SOME PROBLEMS OF THE EVOLUTION OF ASTEROID – RUBBLE PILE G. A. Leikin and A. N. Sanovich, Sternberg State Astronomical Institute, Moscow State University, 119992,Moscow,Universitetskij Prosp. 13, Russia , E-mail:san@sai.msu.ru

ABSTRACT. We consider the collisional evolution of inner structure of a asteroid – rubble pile as a qualitative problem and analyse the results of this evolution in interaction with interplanetary medium. The analysis shows, that asteroid – rubble pile loses its fast fragments in no time but the retaining fragments forms a compact structure immersed in dust – gas atmosphere, created by interaction of interplanetary medium with dispersed product of collisional evolution of asteroid. By interaction of an asteroid – rubble pile with interplanetary medium structures asteroid can increase its brightness on account of blowed up dust simulating phenomenon of distant comet's brightening.

We consider the evolution of an asteroid – rubble pile as an isolated object. Evidently, we can distinguish two processes: distant interactions, where there is no direct contact between separate fragments, and close contact interactions, where the fragments collide with one another. The process of distant interaction is essentially similar to that of the evolution of scattered star clusters and, in itself, leads to the ejection from the pile of individual fragments with maximum energy and angular momentum, the distribution of which may roughly be described by a Maxwell distribution. At the stage of distant interaction, there is practically no inelastic loss of energy.

In contrast, the process of contact interaction is accompanied by a loss of kinetic energy of the fragments, spent in disrupting the rock in collision and contact events, which brings the fragments closer and eventually leads to a quasi-spherical form (or for those retaining an angular moment – quasi-elliptical form) for the rubble pile in the absence of external perturbations.

For estimating a distant interaction time interval we introduce the concept of core of asteroid - rubble pile – a volume in that the fragments mean free path length is comparable to volume dimension .It is clear that the time interval of distant interaction is comparable to $T\sqrt{N}$ (T – the time of crossing the core by fragment having parabolic for asteroid velocity. We assume radius of asteroid's core $R \approx 50$ km, N ≈ 100, bulk density $\rho \approx 2{,}5$ g/cm^3 , parabolic velocity ~ 10 m/s, this gives the distant interaction time interval of order of some hours. It means that in some hours after the breaking of parent body in core of asteroid – rubble pile the spread of fragment velocities should not exceed 10 m/s.

There is also an another mechanism of high velocity fragment losing from the asteroid core: asteroid moves on heliocentric orbit and the spread of fragment velocities must result in spread of orbital elements. Making a crude estimate of semi-major axes spread we get $\Delta\alpha \approx (1/\pi)T_0\Delta v$ ($\Delta\alpha$ - spread of semi-major axes, T_0 – geliocentric period of the asteroid, Δv– fragment velocities spread). If $\Delta\alpha \approx R$, after the time T_0 in the core should remain no fragments having velocities higher $\Delta v \approx (\pi R)/T_0$, i.e. having velocities higher ~ cm/s.

It is clear that the evolution of a closely bound pile leads to the formation of a plentiful fine-fraction on the surface of the fragments. Such an asteroid structure should have an observable density considerably lower than solid rock.

Unprotected from cosmic rays and solar radiation, areas of the surface on the fragments should become charged. This charge should be sufficient to balance the fluxes of positively and negatively charged particles.

Balance of electrical charges at the fragment surfaces is maintained by low-temperature component of interplanetary plasma (≈ 10^5 K). It can be shown, that in this instance particles ≈ 1μm will form an dust-plasma atmosphere of asteroid. The scale height of the atmosphere is low (~ cm).

Such a rubble pile with a dust atmosphere differs from a cometary nucleus only in the absence of a volatile gas component, which is usually considered the cause of the appearance of cometary dust.

In the case of an asteroid rubble fragments of the pile; however, its interaction with the solar corpuscular fluxes does not differ from that of cometary dust and should therefore show the same effects.

In particular, the observation of 'cometary' activity at great heliocentric distances doesn't necessarily indicate the cometary nature of the active bodies – it could be a result of an asteroid – rubble pile entering the solar corpuscular flux. The turbulisation of the magnetized flux on interaction with the asteroid – rubble pile may lead to short-period bursts of activity (especially on interacting with a rotating asteroid), and in some cases, on turbulent disruption of the dust atmosphere of the asteroid, to the formation of an 'asteroid phantom' – a magnetized cloud of dusty plasma.

It should be mentioned, that dust atmosphere blowing up must probably be associated with interplanetary structure crossing (sector border and flare shocks).

In conclusion we should notice, that for a two-fold increasing of asteroid's visual brightness the mass of blowing up dust must amount ≈ 10^{-10} mass of asteroid.