov/casc/Overture/*.