EXPERIMENTAL TEST OF RESONANT ABSORPTION THEORY

Progress Report
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Abstract

We report our first successful observation of resonant electron acceleration in the laser shock front interaction experiment.

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In the last quarterly progress report preliminary attempts to perform the laser-shockfront interaction experiment were reported. These demonstrated that the apparatus functions approximately as required, but no electron emission could be detected. Work during the past quarter has been aimed at identifying and removing the obstacles which caused this problem. This effort, which has now come to fruition, had three main directions:

1. Shock wave synchronization and shock tube operation.

Two related problems have been encountered: shot-to-shot fluctuations in shock speed, which degrade the laser-shockfront synchronization, and unreliable electrical breakdown of the shock tube discharge. Preliminary experiments have been performed which indicate that both will be cured by the use of a higher charging voltage (9 kV vs 3 kV), lower capacitance (3 μ fd vs 40 μ fd), and slower shock wave ($M \approx 5$ vs $M \approx 10$). A new capacitor appropriate to these parameters has arrived, and with it the shock tube is able to fire every 3 sec, the normal repetition rate of our CO₂ laser. This will allow rapid data acquisition. Since the preliminary experiments, some simple electronic circuits have been added to the system, which greatly facilitate the actual running of the experiment.

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CO₂ laser facility a long-needed overhaul. The pulse energy has, as a result, been increased from 40-60 mJ at fair contrast ratio to 110-130 mJ at good contrast ratio. This had a significant effect in allowing electron emission to be detected in static, neutral gas, as well as at the front of a shock wave.

3. Electron detection.

Previous attempts at performing this experiment used as electron detectors X-ray film wrapped in aluminum foil. Such a detector is useful for imaging the spatial distribution of electron emission, but is not sensitive enough to generate quantitative data on the magnitude of the emission. In the past we have used very sensitive but extremely fragile silicon surface barrier detectors for this purpose. Experiments have verified that, with a protective wire mesh under the aluminum foil light shield, these detectors can function safely in the present experiment, and it has been reconfirmed that the emission seen previously in static gas does indeed take place in the presence of the shock wave.

The work that has been done in these areas should allow the experiment to continue toward the goal of a quantitative verification of the resonant acceleration concept.