THE IMPACT RECORD OF DISRUPTED COMETS ON THE MOON. V.V. Shevchenko, Sternberg State Astronomical Institute, Moscow University, 119899 Moscow, Russia, e-mail: shev@sai.msu.su

The comets falling on the near side of the Moon under small angles to the surface pass near to the Earth [1]. During intersection of tidal limit (the Roche distance).the change of trajectory of a comet and disintegration of nucleus happens.

The Roche distance for a small density body passing near to the Earth is estimated from dependences offered in [2] or in [3]:

$$d_r = 1.05\ (M_E/\rho_c)^{1/3} \quad \text{or}$$
$$d_r = 2.0\ (\rho_E/\rho_c)^{1/3}\ R_E,$$

where M_E, ρ_E, R_E - mass, density and radius of the Earth, ρ_c - density of a cometary nucleus. For a body with density about 0.5 g/cm^3 both expressions give close values $d_r = 5\ R_E$.

Simulation of the process of disintegration under effect of tidal forces for comet Shoemaker-Levy 9 [4-6] showed, that at the first stage the debris cloud of small-sized fragments (centimetre and meter sizes) is formed. The cloud has a form of cylinder. Such clouds may have reaccreted into compact objects nearly 2-years later. In case of movement of cometary body in the Earth-Moon system (during less one days period) the reaccretion does not happen. Therefore on the lunar surface a cloud of small-sized fragments falls out (Fig. 1). In result the observable diffuse structures - swirls and small-sized crater clusters will be formed. The following model corresponds to the supposition about origin of the swirls after falling debris clouds of low density fragments. An example of observable consequence of a similar falling can be albedo formation Reiner-gamma on the near side of the Moon. A part of Reiner-gamma swirl with allowing of details up to 300-500 m is shown on the fragment of the Lunar Orbiter IV frame H-157 (Fig. 2).

The common morphological analysis shows presence of two various crater populations. Craters of the recent origin with the sharp forms, which are underlined by presence of internal shadows, overlap albedo features. Craters that are associated with albedo structures have shallow, smoothed forms. It is known that similar crater arise when density of impactor is much lower than density of the target. It corresponds to the process of the falling cometary nucleus or their fragments [7]. A portion of a crater chain on the surface of Callisto can be served as example of high resolution view of a such form (Fig. 3). The smallest visible details are about 130 m across. The image was taken by the Galileo spacecraft [8].

The trajectory of a disrupted cometary nucleus in the Earth-Moon system was calculated in the supposition, that the body passes on a distance about 4 earth radiuses from surface of the Earth. The calculations were provided for the value of initial comet velocity near the Earth of 10 km/s [9]. In Fig. 4 the result of the calculation is shown. It is terminal part of trajectory of the debris cloud near the Moon. The impact with the Moon happens symbolically on the average distance from the Earth (384400 km) through 716.3 min. after that parent body passed minimum distance from the Earth and it was disrupted. Accepting velocity of fragments dispersion equal to 1 m/s, we can receive that size of debris cylindrical cloud at level of the lunar surface is about 80 - 90 km. Thise size coincides with the greatest diameter of the whole system of diffuse fragments in the Reiner-gamma area.

The evaluation of the sizes of separate fragments in a debris cloud confirms reality of a such model. A maximum crater diameter for crater population associated with swirl does not exceed 1 km (Fig. 2). For calculation of the impactor size the following dependence was used [10]:

$$D = 1.34\rho_c^{0.33}\ \rho_m^{-0.33}\ g_m^{-0.22}\ L^{0.79}\ V_c^{0.44}$$

where D - crater diameter, L - impactor diameter, ρ_c - impactor density (1g/cm^3), ρ_m - density of target surface (2.5 g/cm^3), V_c - impactor velocity, g_m = 1.623 m/s^2. For velocity value of 10 km/s a maximum impactor diameter reaches about 40m. This results agree with model of tidal destruction of cometary body near planet [5,6].

References. [1] Vinnikov E.L. et al. (1995) *Solar System Research*, **29**, No. 6, 567-571. [2] Sridhar S., Tremaine S. (1990) *Icarus*, **95**, 86-99. [3] Rahe J. et al. (1994*) In: Hazards due to Comets and Asteroids.* Ed. T. Gehrels. Tucson & London, 623. [4] Sekanina Z. et al. (1994) *Astron. Astrophys.*, **289**, 607-636. [5] Rettig T.W. et al. (1996) *J. Geoph. Res.*, **101**, E4, 9271-9281. [6] Schenk P.M. et al. (1996) *Icarus*, **121**, 249-274. [7] O'Keefe J.D. et al. (1980) *LPS-XI*, 830-832. [8] NASA/JPL Internet WWW, Catalog page for PIA00514, 12-12-1996. [9] Shevchenko V.V., Chazov V.V. (1996) *Vernadsky-Brown microsymposium 24*, 82-83. [10] Melosh J. (1989) *Impact Cratering: A geologic Process.* N-Y: Oxford Univ. Press.

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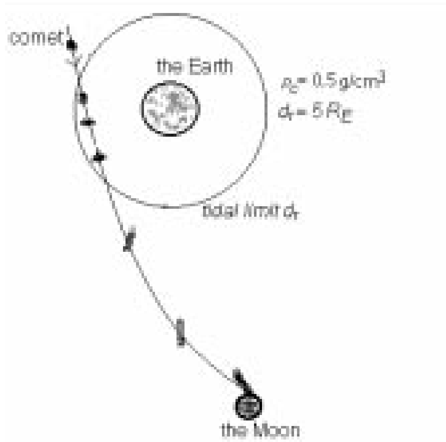

Fig. 1.

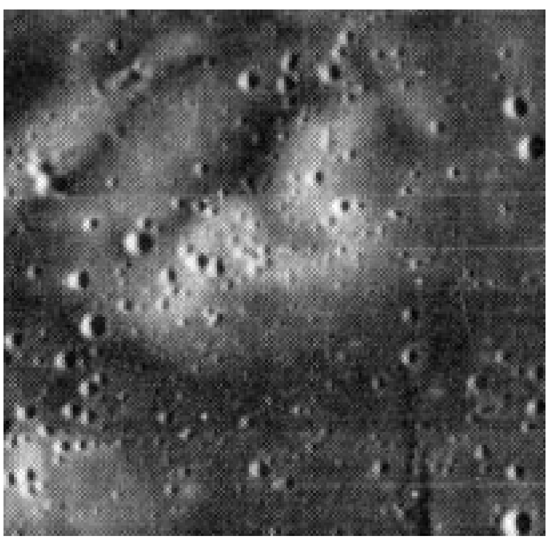

Fig. 2.

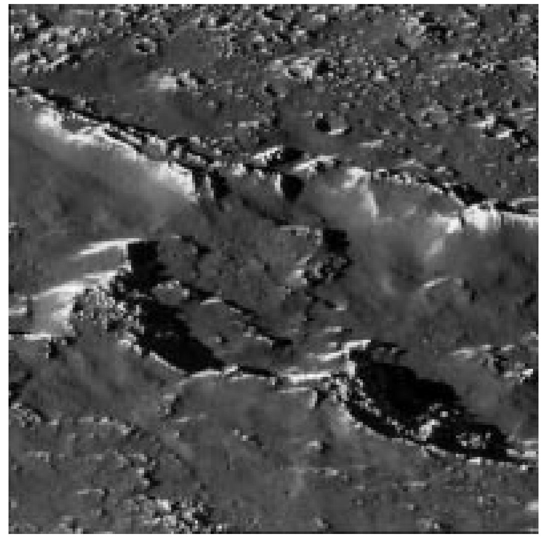

Fig. 3.

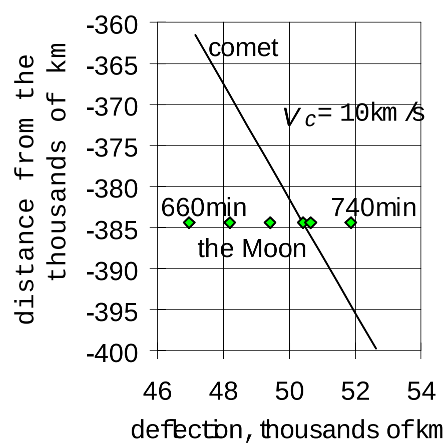

Fig. 4.