MASTER

EXPERIMENTAL TEST OF RESONANT ABSORPTION THEORY

Progress Report
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Abstract

In this report final engineering of the various components of the experiment is discussed, and the first experiments are described.

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In the last three months engineering has been virtually completed on all aspects of this experiment, and the various components of the apparatus have been successfully integrated and utilized. We consider them separately.

Shock Tube: A compact and reliable high-voltage, low-inductance discharge circuit has been assembled in a copper box which provides complete electrical isolation. It is capable of driving a shock of Mach number 17 down a 1/2-inch id quartz tube 9 inches long filled with 40 torr of gas pressure. For several reasons, however, it is preferable to use slower shock, with $M \sim 7$. In this mode the shock tube is so reliable that it can be moved into place and ignored.

Shock Front Detection System: With a new 5 mW HeNe laser, the shock front detector drives a saturating amplifier to produce a 15 V high pulse of risetime 30 nsec, no amplitude fluctuation, and negligible noise. This output provides a trigger for tuning and for firing the main laser. Timing can be adjusted by moving the laser beam parallel to the axis of the shock tube, or by adding electrical delays. The position of the shock front can thus be located at 2 points, using a split laser beam, to within 50 μ m; associated synchronization error is negligible. This component of the experiment is also so reliable as to be ignorable. A second detection channel is available for more intricate timing schemes.

Pulsed CO₂ Laser: All timing events in our laser system have been carefully measured, optimized and interfaced with the shock front detection system. The jitter in pulse appearance time is negligible. Pulse energy, however, will be optimum only after a routine "tune-up" is performed.

Laser Plasma Interaction Chamber: An aluminum cell has been constructed which holds the shock tube and final focussing optics in fixed positions and provides space for diagnostic instruments. The cell can hold two focussing lenses, of focal/aperture ratios of $f/5$ or $f/2.5$; the focal positions can be located with a precision of better than $\pm 200 \mu\text{m}$. The angle between the axes of the laser beam and of the shock tube is $30^\circ \pm 5^\circ$. This evacuable cell is connected to a filtered, cold-trapped gas flow system.

Preliminary Experiments: In a successful attempt to locate the last remaining flaws in the apparatus, shock fronts of $M = 10$ in 43 torr H_2 were irradiated with laser pulses focussed by the $f/5$ lens in a series of 5 runs of 20-30 shots each. Our diagnostic for accelerated electrons was in each run a piece of X-ray film wrapped in aluminum foil, placed 17 mm away from the interaction region, along the shock tube axis. Except for reliability problems which have since been solved, the experiments proceeded correctly. However, due to low laser intensity on target, the expected 3 keV electrons were only marginally energetic enough to reach and expose the film, which was thus found blank. With the $f/2.5$ lens, this problem should be overcome, because the expected electron energy will be doubled. An experiment with this lens will be performed shortly.