PHYSICAL MECHANISM OF COMET (AND ASTEROID) OUTBURSTS: THE MOVIE

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The asteroid-comet continuum has been observationally demonstrated since spectrometric work in the early 1980s [1,2]. Here I describe a mechanism explaining sporadic comet (and "asteroid") outbursts, illustrated by experiments conducted in 1976 at the NASA Ames Research Center's Vertical Gun Facility (VGF). I studied low velocity impacts into simulated regolith powders and gravels, in order to examine physics of low-velocity collisions during early solar system planetesimal formation. In one "accidental" experiment, the bucket of powder remained gas-charged during evacuation of the VGF vacuum chamber. The impactor, moving at 5.5 m/s, disturbed the surface, initiating an explosive eruption of the dust-charged gas, shooting in jets from multiple vents near the impact site at speeds up to about 3 m/s, with sporadic venting until 17 seconds after the impact.

This experiment was described in [3], which concluded that it simulated comet eruption phenomena. In this hypothesis, a comet nucleus develops a lag deposit of regolith, and as the body reaches a certain distance from the sun, the thermal wave penetrates to an ice-rich depth, causing sublimation. Gas rises into the regolith pore spaces, and creates a gas-charged powder, as in our experiment. Any disturbance of the surface, such as a meteoroid, initiates a temporary jet. In the absence of such a disturbance, the gas pressure becomes sufficient to blow off the overburden and initiate widespread eruptions, as seen in Giotto images of P/Halley. Our observed ejection speed would be sufficient to launch dust off of a kilometer-scale comet nucleus.

Film (100 frames/sec) of the event was obtained, but was partially torn up in a projector during an early presentation, and subsequently stored. The film was recently reconstituted at Centric Photo labs in Tucson and is presented here. It dramatically illustrates phenomena on comet surfaces. Parabolic curtains of erupted material falling back resemble curtains of material photographed from earth in real comet comas, pushed "back" into the tail by solar wind forces. In retrospect, the mechanism photographed here helps explain:

(1) Sporadic eruptions in Comet P/Schwassmann-Wachmann 1 (near-circular orbit at ~6 A.U.)

(2) Why the Deep Impact experiment produced a thicker dust curtain than predicted for the crater-forming impact in Comet Tempel 1.

(3) Sporadic eruptions on "asteroid" 2060 Chiron (which stays beyond 8.5 A.U.).

(4) "Sideways" gas emission from walls of depressions on comet 67P/Churyumov-Gerasimenko [3].

The film is posted on the Planetary Science Institute website, www.psi.edu/news/cometmovie

References. [1] Hartmann, W.K. et al. 1982, Icarus, **52**: 377-407. [2] Cruikshank, D.P. et al. 1985 Nature 315, 122-124, doi:10.1038/315122a0. [3] Hartmann, W. K. 1993 Icarus, 104: 226-233.[4] Science 23 327:no.6220; DOI: 10.1126/science. aaa1044