COMPARATIVE RESULTS FROM GIANT IMPACT STUDIES. A. G. W. Cameron, Harvard-Smithsonian Center for Astrophysics.

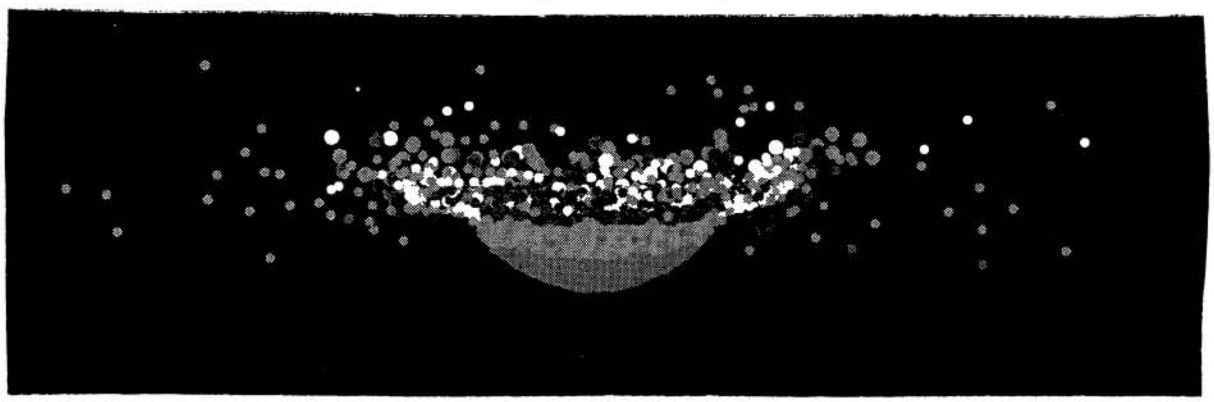
The author's program of simulations of Giant Impacts on the protoearth has nearly finished its current phase; seven of nine simulations have completed at the end of 1993, and an additional simulation of a 0.2 $M_\oplus$ planet impacting centrally on a 0.8 $M_\oplus$ planet has been carried out. The results have shown the universality of the development of large hot rock vapor atmospheres around the impacted planet. In the equatorial plane the density distributions of these atmospheres are remarkably similar, being largely independent of the variations in collisional angular momentum (over a factor of two) or of the ratio of projectile to target mass (from 2:8 to 5:5).

During the last eight years the author, together with several colleagues, has carried out a series of numerical investigations of the Giant Impact theory for the origin of the Moon (1–4). Current smooth particle hydrodynamic (SPH) simulations use 10,000 particles with 5,000 particles in the target and 5,000 in the impactor.

So far seven runs (out of nine) have finished; these have target to impactor mass ratios varying from 5:5 to 8:2. The collisional angular momenta range from 1.2 to 2.2 times the present angular momentum of the Earth-Moon system. In addition, one run with a mass ratio of 8:2 was carried out with zero angular momentum, involving a central impact. All of these runs started with zero velocity at infinity, so that the impact occurred at escape speed.

The initial temperatures of all colliding bodies were taken to be 2,000 K, which is high enough realistically to represent a history of collisional accumulation and low enough to suppress thermal evaporation of matter from the surface. After the collision, wherever very hot rock appears in a surface region, rock vapor evaporates and forms a hydrostatic atmosphere around the body. This rock vapor is simply the vapor phase of the dunite equation of state developed by Jay Melosh (3).

A comparative analysis of the computational results is still being carried out, and only a flavor of them can be reported in this abstract. First, the collisional event involving the central impact was rather spectacular. The impactor produced a major compression of the impacted hemisphere; a view of the system from the side at the time of maximum compression is shown here. The impactor struck the target from above and is buried in the other material, making the system look much like a thick but shallow bowl. The rebound from this compression set off wild oscillations of a variety of modes before things settled down with most of the energy converted to heat. The usual rock vapor atmosphere formed around this system due to evaporation.



The top figure on the second page shows the density distribution of the rock vapor atmosphere in the equatorial plane for cases 2 and 6 and the central impact. Case 2 was the collision between two half-protoearths (5:5 mass ratio) and an angular momentum of 2.2 times that of the present Earth Moon system. Case 6 involved a mass ratio of 8:2 and an angular momentum of 1.4 times that of the present Earth-Moon system. The density distributions of these two cases are remarkably similar, and the other numbered cases are in turn quite similar to these two. However, the zero angular momentum case (central impact) falls off a little more rapidly, showing the effect of rotational flattening toward the equatorial plane.

The bottom figure on the second page shows the angular velocity variations with radial distance for cases 2 and 6; the figure shows both the calculated results and what the angular velocity would need to be to place material in Keplerian orbit. Again the results for cases 2 and 6 (and other cases as well) are very similar; note that at small distances the condensed parts of the systems are in corotation. The angular velocities are subkeplerian in all cases. The central impact case (not shown) has deviations of both signs from zero angular velocity, presumably due to turbulence generated by the impact.

This work was supported in part by NAGW-1598.

References: (1) Benz, W., Slattery, W. L., and Cameron, A. G. W. (1986) *Icarus*, **66**, 515–535; (2) Benz, W., Slattery, W. L., and Cameron, A. G. W. (1987) *Icarus*, **71**, 30–45; (3) Benz, W., Cameron, A. G. W., and Melosh, H. J. (1989) *Icarus*, **81**, 113–131; (4) Cameron, A. G. W., and Benz, W. (1991) *Icarus*, **92**, 204–216.

COMPARATIVE RESULTS FROM GIANT IMPACT STUDIES Cameron, A. G. W.