6.1 CONTRIBUTED ABSTRACTS

A PLANETARY ULTRA HYPERVELOCITY IMPACT MECHANICS AND SHOCK WAVE SCIENCE FACILITY

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Macroscopic experiments in which the amount of shock-induced melting, vaporization and ionization produced during impact of projectiles at speeds from 8 to 15 km/sec have never been conducted. Experimentation with ~10 m diameter range projectiles, have been of great value for interpreting the results of micrometeorite, cosmic and cometary dust space-flight experiments and for ground-based research on zodiacal light. The small projectile experiments have uncovered several new physical processes which could never have been discovered via only numerical calculations. Radiant energy losses from impacted regions occur so rapidly in this size regime that these affect the cratering morphology and undoubtedly chemical processes, such as incongruent vaporization and impact-induced ionization. Because impact experiments carried out with light gas gun are limited to achieving the range of shock pressures (2 Mbars) inducing melting, but not copious vaporization in silicates, there are virtually no experimental insights into such currently controversial issues in planetary science as

1. The physics of "after burn" for oblique impact on the earth and the possible formation of the moon.

2. The amount of production of very fine vaporized ejecta condensate from large impact of such as from the hypothetical K-T bolide.

3. The nature of incongruent vaporization of minerals and the possible impact devolatilization of the moon. This requires data on the speciation in the impact induced vapor.

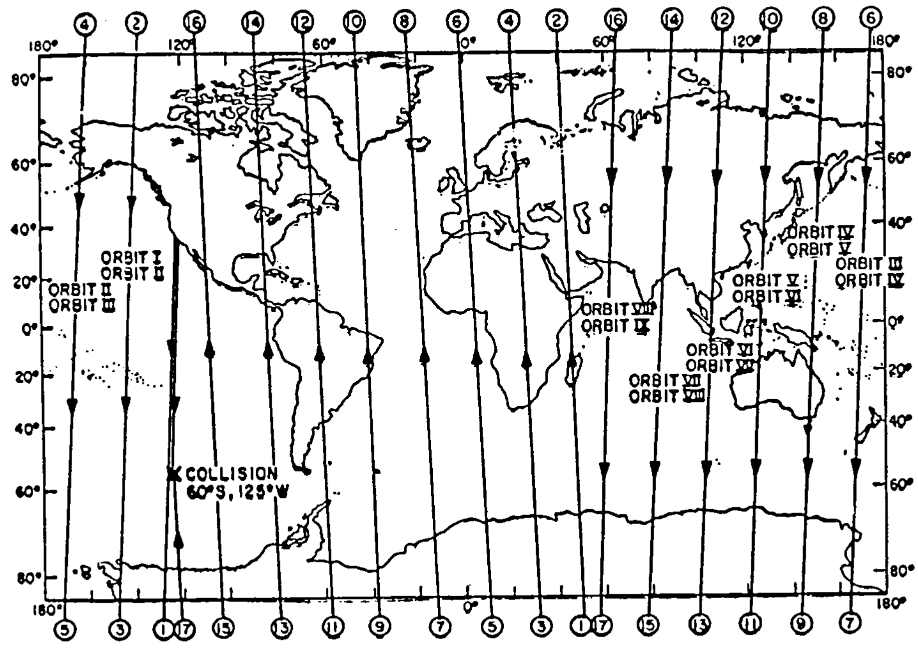
4. The production of impact-induced vapor plumes, upon oblique impact onto various planetary targets and the possible relation of this process to sampling, via impact ejection, of different planets (e.g. Mars).

Using the concept of intercepting orbits from a pair of Space Station serviced free-flyers, a new class of impact and shock wave experiments pertinent to planetary science can be carried out. One proposed free-flying vehicle (A) is an impactor dispensor, and the second free-flyer (B) is an impact laboratory. How collision is achieved by utilizing essentially twice orbital velocity is demonstrated in Fig. 1. Vehicle A contains a series of small (1 kg) flyer plates or other projectiles which are launched into the trajectory of Vehicle B at appropriate points. Vehicle B is a large impact tank similar to those in terrestrial gun laboratories, except it contains a supply of targets and instrumentation such as high speed cameras, flash x-ray apparatus and digital recorders. As indicated in Fig. 2 shock and isentropic pressures of up to 20 Mbar are achievable with such a system which provides 15 km/sec impact velocities for precisely oriented projectiles. Future augmentation with other devices, now being developed e.g. rail guns, can, in principle, boost performance and the ability to obtain high precision data to carry out pioneering research at even higher pressures in the future.

References:

M.A. Podurets, G. V. Simakov, R. F. Trunin, L. V. Popov, and B. N. Moiseev, Compression of water by strong shock waves, Sov. Phys. JETP 35, 375-376, 1972.

Ragan, C.E., III, Silbert, M.B., and Diven, B.C, Shock compression of molybdenum to 2.0 TPa by means of a nuclear explosion, J. Appl. Phys. 48, 2860-2870, 1977.



100 naut. mi. circular orbit
Orbit period 88.2 min.
2nd vehicle launch occurs after
8.16 orbits of 1st vehicle

Fig. 1 - Ground track of vehicle launched due south from Vandenburg AFB, into 100 nautical mile elevation polar orbit, demonstrating how a second vehicle launched 8.16 orbits after first vehicle will give rise to a collision over 60°S, 125°W.

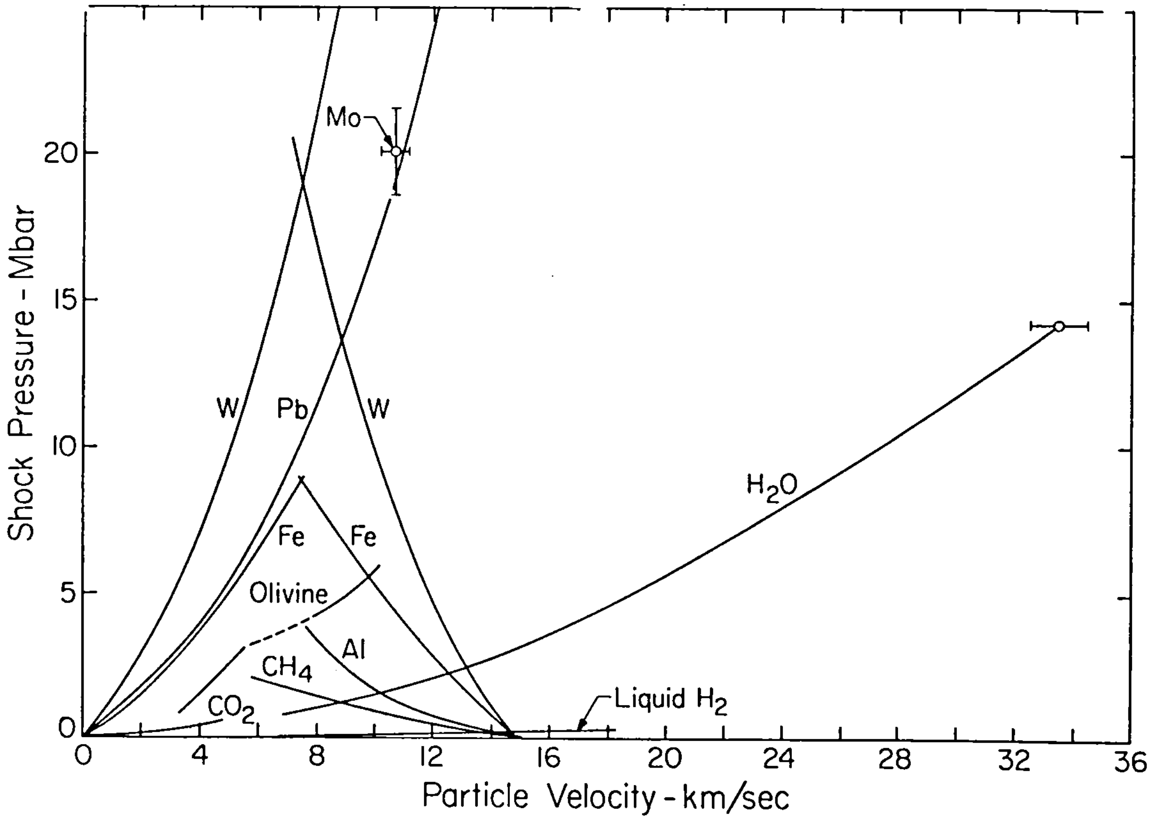


Figure 1 – Pressure-particle velocity plane for various materials, impacting at 15 km/sec. Shock pressure found by intersection of pressure-particle velocity curves, centered at 0 and 15 km/sec, e.g., ~19 Mbar for W impacting W; ~13.6 Mbar for W impacting Pb; 1.6 Mbar for Al impacting H_2O. Specific data for Mo and H_2O, with experimental errors shown, are from Ragan et al. (1977) and Podurets et al. (1972), both obtained using nuclear explosives. As can be seen from the figure, by choosing impactors and target materials a wide range of very high pressures may be achieved via a single available impact velocity.