QUANTITATIVE MEASUREMENTS OF THE DENSITY GRADIENT ON THE FLAT SHOCK WAVE BY MEANS OF BACKGROUND ORIENTED SCHLIEREN

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***ABSTRACT**:* The paper presents the results of experimental quantitative studies of flat shock waves by means of background oriented schlieren (BOS) method. The results of previous experiments, as well as works by other scientific groups, show that quantitative capturing of the density jump on a shock wave with the BOS in its conventional scheme poses a difficult problem [1]. It is shown that the problem arises from the limitations on the density gradient being captured by the BOS processing. The limitations are defined by the set-up optical scheme and the properties of the cross correlation algorithm used in the processing program. Key problems are connected with the small width of the shock wave. Although the position and shape of the shock is generally well-defined by BOS, the quantitative measurements of the density field do not provide reliable results.

In order to solve these problems, a modification of the optical scheme and image processing sequence is proposed. In this scheme, the flat shock wave front is being captured at an angle to the axis of the optical scheme. In this set-up the visible width of the shock becomes significant (Fig.1), and the observed density gradient decreases proportionally.

Several variants of the image processing technique can be used with this optical set-up to measure the density jump on the shock wave. Three such options have been tested, and the results were compared with the normal shock theory calculated via the Rankine-Hugoniot shock conditions. The results show acceptable agreement between the BOS data and the theoretical calculations. Accuracy of the proposed experimental technique is discussed.

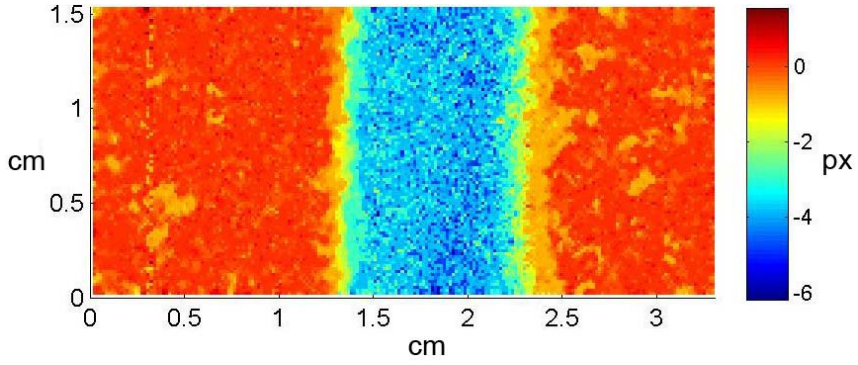

Fig. 1 An experimental field of horizontal image displacement caused by density variation on the front of a flat shockwave with M=2.1, captured at an angle of 20° to the shock plane.

References

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