Investigation of Particle Movement After Disruption

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Introduction

The disruption of meteorites has been studied for many years to track the behaviors of the particles after disruption events. Models have been constructed to mirror these disruptions [1,2,3]. As time has progressed, these models have improved to more closely resemble the actual disruption events, but there is still room for improvement. This work includes analysis of the size, mass, and velocity of expelled particles in order to provide real sample data for the production of more accurate models. Video files of disruption events of various meteorites are recorded using high-speed cameras at the NASA Ames Vertical Gun Range [4]. These video files are analyzed to measure particle velocity and size.

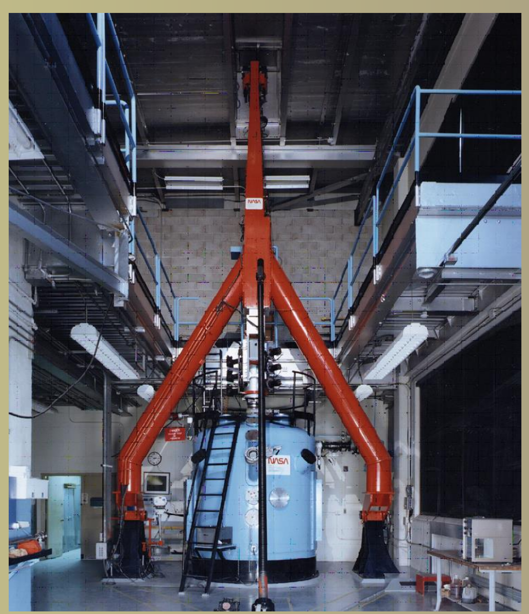

Figure 1. NASA Ames Vertical Gun Range in Mountain View, CA. Meteorite disruptions are simulated in the chamber and recorded using high speed cameras.

Methodology

A video file is converted into a TIFF stack and opened using the program ImageJ. Particles are monitored as they travel, with close attention being paid to the detectors that are placed around the sample prior to the disruption event. In addition to the distance measurements taken prior to the shot in the AVGR gun chamber, the measuring tool in ImageJ can help provide an accurate travel distance for each particle.

Figure 2. One of the setups of the gun chamber. A white sheet covers the whole chamber along with foil detectors hung to collect sizes of particles. The sample is suspended in line with the gun with fishing line and paper is used to cover the projectile entrance to keep out unwanted debris.

The video frame in which a particle passes through a given detector is coupled with the frame rate of the camera to find the travel time. The distance traveled is divided by the travel time to yield the velocity of the particle, which is then matched to particle size. A visual representation of velocity determination can be seen in Figure 3.

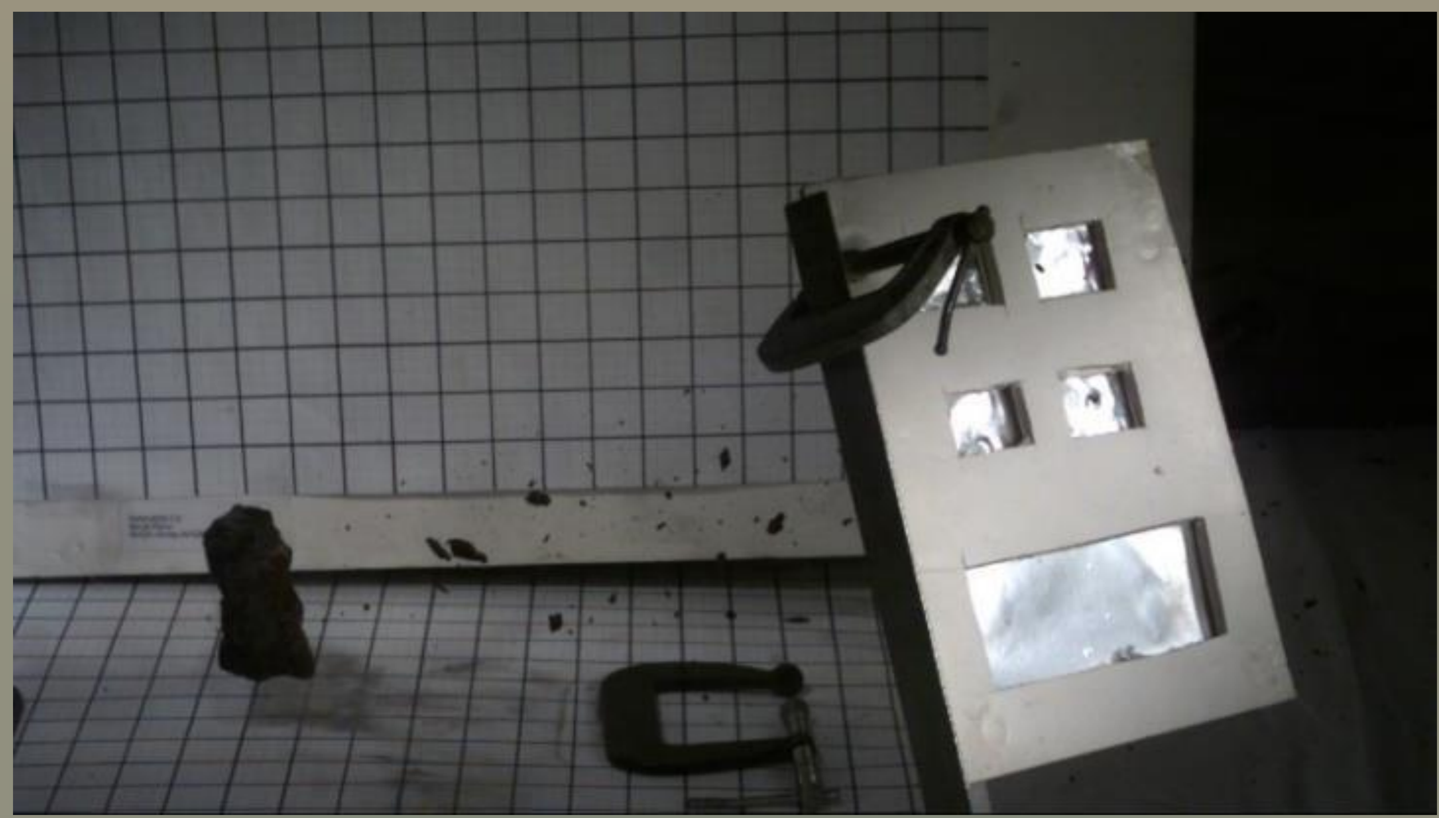

Figure 3. An image from a video file clearly shows the disrupted meteorite with the expelled particles travelling toward the detector on the right. This setup included the use of grid paper around the sample to allow for more effective tracking of the particles after a disruption event.

Particle size is initially approximated using the measuring tool in ImageJ. Individual slides from the detectors are then scanned using the computer program CyberViewX, accurately measuring the size of the hole left by a specific particle. These two measurements can be matched with particles that were collected and weighed after the disruption event.

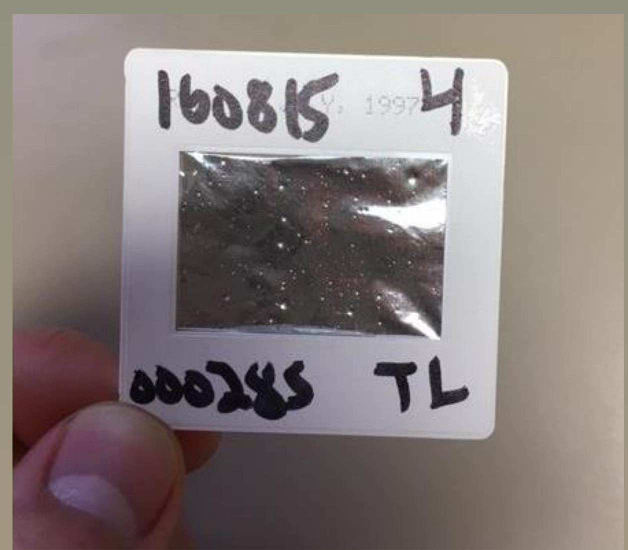

Figure 4. A foil from shot 160815. It was the top left slide on detector 4 with a thickness of 0.00285 μm The foil was placed on a 35 mm slide mount.

Figure 5. A scanned image of a foil detector from CyberViewX. From here, the image is ready for analysis to determine individual particle sizes.

References: [1] Asphaug E. and Agnor C. (2005) *BAAS, 37,* 623. [2] Jutzi, M. et al. (2009) *Icarus, 201,* 802-813. [3] Flynn, G. J. et al. 2015. Planetary and Space Science 107:64-76. [4] Flynn G. J. and Klock W. (1998) LPS XXIX, Abstract #1112.

Results and Discussion

Video files from eleven different shots were analyzed. Many particles were observed being ejected from each sample after the collision, although only a small fraction of them made contact with the detectors. The particles varied in size, some being too small to distinguish before they left a visible hole in the detector. Particle velocity ranges from 4.381 m/s to 150.563 m/s.

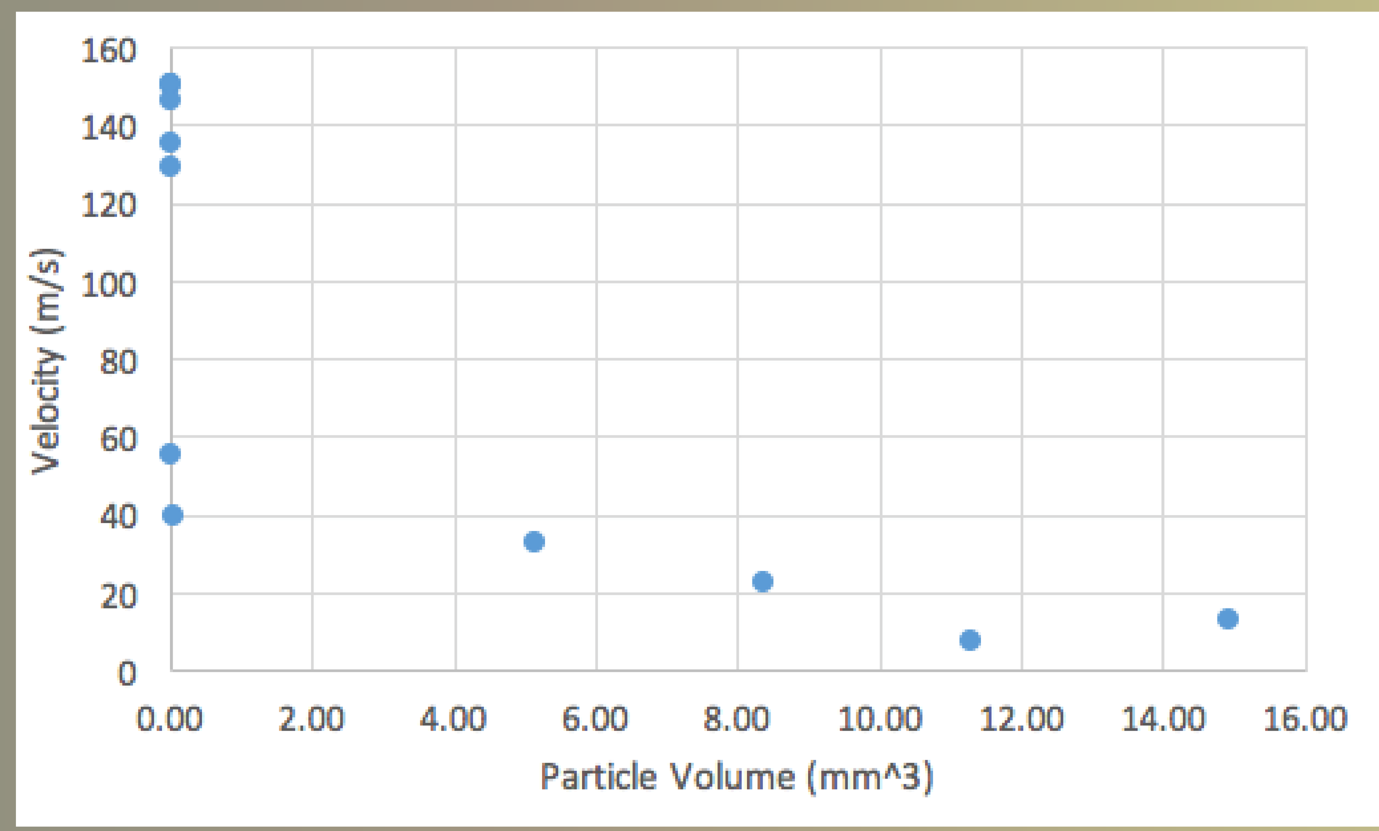

Figure 6. A sample selection of particle data. The graph shows the approximate size of the particle along with the velocity of the particle when it makes contact with the detector.

At this point, the velocities of individual particles have been determined. Particle size measurements using the scanner and CyberViewX are still in progress. Although exact sizes are still being calculated, trends in the data are apparent. The fastest particles tend to travel from 130 to 150 m/s and are some of the smallest. Larger particles are usually seen travelling slower, averaging between 10 and 40 m/s. Some of the slowest particles made contact with a detector without passing completely through it – typically travelling below 10 m/s.

Finally, the masses of any particles that can be matched to a particle of interest from a certain video clip will be recorded and analyzed. These results will be tabulated and compared graphically to determine any relationships between them, permitting the improvement of meteorite simulation programs.

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