A new experiment-based collision model to overcome the bouncing barrier

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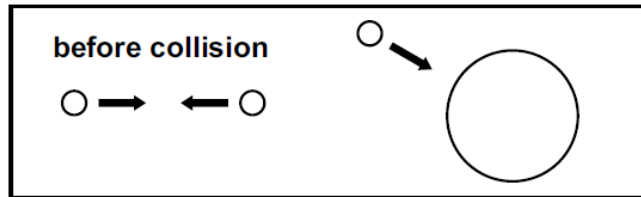[3] Max-Planck-Institute for Astronomy, Heidelberg, Germany
[4] Institute for Theoretical Astrophysics, University of Heidelberg, Germany

Collaborators: E. Beitz, T. Birnstiel, C.P. Dullemond,
Th. Henning, S. Kothe, C. Ormel, R. Schräpler, R. Weidling
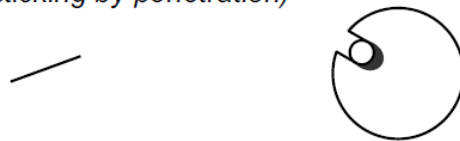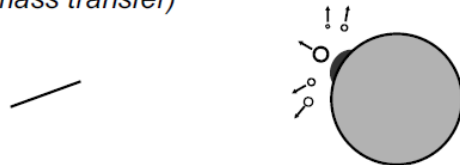
Model of Güttler et al. (2010)

Reduced Model

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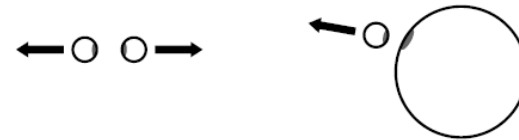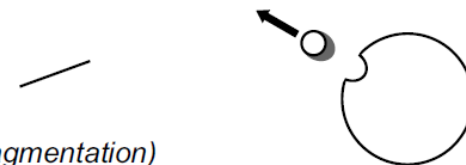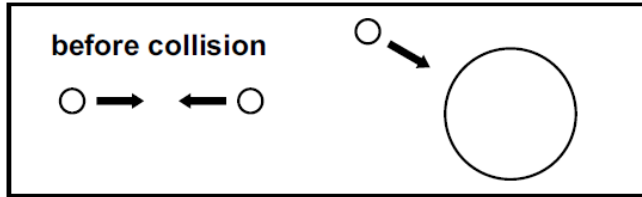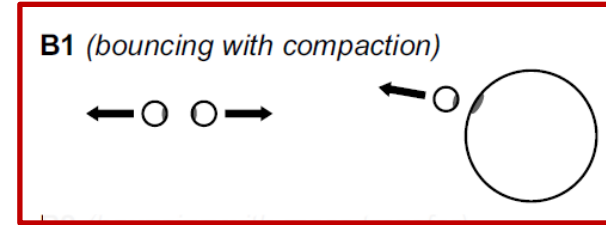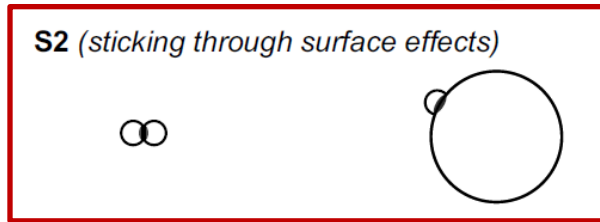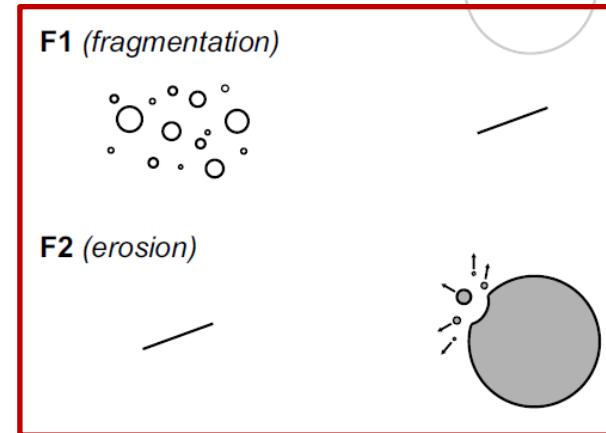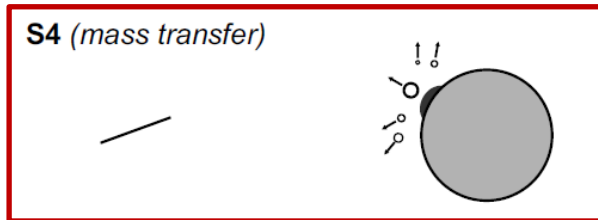
Sticking & Bouncing Collisions
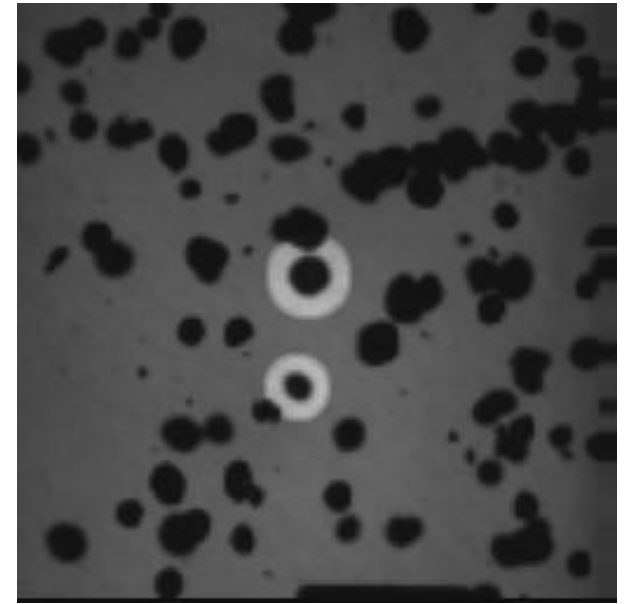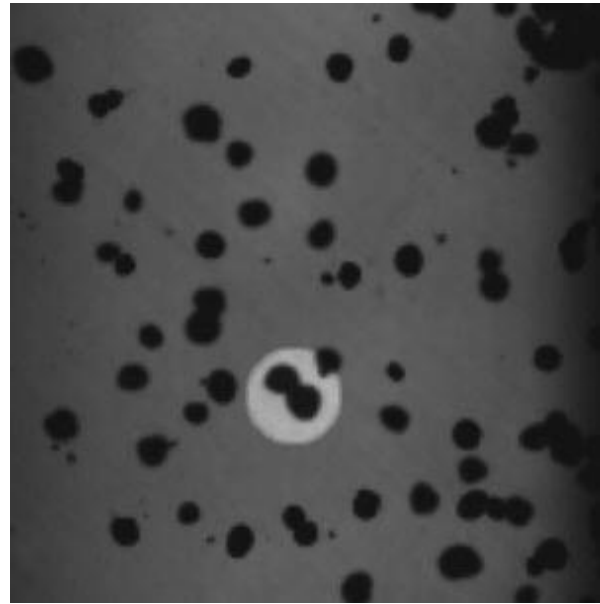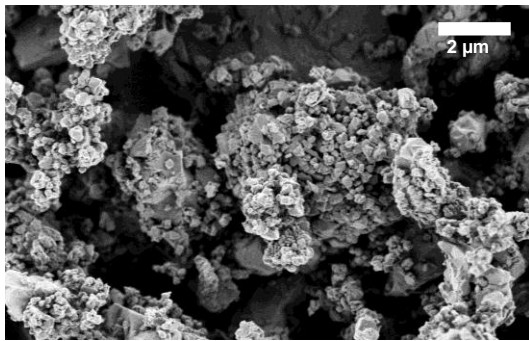
Dust aggregates
Diameter: 1-2 mm
Filling factor: 0.35

Sticking collision
Velocity: 9 mm/s

→ see talk of
René Weidling!

Bouncing collision
Velocity: 62 mm/s

Weidling, Güttler, Blum (2012, Icarus)
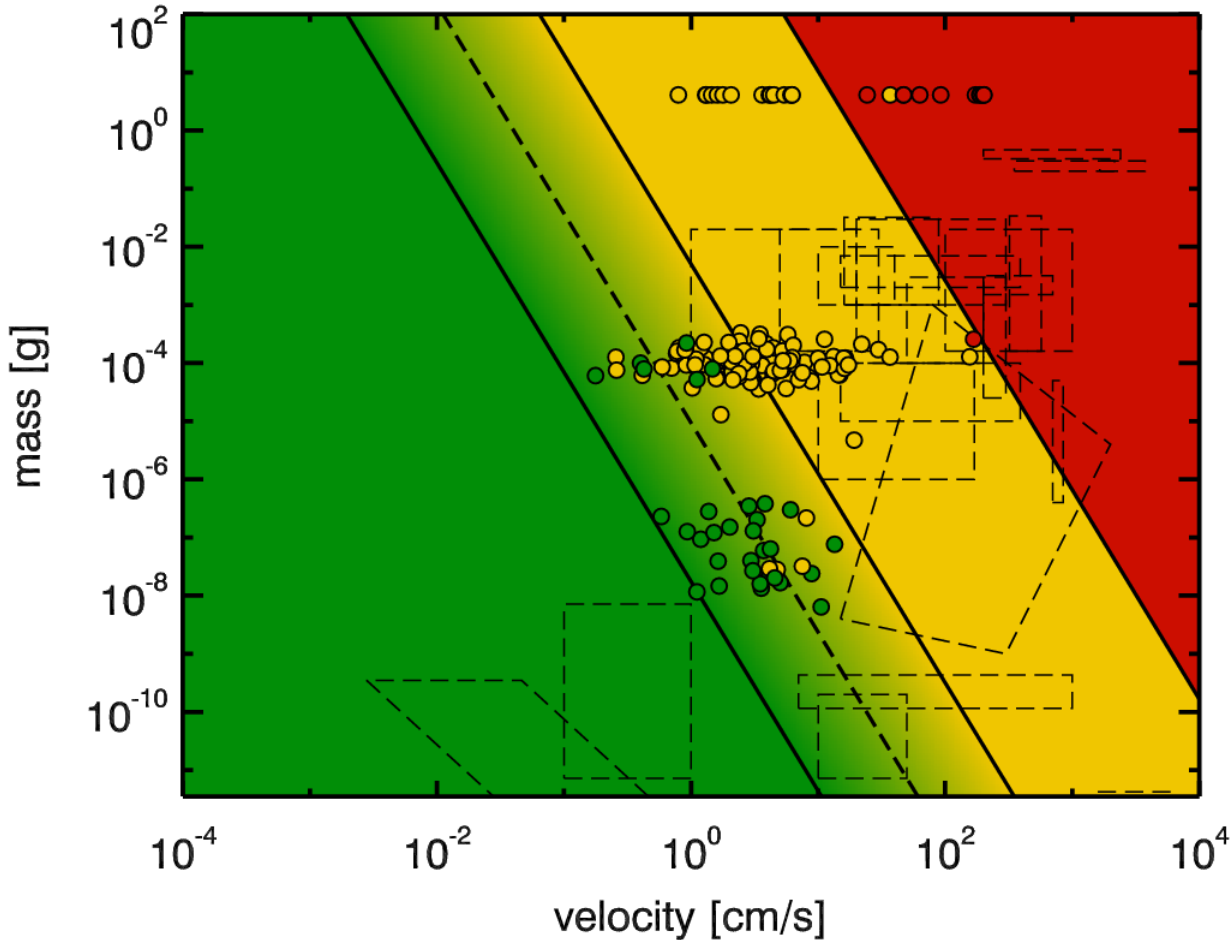
Sticking & Bouncing Threshold
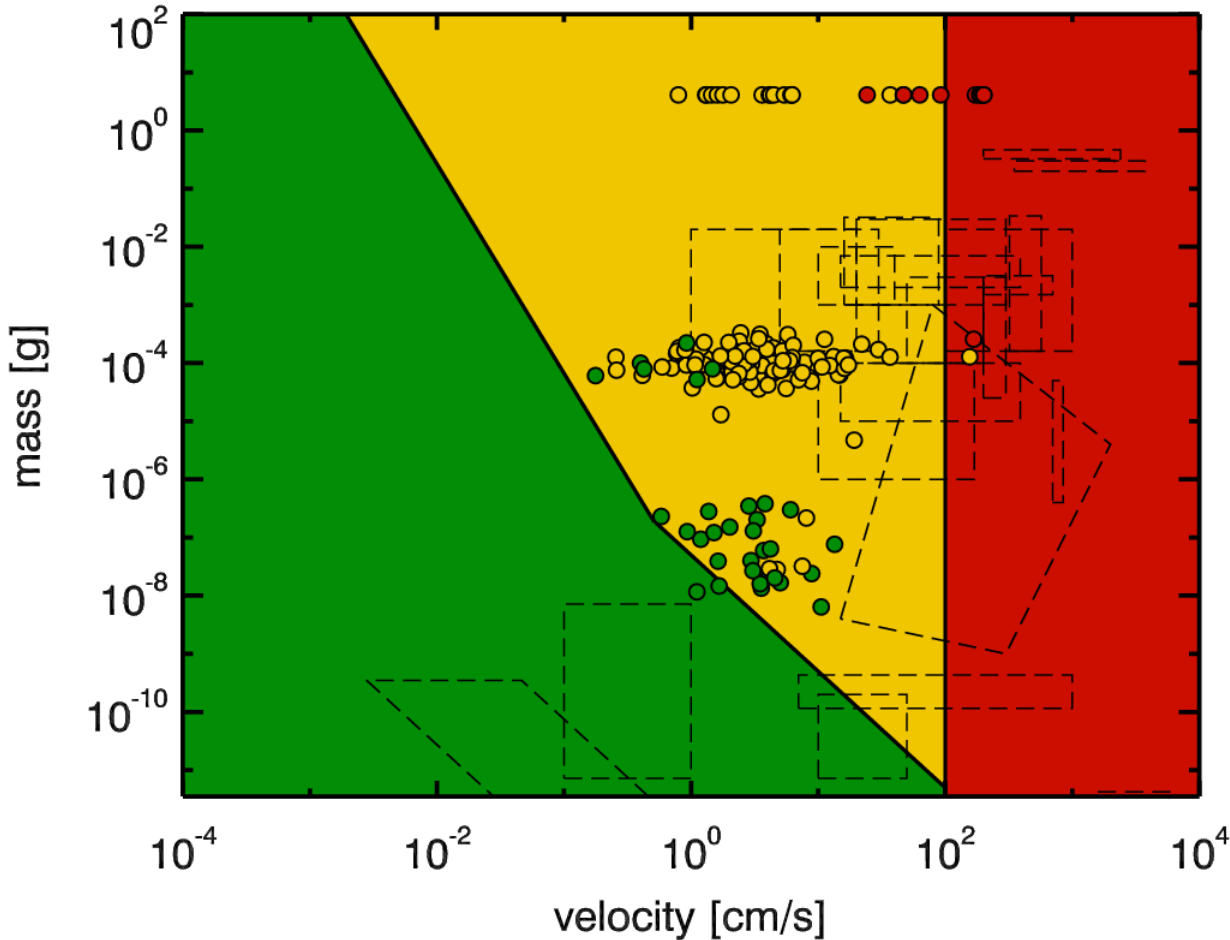
Simplified version of the Güttler et al. (2010) model.

→ see poster of Stefan Kothe!

→ see talk of René Weidling!

Sticking & Bouncing Threshold

$$\Delta v_{\text{stick}} = \left(\frac{m_{\text{p}}}{m_{\text{s}}}\right)^{-5/18} \quad [\text{cm s}^{-1}]$$

$$\Delta v_{\text{bounce}} = \left(\frac{m_{\text{p}}}{m_{\text{b}}}\right)^{-5/18} \quad [\text{cm s}^{-1}]$$
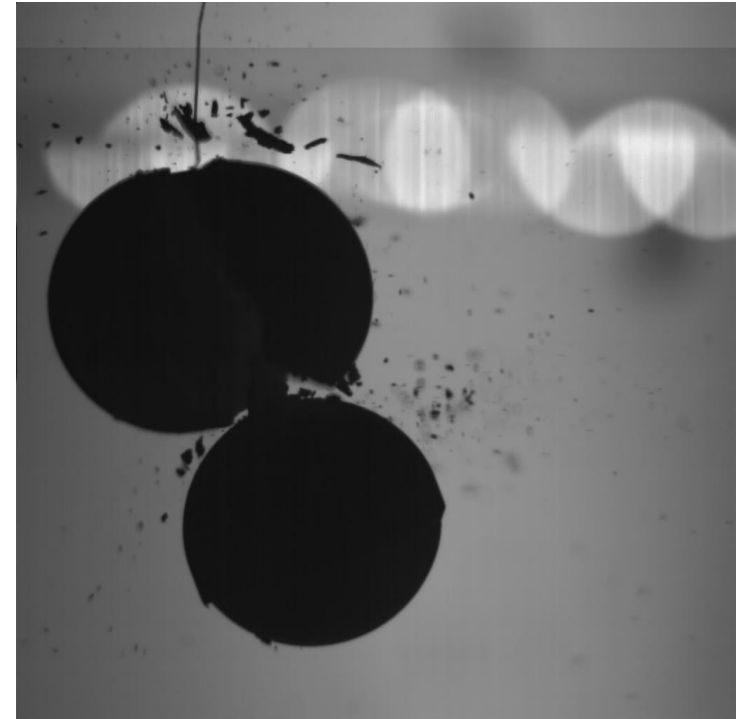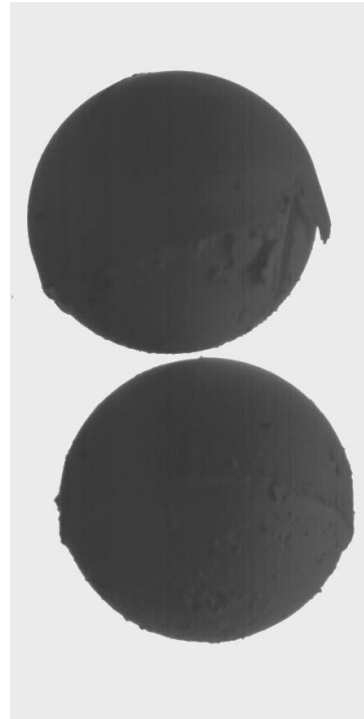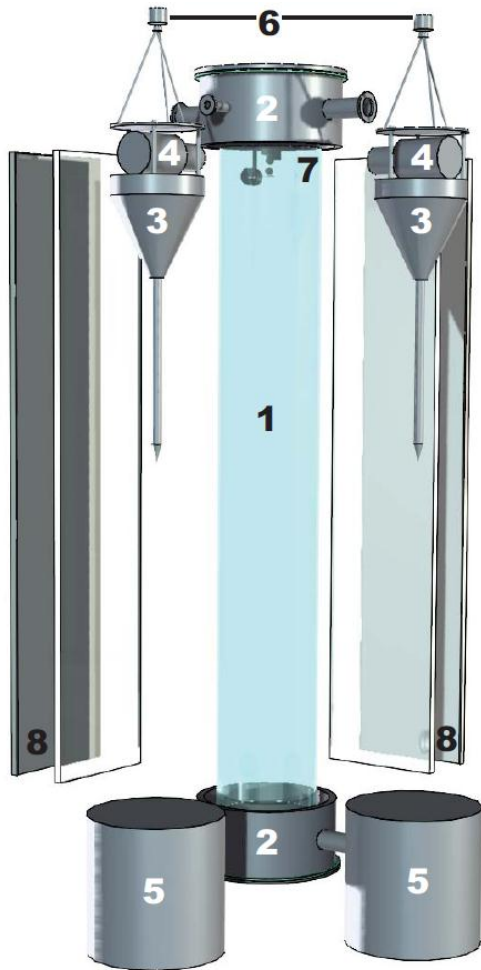
$$m_{\text{s}} = 3.0 \times 10^{-12} \text{ g}$$

$$m_{\text{b}} = 3.3 \times 10^{-3} \text{ g}$$

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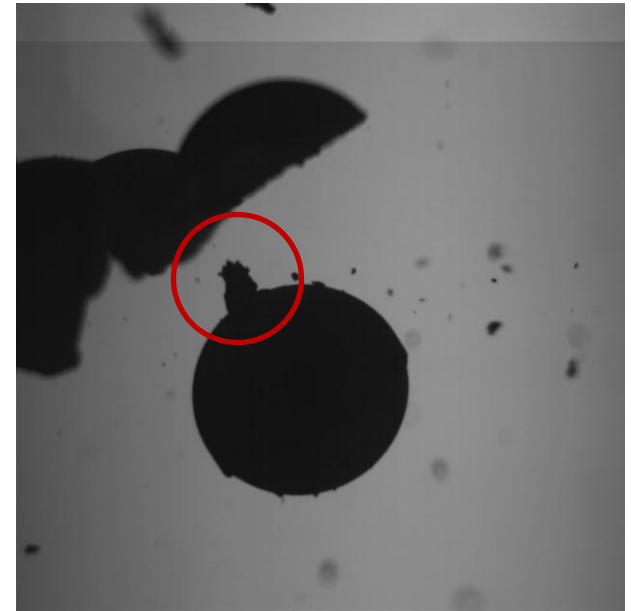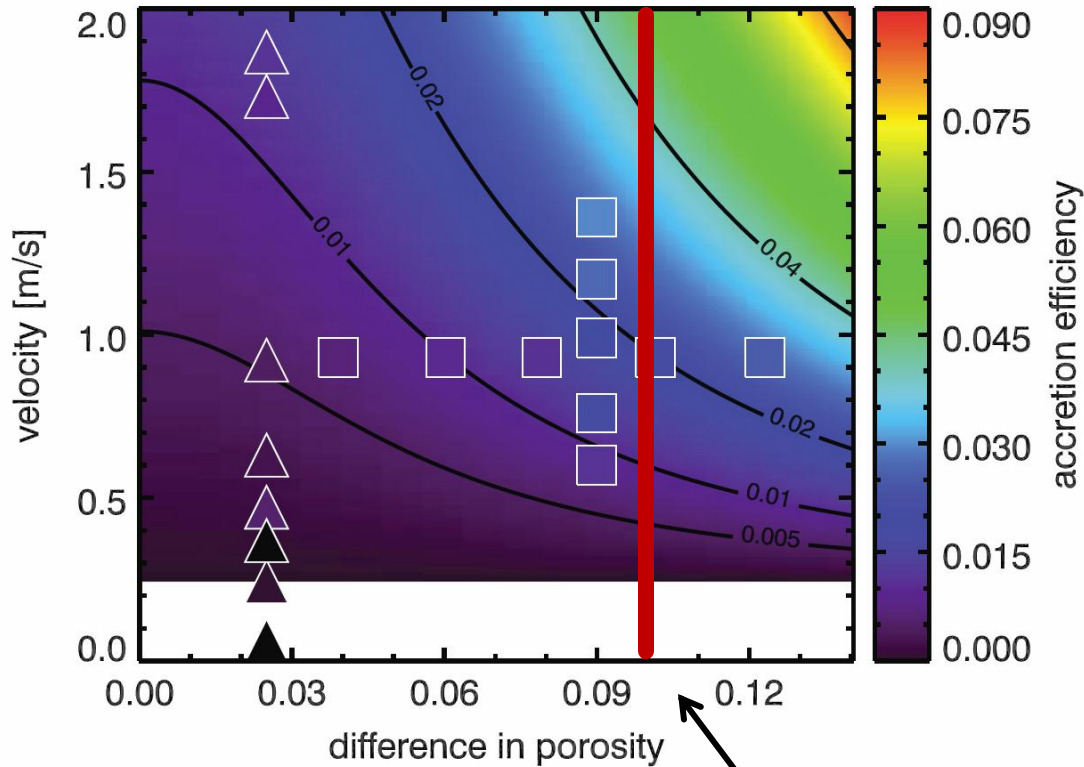
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Fragmentation Threshold I

diameter: 2 cm
volume filling factor: 0.5
velocity left: 1 cm/s
velocity right: 1.8 m/s
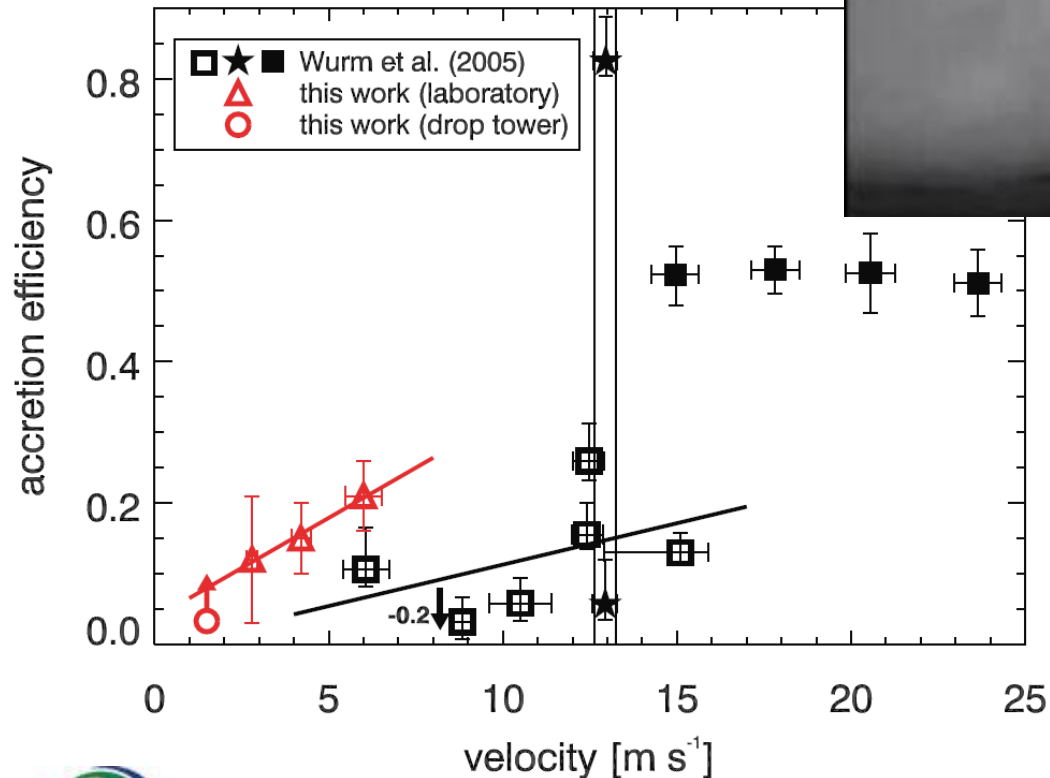
Beitz, Güttler, Blum, Meisner,
Teiser, Wurm (2011, ApJ)

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Mass Transfer I

Beitz et al. (2011)

For the model, we assume Δϕ=0.1.

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Mass Transfer II

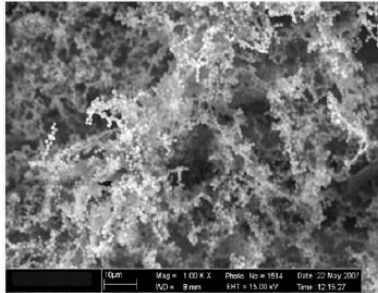Also see: Wurm et al. (2005), Teiser et al. (2009, 2011), Beitz et al. (2011)

TARGET

impacts of millimeter aggregates at 1-6 m/s
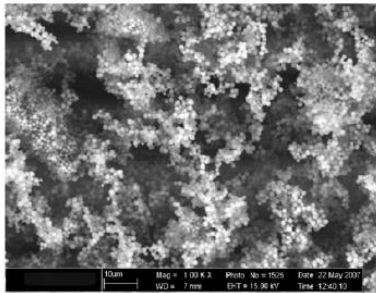
against a porous but sintered target

Kothe, Güttler, Blum (2010, ApJ)

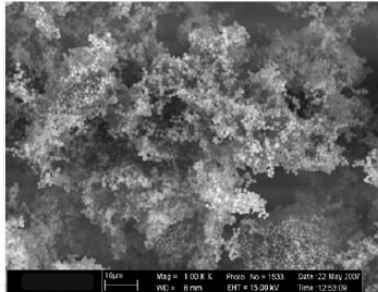C. Güttler et al.: A new experiment-based collision model
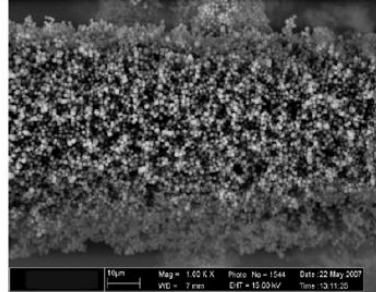
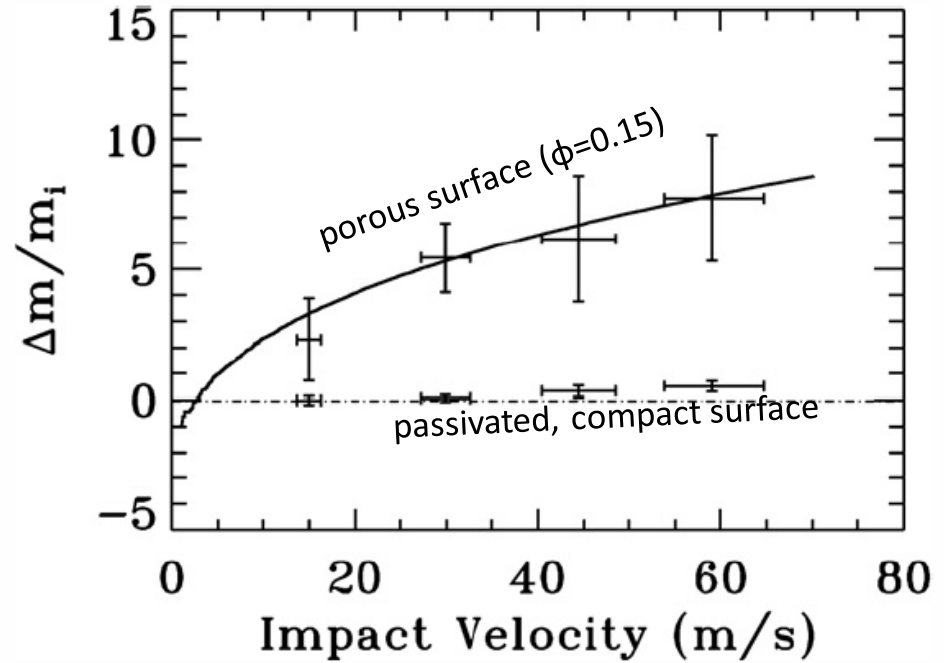# Erosion I

Before Impact

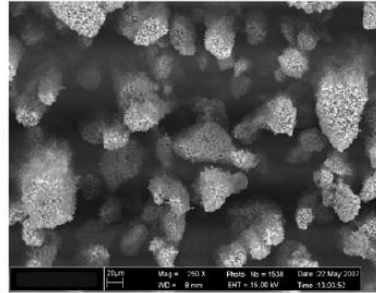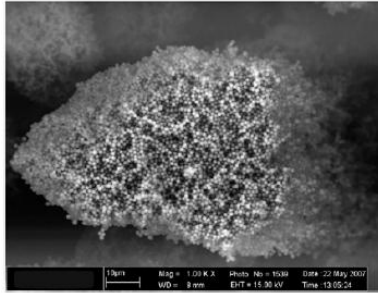After Impact of 15 m/s Monomers
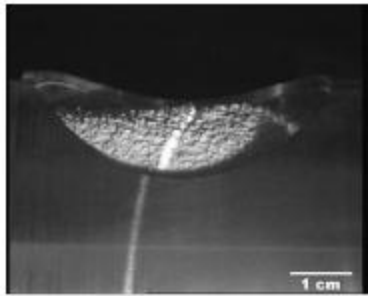
After Impact of 30 m/s Monomers

After Impact of 44 m/s Monomers

After Impact of 59 m/s Monomers

porous surface (ϕ=0.15)

passivated, compact surface

Schräpler & Blum (2011, ApJ)

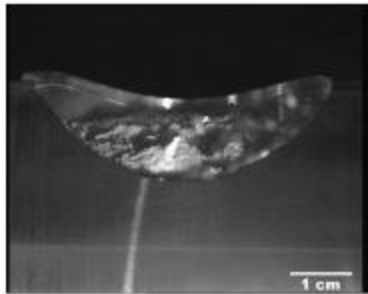C. Güttler et al.: A new experiment-based collision model

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Erosion II (Cratering)
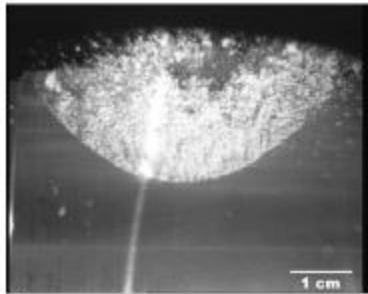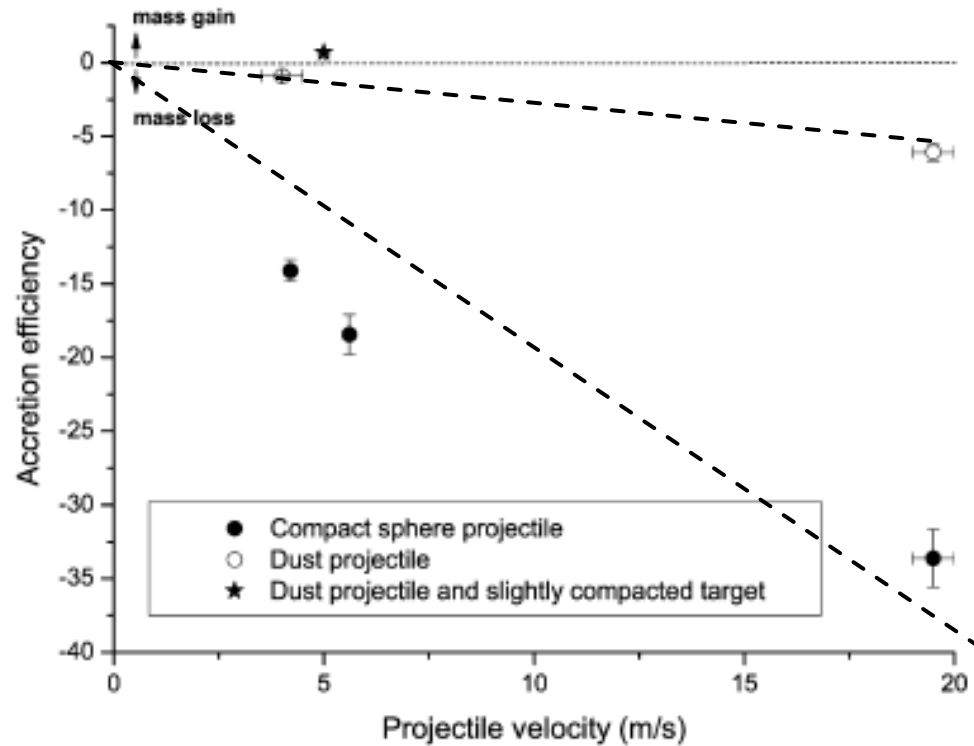
Paraskov, Wurm, Krauss (2005, Icarus)

C. Güttler et al.: A new experiment-based collision model

Mass Transfer & Cratering
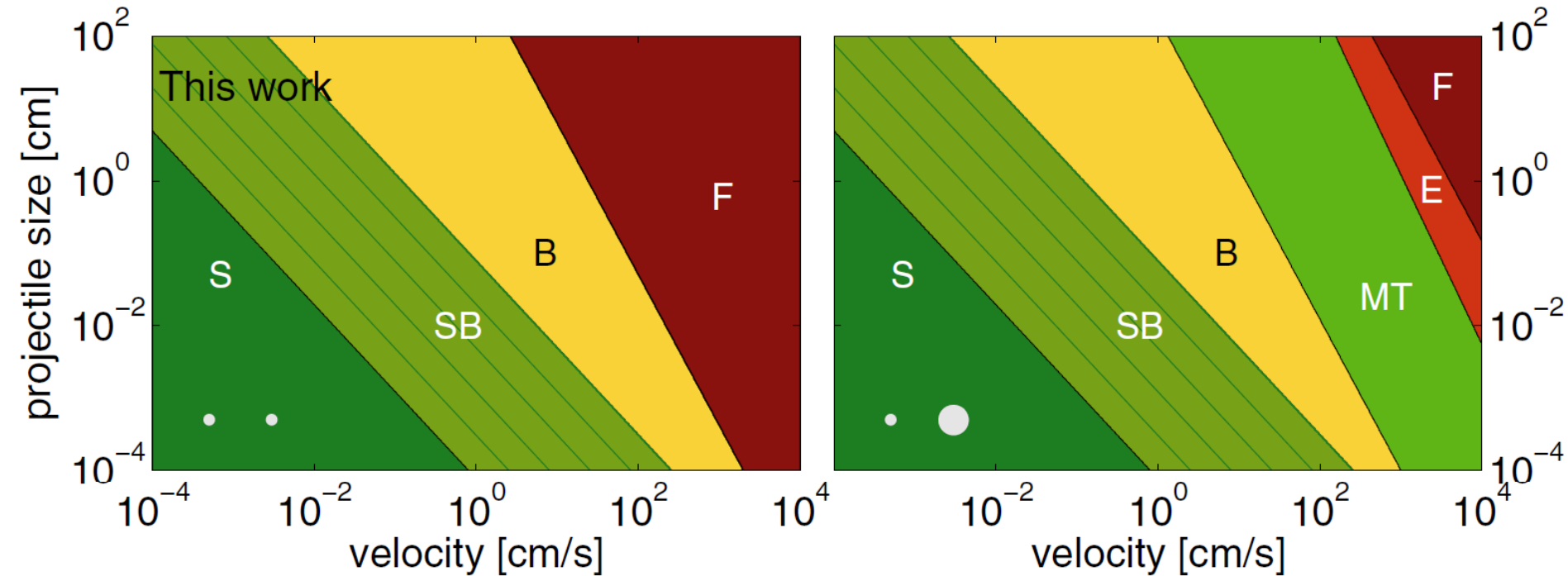

No. 11 |———| 1 cm

No. 18 |———| 1 cm

Teiser & Wurm (2009a, MNRAS)
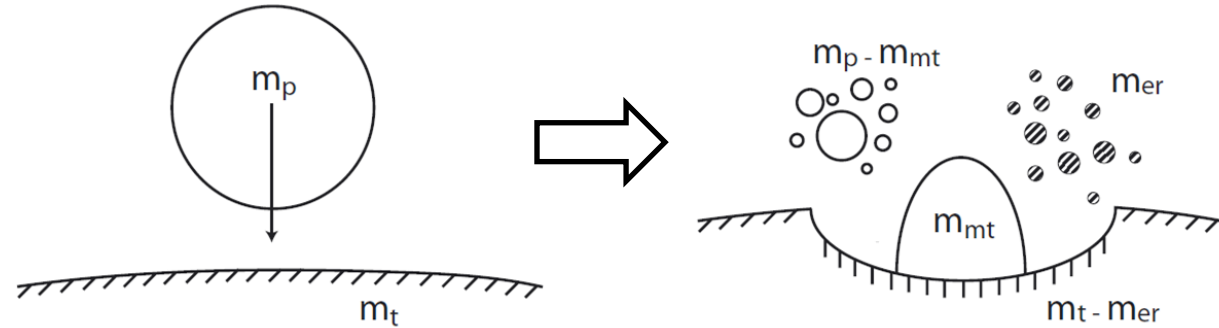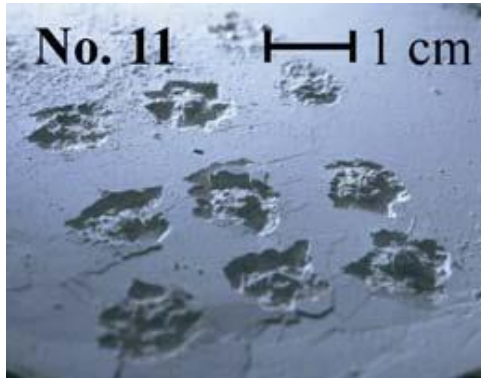
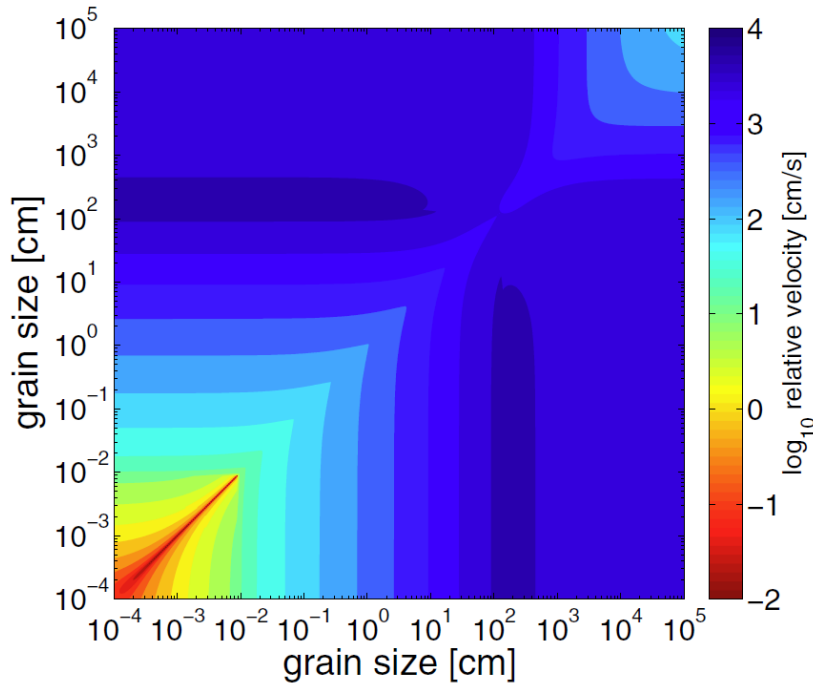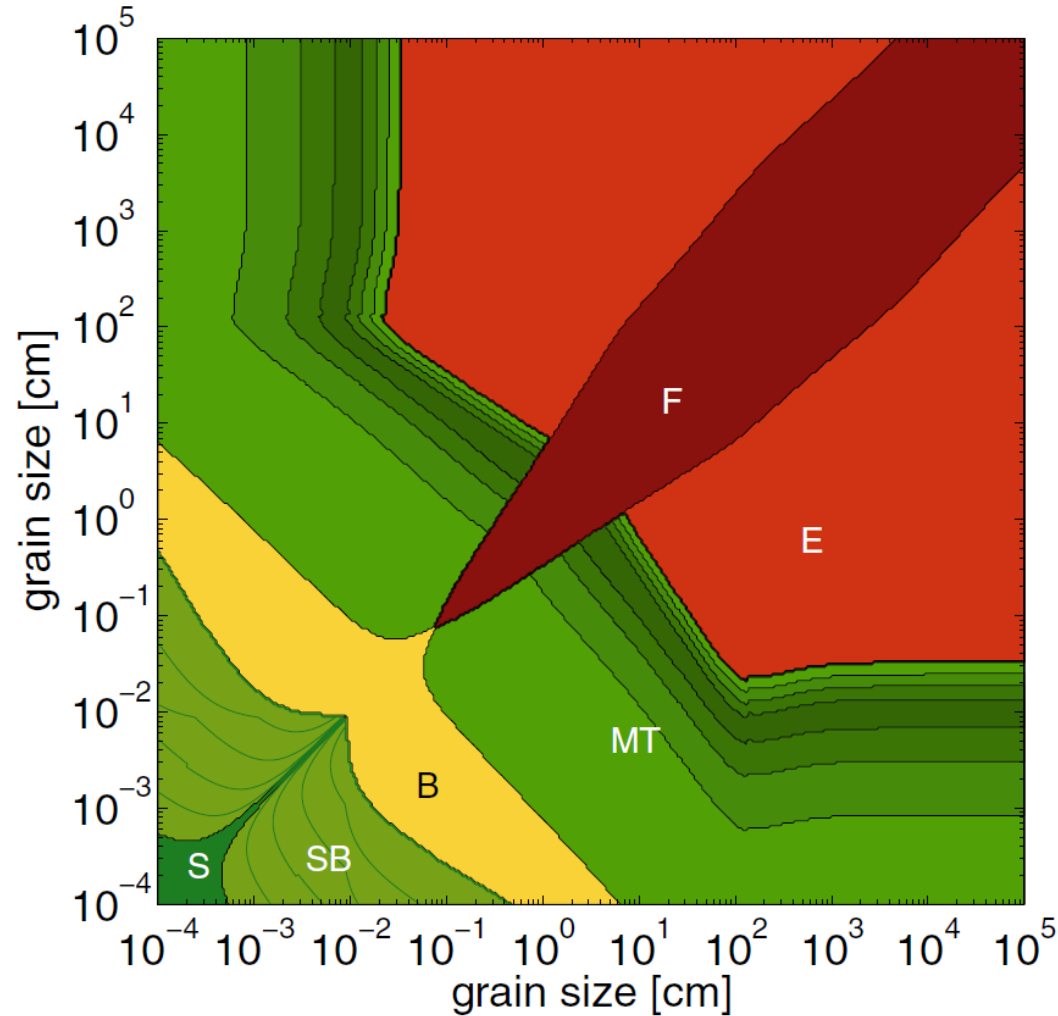Windmark et al. (2012a, A&A)
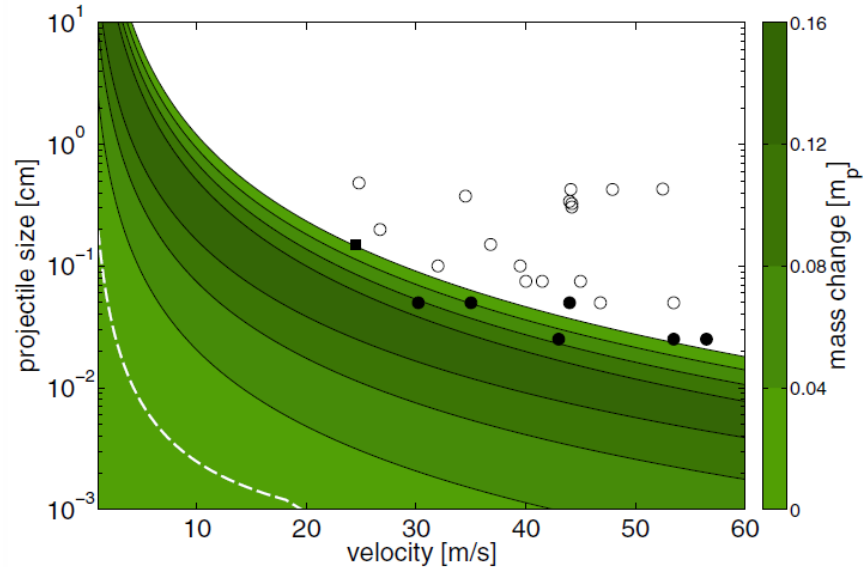
Collision Model I

Collision Model II

collision velocities at 3 AU
and corresponding outcomes
according to collision model

Thank you for your attention!

Results and implications in the next presentation by F. Windmark.