LOW-VELOCITY IMPACT EXPERIMENTS OF ICE AND POROUS GYPSUM SIMULTING EQUAL-SIZED PLANETESIMAL COLLISIONS. Y. Koumoto[1], M. Yasui[2] Y. Shimaki[3] and M. Arakawa[1], [1]Grad. School Sci., Kobe Univ. (0813413s@stu.kobe-u.ac.jp), [2]Org. Adv. Sci. & Tech., Kobe Univ., [3]Grad. School Env. Studies, Nagoya Univ.

Introduction: Planetary bodies in the solar system have grown by mutual collisions among planetesimals. The Hayashi model suggested that many equal-sized planetesimals depending on the heliocentric distance were formed by the gravitational instability of dusts in the solar nebula. Moreover, it is expected that the collisional velocities among planetesimals were equal to or larger than their escape velocities and not only a head-on collision but also an oblique collision with various impact angles occurred. In this study, we conducted oblique impact experiments with low-impact velocity for samples simulating rocky and icy planetesimals and examined the effects of composition and impact angle on the impact strength and fragment velocity.

Experimental method: We prepared projectiles and targets by using polycrystalline ice and porous gypsum with a porosity of 55 %; they simulates icy and rocky planetesimals, respectively. All samples have a spherical shape with a diameter of 30 mm. Impact experiments were conducted by an one-stage He-gas gun in Kobe University for gypsum samples and in the cold room of ILTS at -10 ^oC for ice samples. The impact velocities (v_i) were from 13 to 83 m/s for a head-on impact and 70 m/s for an oblique impact. The impact angle (θ) changed every 15^o from 0 to 75^o. The target was set in the recovery box, after the shot, the mass of each fragment were measured. The collisional disruption of the projectile and the target was observed by a high-speed video camera at the frame rate of 3000-8000 frames s^{-1}. We measured the antipodal velocity (v_a), which was the fragment velocity ejected from the antipodal point of the impact point on the target to study the effect of oblique impacts on the fragment velocity.

Results: We found in the case of the head-on collision that the v_a was almost consistent with the velocity of the center of mass (v_g). However, the v_a was about 10-15 m/s smaller than the v_g due to the crush of the target in the case of ice sample. Moreover, many fine fragments were ejected from the impact point in a direction perpendicular to the impact direction, and the maximum fragment velocitity was almost the same as the impact velocity. In the case of oblique impacts, the v_a decreased with the increase of the θ. The fragment velocity ejected from the impact point to the tangential direction of the impact surface was about 1.5 times larger than the v_i due to jetting to the downstream while it was more than two times smaller than the v_i to the upstream. The relationship between the v_a and the θ could be written by v_a=20(cos θ)$^{3.6}$ for the ice target of l=0-45^o, v_a=7.7(cos θ)$^{0.95}$ for that of θ=45-75^o, and v_a=31(cos θ)$^{1.3}$ for porous gypsum (Fig.1). We notice that in the cases of θ =45-75^o, the power law index of cos θ was almost 1 and the maximum fragment mass normalized by the original sample mass m_l/M_t was about 0.1-1.0.

In the case of head-on impacts, the Q^* for ice was 89 J/kg at the mass ratio of projectile to target M_p/M_t of 0.003-0.13 [1] [2], and the Q^* for porous gypsum was 446 J/kg at the M_p/M_t of 0.027-0.56 [3]. In this study, the Q^* of ice and porous gypsum samples were almost consistent with those obtained by these previous works. In the case of oblique impacts, the m_l increased with the θ, and the relationship between the m_l/M and the θ could be written by m_l/M = 0.044(cos θ)$^{-1.4}$ for ice and m_l/M = 0.44(cos θ)$^{-0.62}$ for porous gypsum. Moreover, it is suggested that the normal component of impact velocity to the tangential surface at impact point (v_i cos θ) had the significant effect on the m_l/M so we reanalyzed the data by using the Q (cos θ)^2. As a result, the results for head-on impacts were almost consistent with those for oblique impacts, that is, we succeeded to scale the effectt of impact angle on the m_l/M.

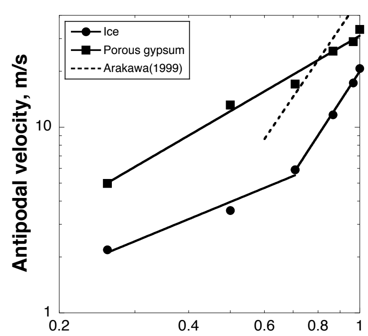

Fig.1. Relationship between v_a and cos θ for ice and porsou gypsum.

[1] Arakawa M. et al. (1995) *Icarus, 118,* 341–354. [2] Arakawa M. (1999) *Adv. Space Res., 23*, 1217-1224. [3] Yasui M. and Arakawa M. (2011) *Icarus*, *214*, 754-765.