P03

アルミニウム合金同士の超高速衝突における運動量移動の測定

Measurement of Momentum Transfer in Hypervelocity Impact between Aluminum Alloy

林浩一（鳥羽高専），西田政弘（名工大），黒崎裕久，柳沢俊史（JAXA）
Koichi Hayashi (NIT, Toba College), Masahiro Nishida (Nitech), Hirohisa Kurosaki
and Toshifumi Yanagisawa (JAXA)

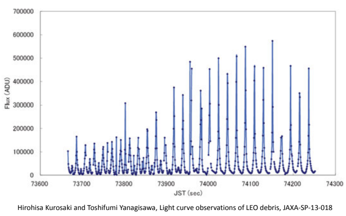
一部のデブリは自身が回転しながら地球周回軌道上に存在している．この回転運動発生原因の一つとして，微小なデブリの超高速衝突が挙げられる．微小デブリが超高速で衝突した場合，微小デブリの破砕や，被衝突デブリにクレータが形成される過程で，イジェクタの飛散が発生する．それにより被衝突デブリは，衝突前の微小デブリが持つ運動量よりも大きな運動量を獲得することになる．本発表では，アルミニウム合金製の振り子ターゲットに，アルミニウム合金製の球を超高速衝突させた時の，振り子ターゲットの最大振れ角を測定することで，被衝突デブリを模擬した振り子ターゲットが獲得する運動量の測定を行った結果を報告する．

Some space debris travels around the earth while rotating. We hypothesized that the rotary motion of the space debris is caused by the collision with micro size space debris. When a projectile and a thick target collide at hypervelocity, many fragments from the thick target surface are ejected. When a projectile which simulated a micro size space debris and a thick target which simulated a space debris collide at hypervelocity, many fragments from the thick target surface are ejected. As a result, the momentum of the projectile is enhanced and moves to the target. We measured the momentum transfer in hypervelocity impact using pendulum target.

アルミニウム合金同士の超高速衝突における運動量移動の測定
Measurement of Momentum Transfer in Hypervelocity Impact between Aluminum Alloy

林浩一（鳥羽高専），西田政弘（名工大），黒崎裕久，柳沢俊史（JAXA）
Koichi Hayashi(NIT, Toba College), Masahiro Nishida(Nitech), Hirohisa Kurosaki, Toshifumi Yanagisawa(JAXA)

1. Introduction



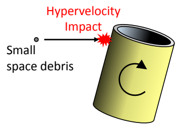
Hirohisa Kurosaki and Toshifumi Yanagisawa, Light curve observations of LEO debris, JAXA-SP-13-018

Brightness of reflected light
of the space debris changes vibrationally

⬇

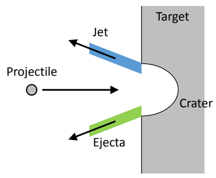
Some space debris are rotating

Hypothesis



Rotary motion of
the space debris is caused
by hypervelocity impact
with small space debris

2. Efficiency of Momentum Transfer

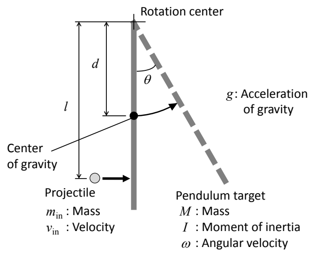


$$p_{total} = p_{in} + p_{jet} + p_{ejecta}$$
$$= p_{in}\left(1 + \frac{p_{jet}}{p_{in}} + \frac{p_{ejecta}}{p_{in}}\right)$$
$$= p_{in}(1+\eta)$$

p_{total} : Momentum of target
p_{in} : Momentum of projectile
p_{jet} : Momentum of jet
p_{ejecta} : Momentum of ejecta
η : Efficiency of momentum transfer

3. Measurement of η

Experimental Method



Energy conservation law

$$Mgd(1-\cos\theta) = \frac{1}{2}I\omega^2$$

⬇

ω is calculated

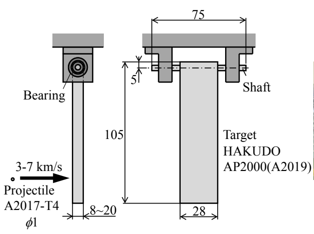
Momentum conservation law

$$m_{in}v_{in}(1+\eta)l = I\omega$$

⬇

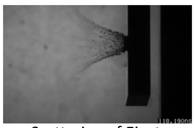
η is calculated

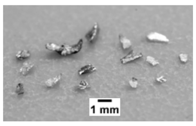
Experimental setup



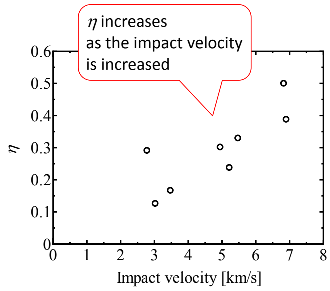

JAXA/ISAS 2 stage light gas gun

Results


Scattering of Ejecta



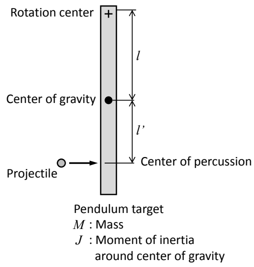
Ejecta



Effects of impact velocity on η

4. Compensation of η

Center of percussion



Difference in distance between
impact position of projectile
and center of percussion of target

$$l' \neq \frac{J}{Ml}$$

⬇

Force to act on axis of target increases

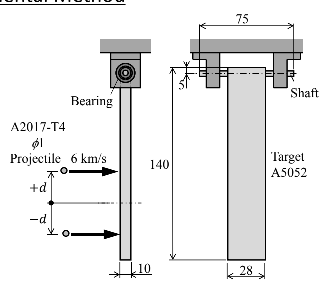
⬇

Frictional force to occur at support point
of axis of target increases

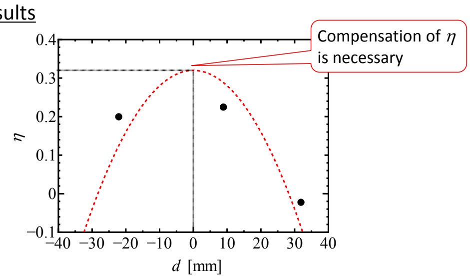
⬇

η decreases

Experimental Method



Results



Effects of impact position on η

5. Conclusions

Efficiency of momentum transfer η in hypervelocity impact
between aluminum alloy was measured

- η increases as the impact velocity is increased
- η is changed by impact position of projectile

➡

Next steps

- η measurement with greater impact velocity
- Establishment of h compensation method