Production of diverging and converging spherical shock waves and eccentric interaction of converging shock waves with cylindrical interfaces

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Introduction

- Upon focusing of spherical or cylindrical shock waves, high pressures and temperatures created at the center of convergence and have been used for various scientific and industrial applications.

- It is not necessarily easy in laboratories to produce uniformly converging shock waves.

- Applications of R-M instability appearing in converging spherical and cylindrical geometries, such as inertial confinement fusion, supersonic combustion, and astrophysics, made it of considerable interest.

- In the present research, results of recent experiment of R-M instability will be reported.

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Aspheric spherical test section

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Front view of the aspheric spherical test section

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Laser light rays in the aspheric test section

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Double exposure holographic interferometric optical set-up

Parabolic mirror
\[ d=1000 \text{ mm}, \ f=8 \text{ m} \]

Film holder

Aspheric test section

Ruby laser
\[ d=1000 \text{ mm}, \ f=8 \text{ m} \]

5:5 Beam splitter

Optical fiber

Parabolic mirror
\[ d=1000 \text{ mm}, \ f=8 \text{ m} \]

From pressure transducers

Digital memory

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Structure of vertical diaphragmless shock tube

Test section

Low pressure channel

High pressure chamber

Auxiliary pressure chamber

Leak section

Glass window

Test gas

Mirror

Vertical channel

High pressure chamber

Rubber membrane

Paux.

Inner-wall

Out-wall

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Double exposure holographic interferometry

Film holder

Parabolic mirror
d=300 mm, f=3 m

Parabolic mirror
d=500 mm, f=5 m

6:4 Beam splitter

Ruby laser

Power

Digital memory

Delay

Ch1

Ch2

Ch3

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Test section with cylindrical bubble

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Pressure histories at the test section for eccentric interaction of cylindrical shock wave with cylindrical SF$_6$ bubble, $M_{si}=1.18$, $P_0=101.13$ kPa

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$M_{s_i}=1.18$ in air, $P_0=100.3$ kPa, $D_{SF_6}=50$mm

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Reflected SW

Transmitted SW

Converging SW

Perturbed interface

Initial interface position

100 μs

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Reflected SW  Diverging SW  Transmitted SW focusing

Perturbed interface  Initial interface position

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Large scale vortex

2.3 ms

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Time variation of average SF$_6$ jet velocity in air

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Summary

1) Converging spherical shock waves and their interaction with micro-explosive product gases were investigated by using a spherical transparent test section.

2) Using double exposure holographic interferometry, the interactions of converging shock waves with light/heavy cylindrical gaseous interface were quantitatively visualized. A relatively strong secondary shock wave focusing in SF₆ heavy gas bubble resulted a strong SF₆ jet in air, which made the final distortion of the bubbles to be different from planar shock wave loading.

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