INTRODUCTION

Meteorites falls suggest a wide variety of atmospheric behavior (Fig. 1). Here we review what can be learned about planetary defense from meteorites and meteorite falls.

I. THE MECHANICS OF METEORITE FALLS

Eye witness observations of meteorite falls can provide insights into meteorite entry, e.g., 20 falls reported in the 1960s produced the following: Explosion 85%, Rumbling 35%, Whistling 45%, Light 55%, Flares 10%, Dust trail 30%. All falls before 1860, a sulfurous smell [5]. Witnesses can also record the amount of dust which provides information on the amount of fragmentation and ablation [6]. Light curves, for ~20 meteorites [e.g. 7-9], provide quantitative information on the beginning and end of luminous flight, the rate of energy loss, the dynamic and photometric mass, major break-up events, velocity as a function of time, and especially they can be used to test numerical models.

The fusion crust records quantitative details of the later stages of flight (Fig. 1), namely airflow around the meteorite, orientation, thermal gradients, ablation rates, fragmentation history, orientation [5,10,11]. Meteorite Fragments from ten craters [12] provide an opportunity to test numerical models because we have two pieces of critical data, the crater and the meteorite (Fig. 2).

II. DETAILS OF FALL AND ASTEROID SURFACES

Meteorite characterization not only aids in modelling atmospheric behavior, it also has the potential to provide insights into the asteroid surfaces.

Laboratory Studies of Meteorites enable a large number of relevant measurements.

Cosmogenic isotope studies can determine preatmospheric mass (Fig. 3) [5]. An extensive literature database exists for the chemical composition of all classes of meteorite.

Meteorites of the same chemical class can have very different internal properties that can greatly influence atmospheric behavior (Fig. 4). Laser-driven shock experiments to measure temperature dependence of flow stress, phase transition pressure, and tensile (spall) strength for a range of meteorite types. Will be measured at LLNL.

Density, porosity, thermal conductivity, heat capacity, acoustic properties, and tensile, compressive, and deformation strength, albedo and spectra, will be measured at LLNL.

III. ASTEROID SURFACES

The gas-rich regolith breccias (with characteristic light-dark texture) are samples from the very surface of their parent asteroids and provide unique information on the surface of asteroids (Fig. 6, [16]).

CONCLUSION

Meteorite studies constitute an integral part of the Nation’s planetary defense efforts alongside NEA characterization, numerical studies of reentry, risk analysis, and deflection techniques [17].