THEORETICAL CRATER-DENSITY ASYMMETRIES ON GANYMEDE AND CALLISTO

Alex Woronow, Lunar & Planetary Lab, University of Arizona, Tucson, AZ 85721

If the bodies which cratered Ganymede and Callisto originated externally to the jovian system, then one would expect a difference in the crater densities on the leading and trailing hemispheres of those bodies. The reasons for the asymmetry are 1) the relatively high orbital velocity of the satellites compared to the encounter speed of the projectiles coupled with 2) the rotational lock of the satellites. Thus, the leading face of each satellite experiences an addition of impact speed and orbital speed while the trailing face experiences a subtraction.

No asymmetry will occur if either the satellites are not rotationally locked during the period of intense bombardment or the impacting projectiles originate within the jovian system. But if an asymmetry is found then it would provide information about the original orbits of the projectiles.

We examined this problem in the forward direction: given an encounter speed, calculate an asymmetry. For the first case to be discussed the calculations were done by numerical integration taking into account the gravitational accelerations of jupiter and the target satellite, and the orbital velocities of both Jupiter and the target satellite. For the second case we used an analytical solution for the "Compton and Getting effect". Gravity scaling was assumed in both cases.

Case 1: The projectiles are assumed to have orbital planes nearly coplanar with the satellites' orbits (roughly the ecliptic plane). This results in rather high crater density differences (Fig. 1). But of equal importance is the geometry of density asymmetry which is imposed on the surface; namely, all points on a specified longitude see exactly the same cratering rate.

Case 2: The projectiles are assumed to have orbital planes distributed isotropically in space. This results in a much smaller density difference (Fig. 2) than does Case 1. Furthermore, the signature on the surface is not one of uniform density along a longitude line, but of uniform density at a fixed distance from the leading point of the surface (leading with respect to the orbital motion of the satellite modified slightly by the orbital motion of Jupiter).

The important results of these analyses are 1) the geometry of any asymmetry contains information on the geometry of the impactors' orbits; 2) even small leading/trailing differences are theoretically possible from external impactors (one need not call on ad hoc thermal effects); and 3) impactors internal to the jovian system will leave no asymmetry at all.

CRATER-DENSITY ASYMMETRIES

WORONOW, A.

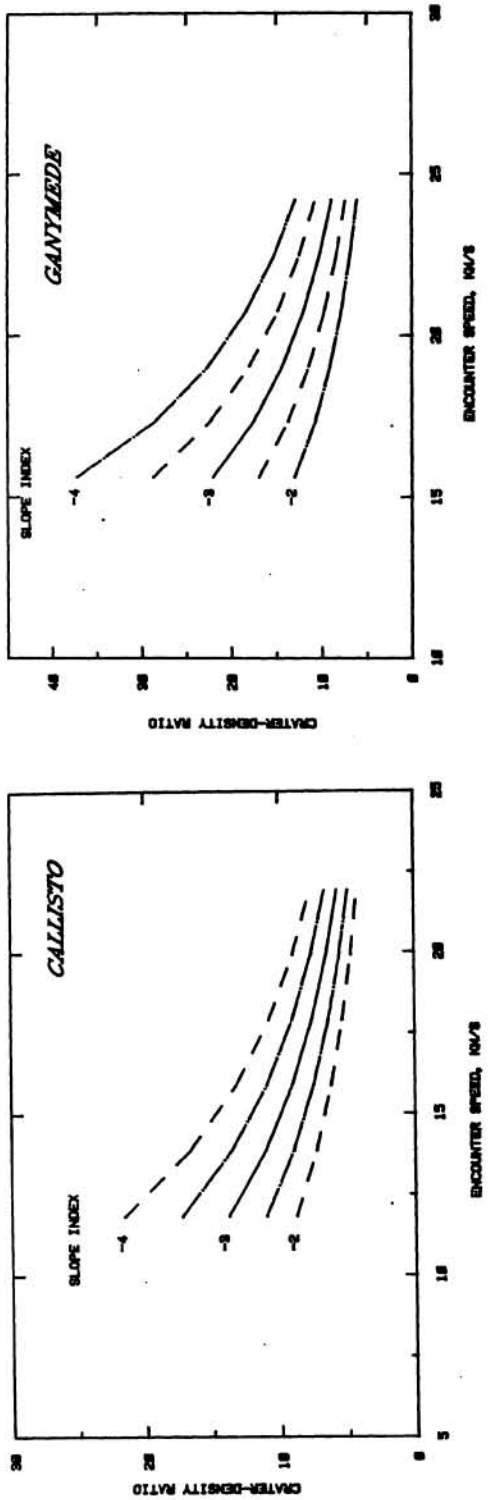

Fig 1

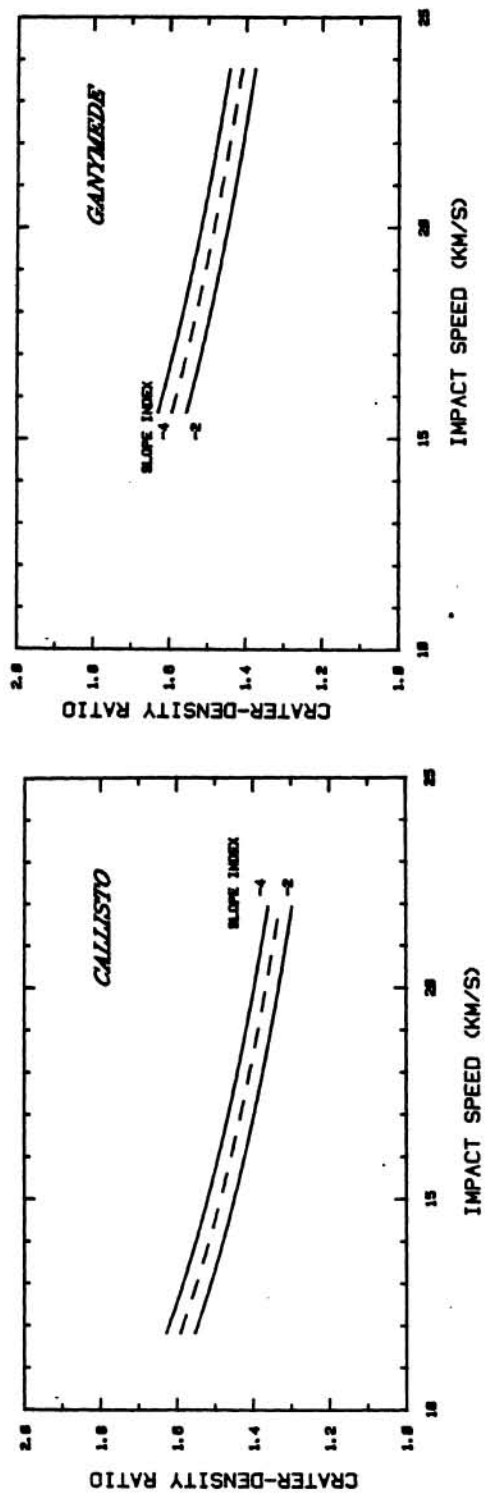

Fig 2