REVISED FRAGMENTATION MODEL OF PLANET-SIZED COLLISIONS. T. Fujita[1], H. Genda[2], H. Kobayashi[3], H. Tanaka[4], and Y. Abe[1], [1]Department of Earth and Planetary Science, The University of Tokyo (tfujita@eps.s.u-tokyo.ac.jp), [2]Earth-Life Science Institute, Tokyo Institute of Technology, [3]Department of Physics, Nagoya University, [4]Institute of Low Temperature Science, Hokkaido University

Introduction: Collisions between planetesimals or a planetesimal and a protoplanet are thought to occur frequently in the stage of planet formation and let them grow up. The critical impact energy for catastrophic disruption 'Q_D^*', where the largest remnant has half the target mass, has been well investigated under various conditions (e.g., [1]), and such a catastrophic impact was regarded as important process for planet formation (e.g., [2]).

However, recent studies (e.g., [3]) suggested that cratering impacts with specific impact energy much less Q_D^* were also important and the mass of growing planets was limited by such cratering impacts. Therefore, in order to develop the more accurate theory of planet formation, it is important to investigate how much fragments cratering impacts produce.

Here, we perform high-resolution impact simulations in gravity-dominant region. We reestimate Q_D^* and check the resolution convergence, because resolution of the impact calculations in the previous studies seems to be not enough. We also investigate the relation between the total mass of ejected fragments and impact energy.

Method: Using the smoothed particle hydrodynamics method (SPH) [4], we systematically perform the hydrodynamic simulations of collisions between planetesimals at various impact energies with about 5 million SPH particles. We reexamin Q_D^* and derive a scaling law representing a relation between total mass of ejected material and impact energy. Specifically, in our simulations bodies with different size collide head-on or obliquely against 100km- and 10km-diameter bodies at different speed, and the amount of the total mass of ejected material can be calculated.

Results: We find that the newly obtained Q_D^* is about one order of magnitude smaller than that of the previous work [2] due to higher-resolution simulations and the more accurate analytical method. This means collisions between planetesimals or a planetesimal and a protoplanet are more destructive than previously thought.

In the case of collisions with impact energy less than Q_D^*, as shown in Fig.1, the total mass of fragments (M_{frag}) is not linear with the specific impact energy (E_{imp}) due to the curvature of the target sphere. The relation can be described as $M_{frag} \propto E_{imp}^{1.4}$ for 100km-sized target as an example and is different from the expectation of [1]. On the other hand, in the case of collisions with very low impact energy, M_{frag} is linear with E_{imp} because the effect of the curvature is so slight that such collisions can be regarded as like a crater-forming impact; a sphere collides against a flat ground. Therefore, the scaling law representing the relation between M_{frag} and E_{imp} is described based on these two facts. Moreover, we find this scaling law depends upon E_{imp} uniquely. In addition, this scaling law is independent on target size and varied by impact angle.

We will present our analytical method and results of 10km-sized target or the oblique collision in detail on our poster.

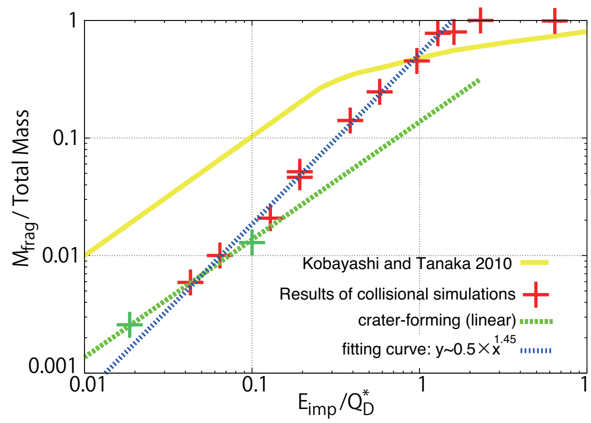

Fig 1. Total mass of fragments (M_{frag}) normalized by total mass as a function of the impact energy (E_{imp}) normalized by Q_D^* in the cases of head-on collision with 100-km sized target. The scaling law we derive is shifted down compared with [1] for $E_{imp}/Q_D^* < 1$.

References:

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