

# Dust-aggregate collisions at low velocities

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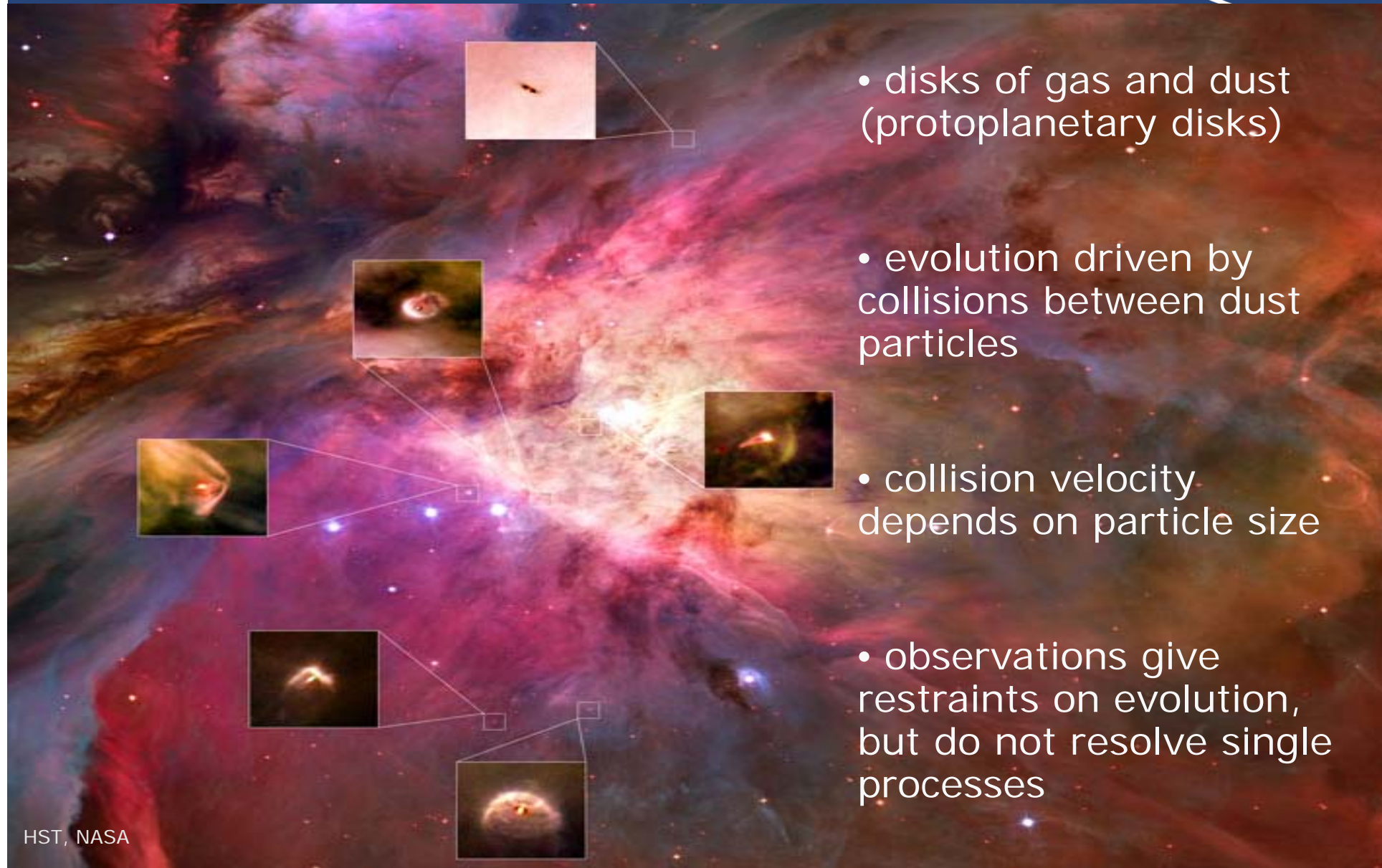
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Planet Formation and Evolution  
04.09.2012

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# Planet Formation



- disks of gas and dust (protoplanetary disks)

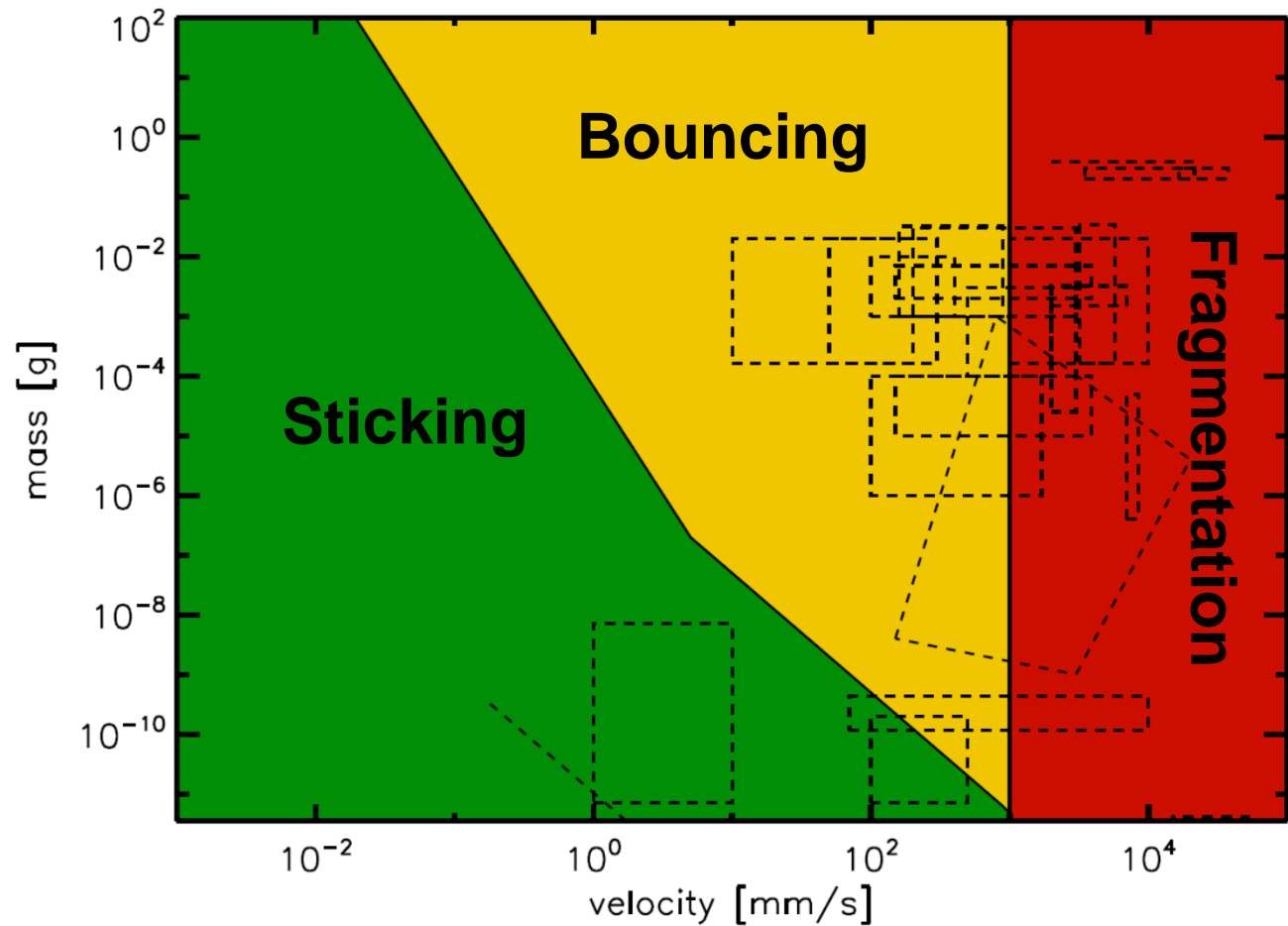
- evolution driven by collisions between dust particles

- collision velocity depends on particle size

- observations give restraints on evolution, but do not resolve single processes

HST, NASA

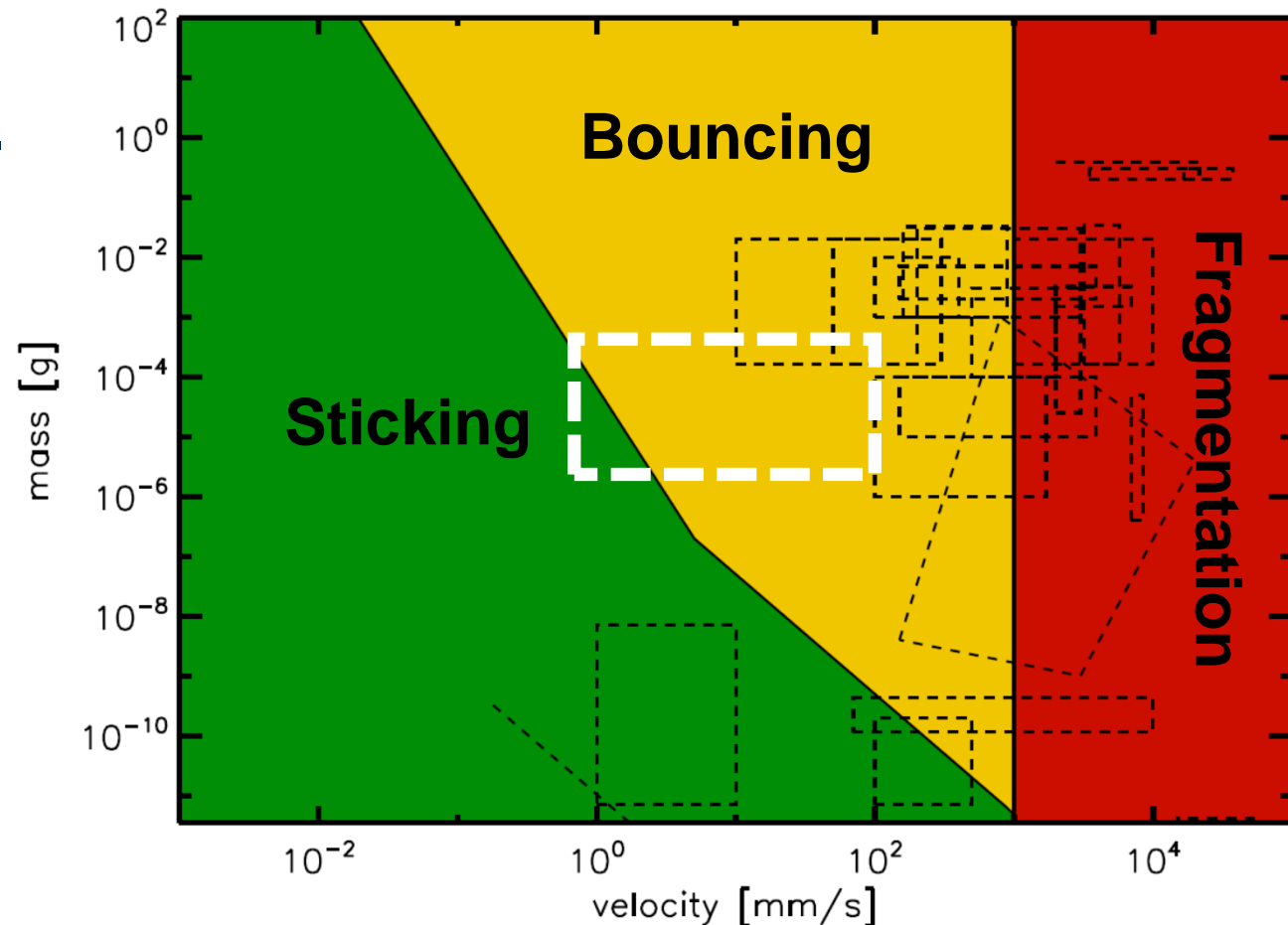
# The Collision Model



Güttler et al., 2010

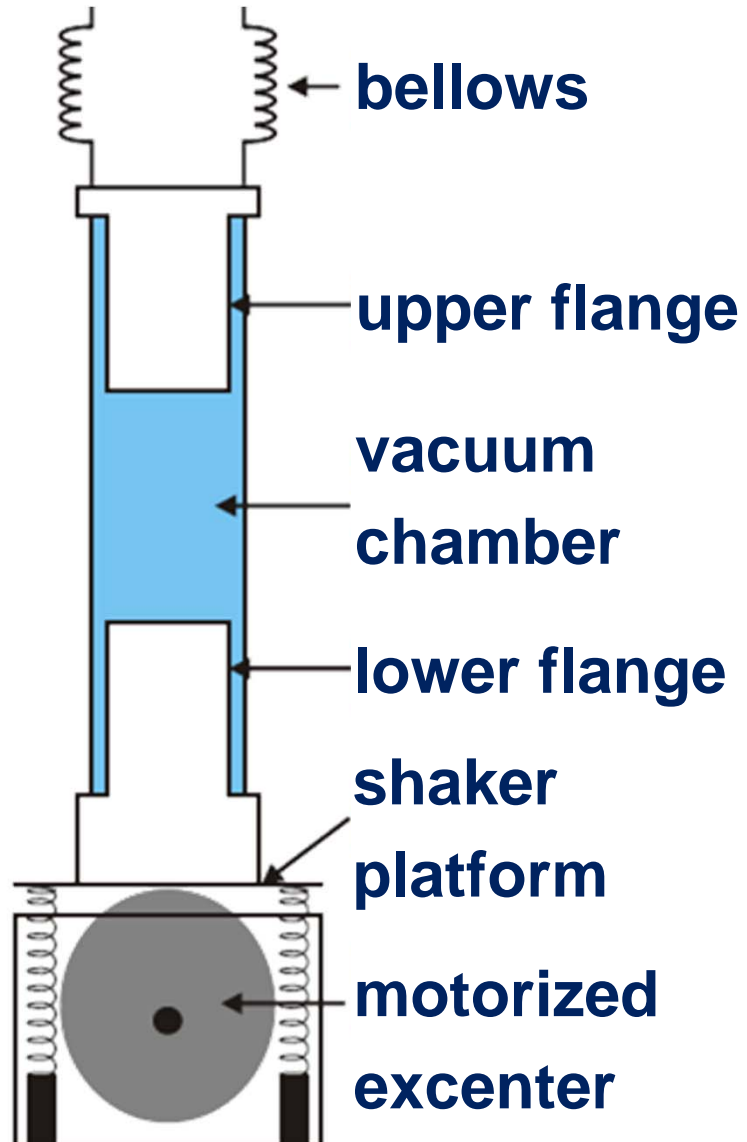
# The Collision Model

- no experiments in aspired parameter range
- border between sticking and bouncing only theoretical
- experiments not possible in laboratory

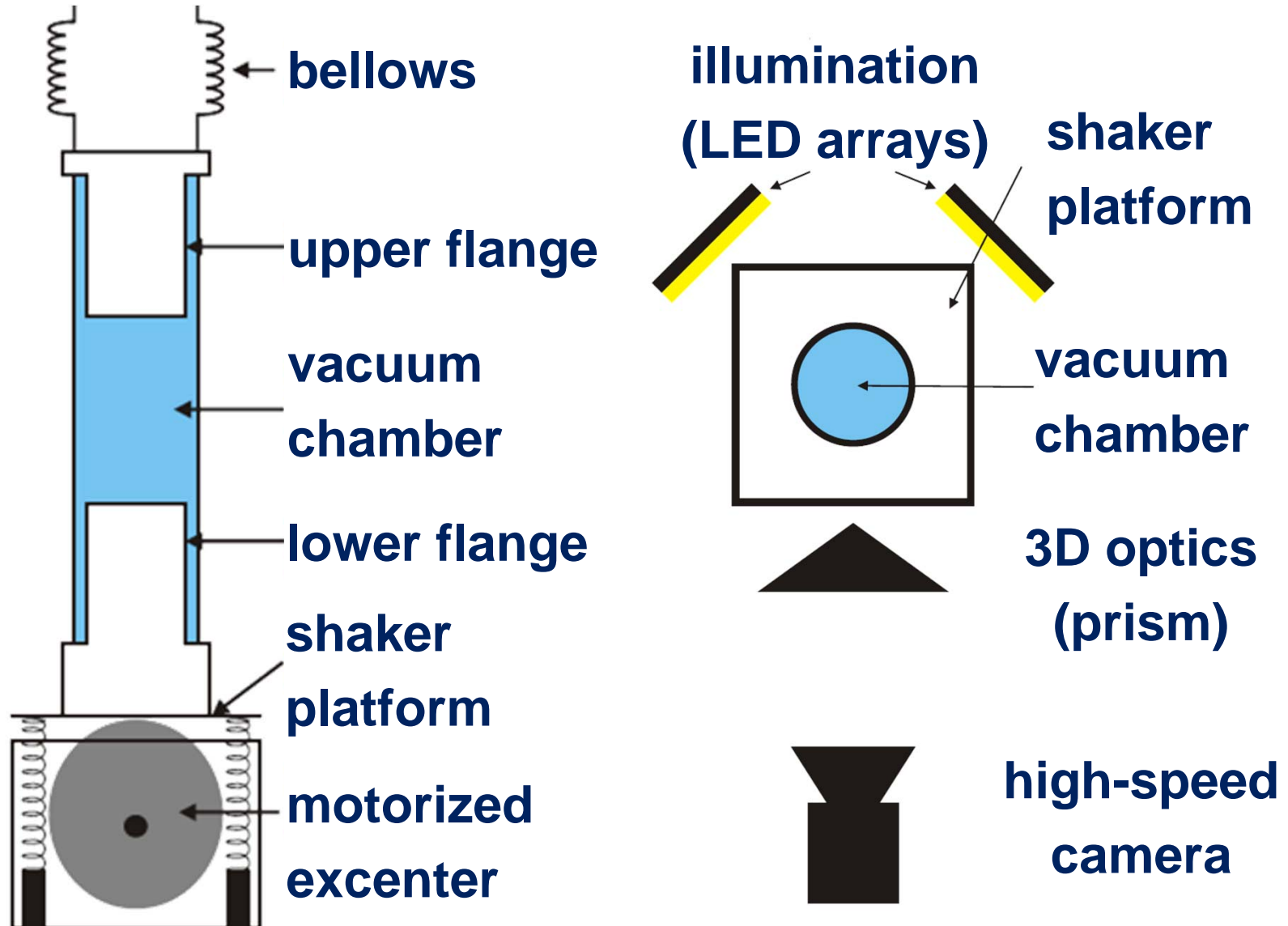


Güttler et al., 2010

# Experimental Setup



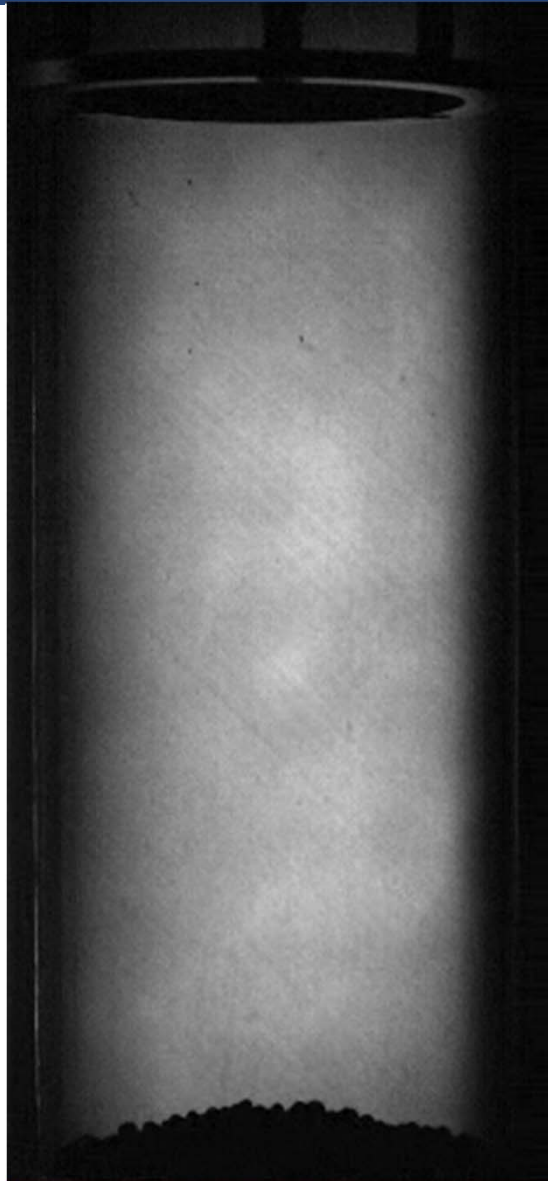
# Experimental Setup



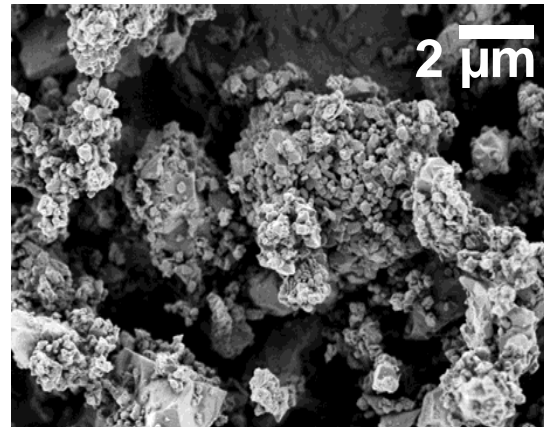
# Experimental Setup



# 1 mm-sized Particles



- 0.5 – 1.5 mm sized agglomerates, consisting of irregular, polydisperse SiO<sub>2</sub> dust



- shaking in the beginning
- magnet injection to stir ensemble





# Collisional Outcomes (1 mm)

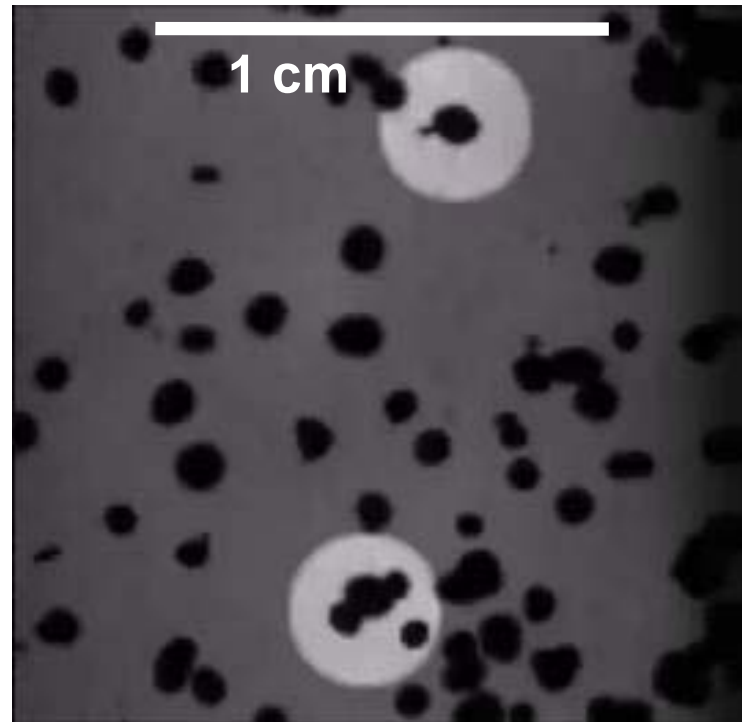
## Bouncing

0.166 and 0.142 m/s



## Sticking

0.009 m/s



## 125 analyzed collisions:

- 1x fragmentation
- 117x bouncing (95x 1mm, 22x 1.5mm)
- 7x sticking

# Collisional Outcomes (1 mm)

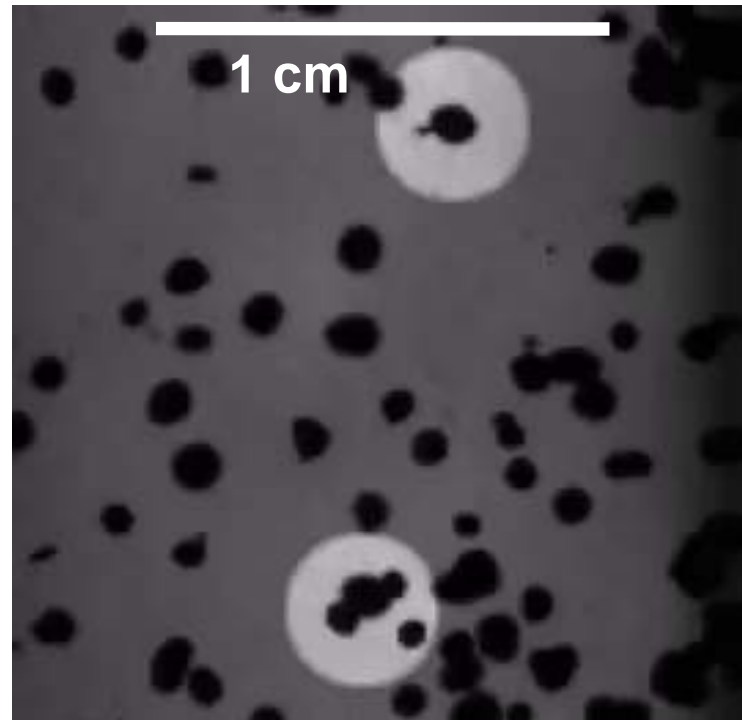
## Bouncing

0.166 and 0.142 m/s



## Sticking

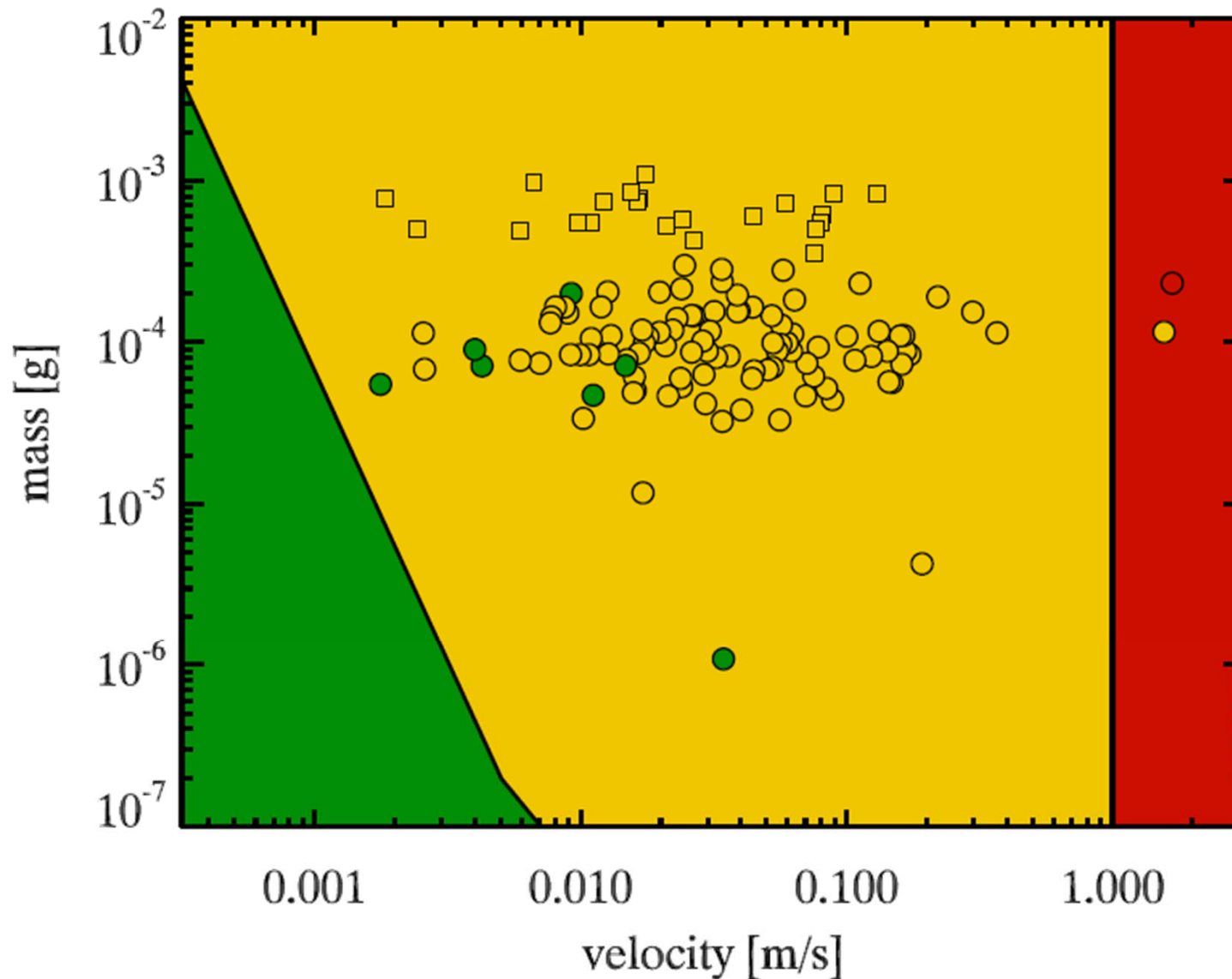
0.009 m/s



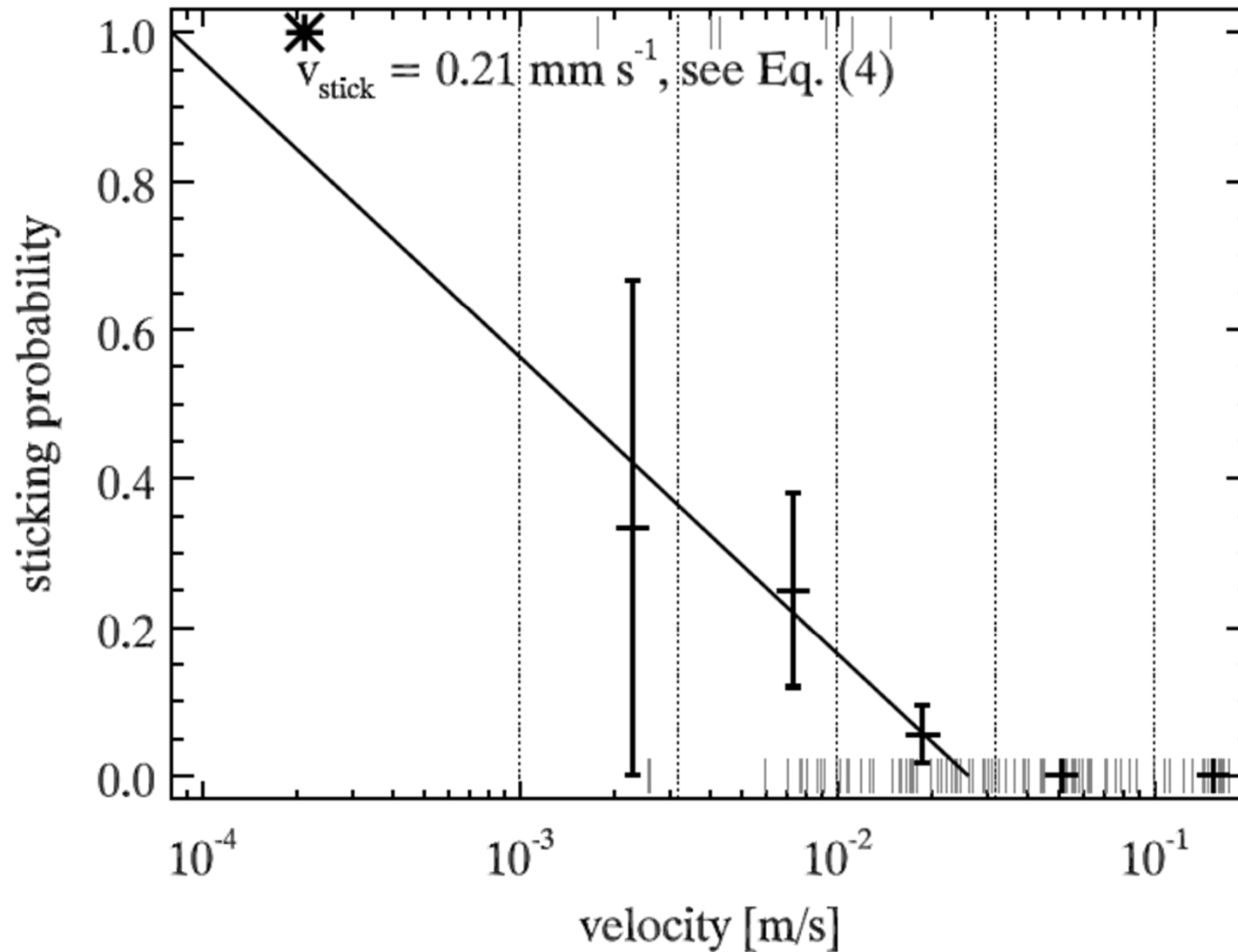
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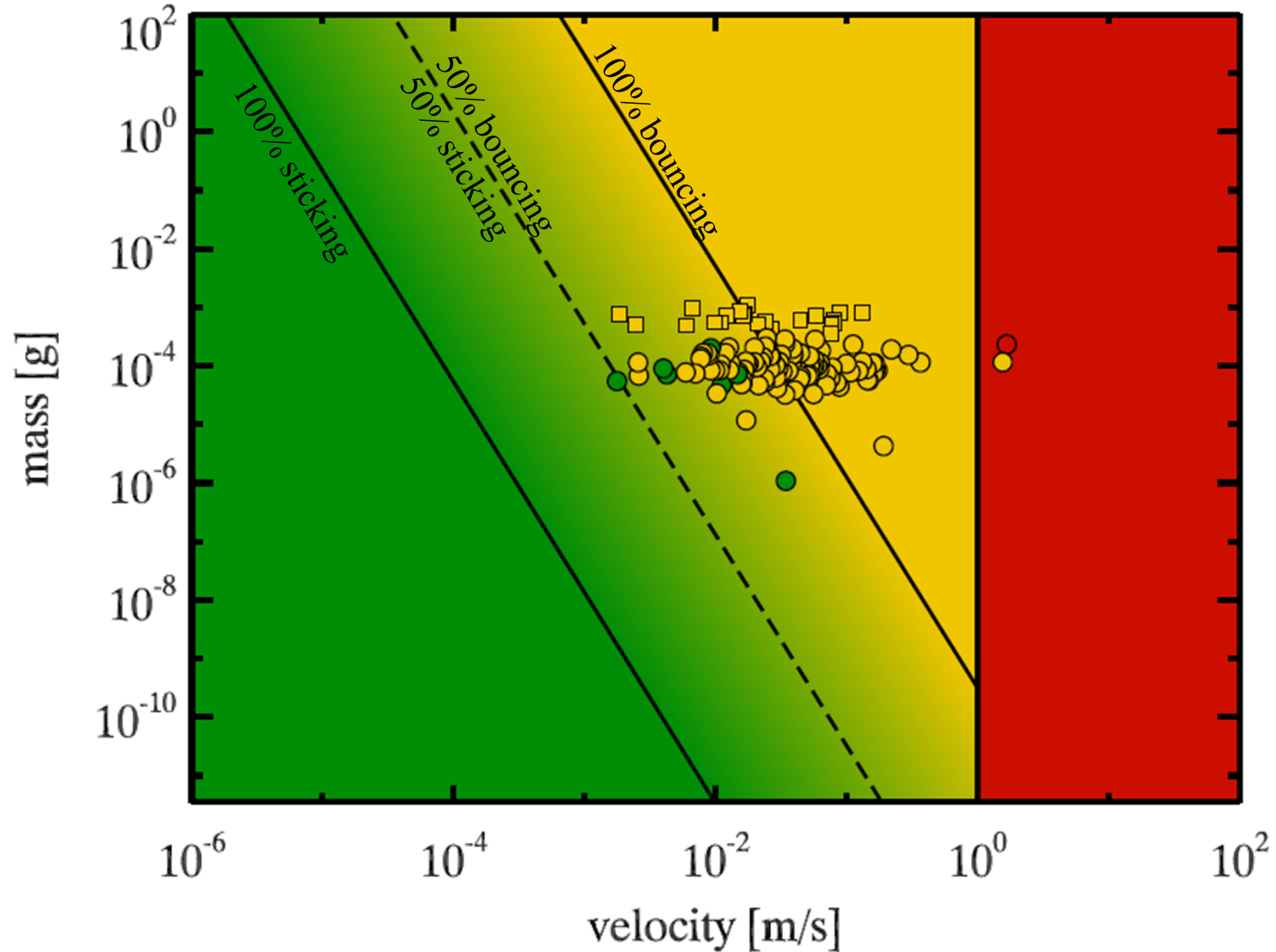
# Updating the Collision Model



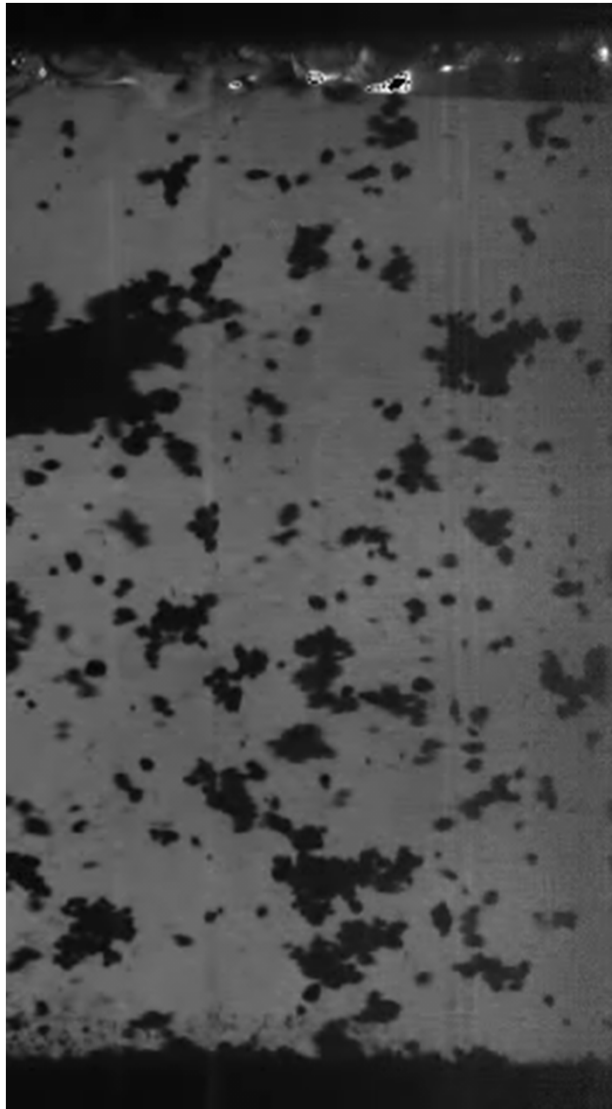
# Sticking Probability (1 mm)



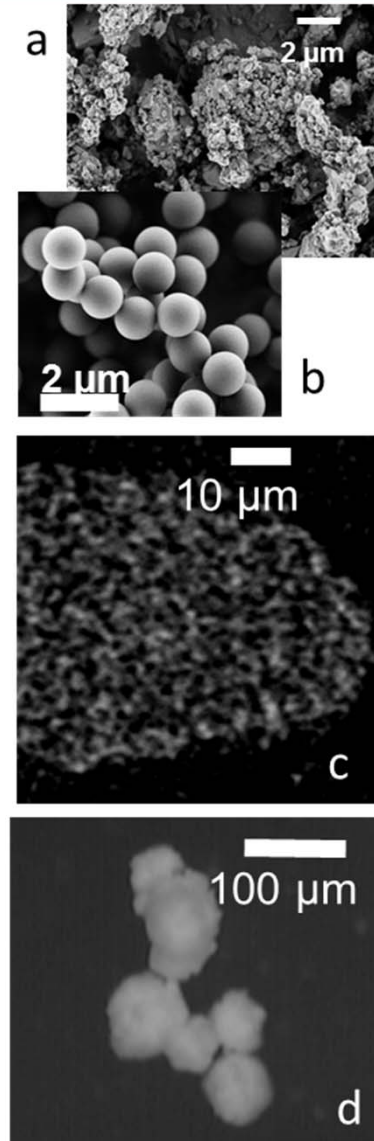
# Updating the Collision Model



# 200 $\mu\text{m}$ -sized Particles

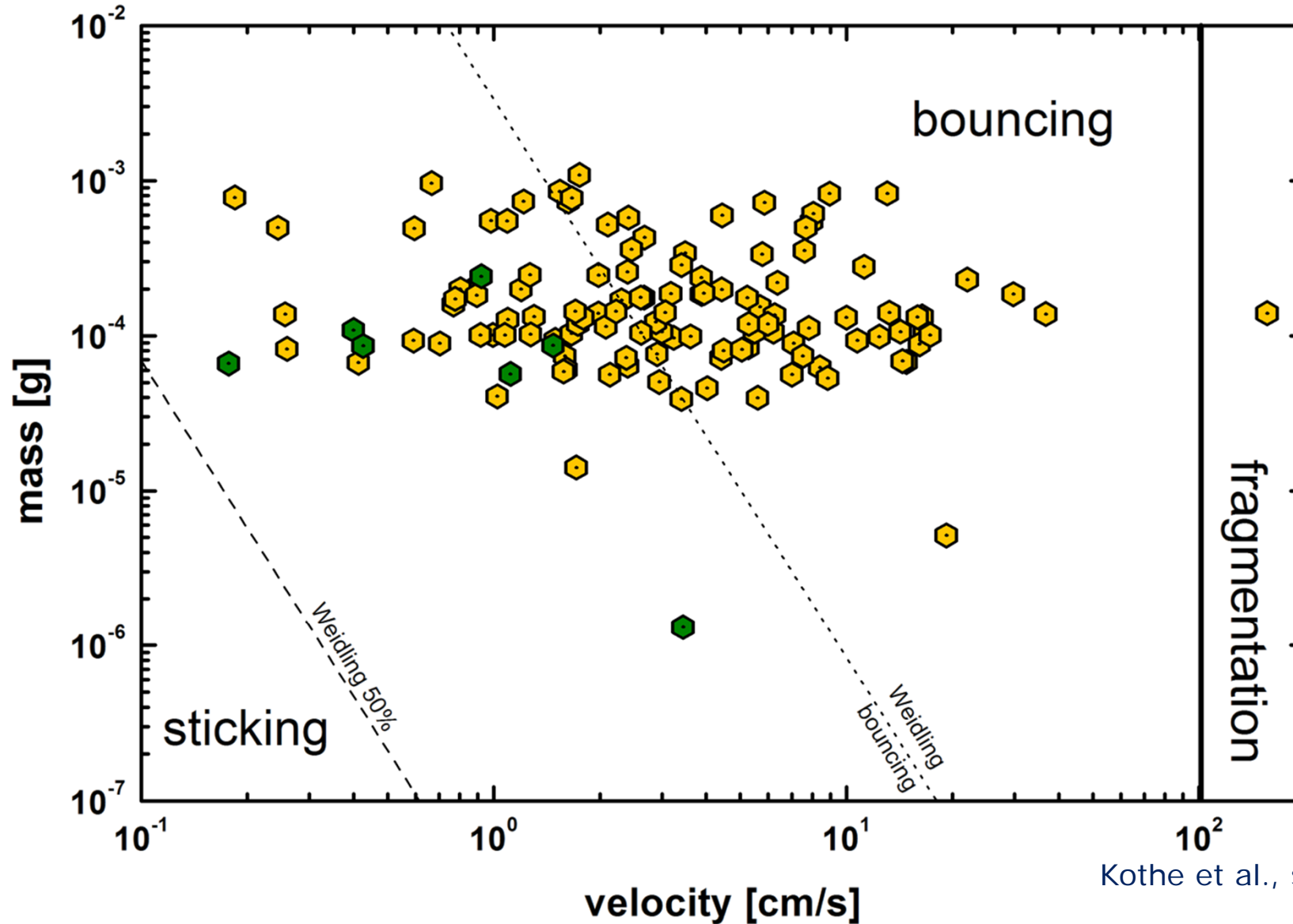


- 100 – 250  $\mu\text{m}$ -sized agglomerates, consisting of monodisperse  $\text{SiO}_2$  dust
- data of monodisperse and irregular monomers comparable
- collisions of single aggregates as well as between clusters



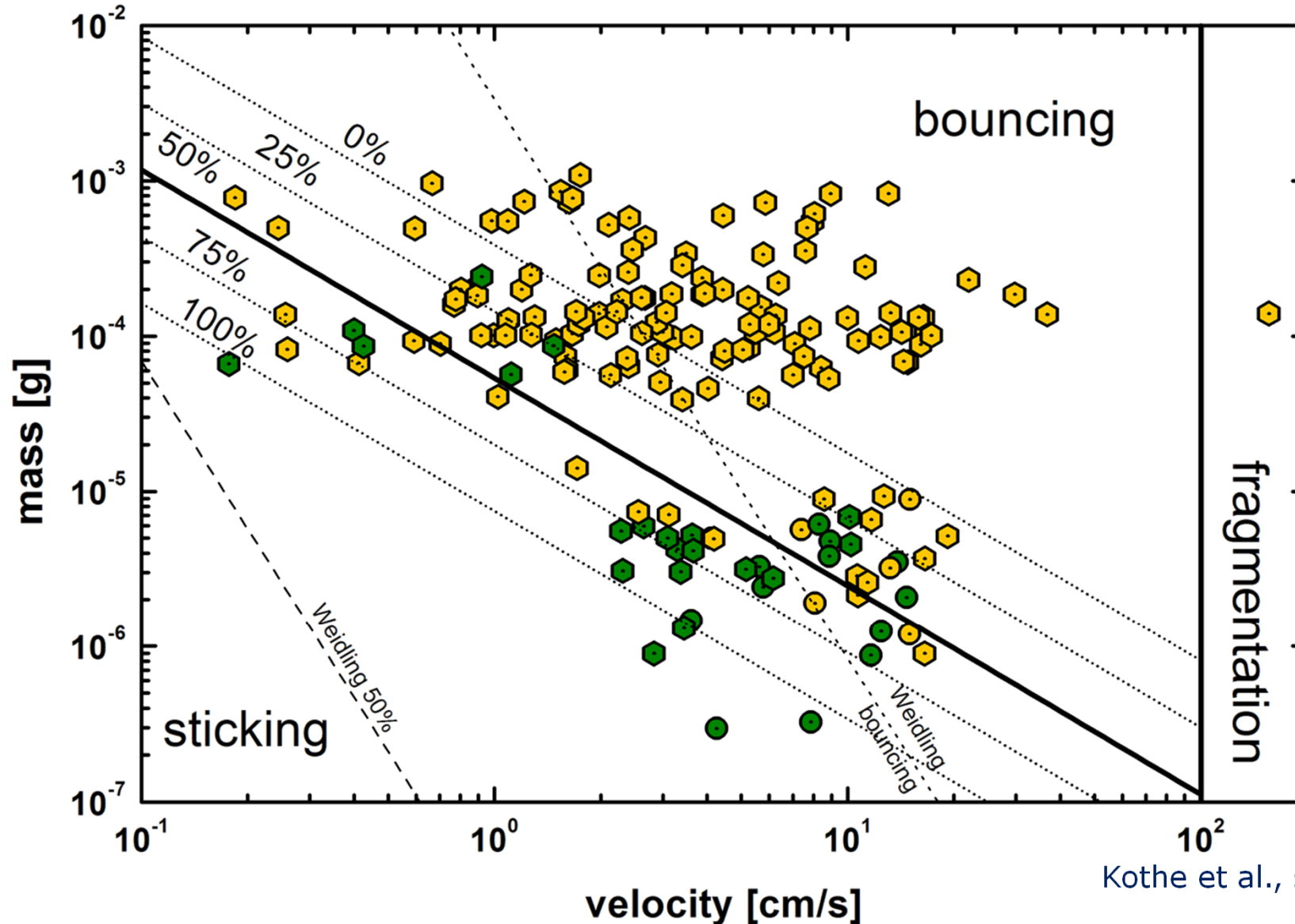
Kothe et al., subm.

# Updating the Collision Model



Kothe et al., subm.

# Updating the Collision Model



Kothe et al., subm.



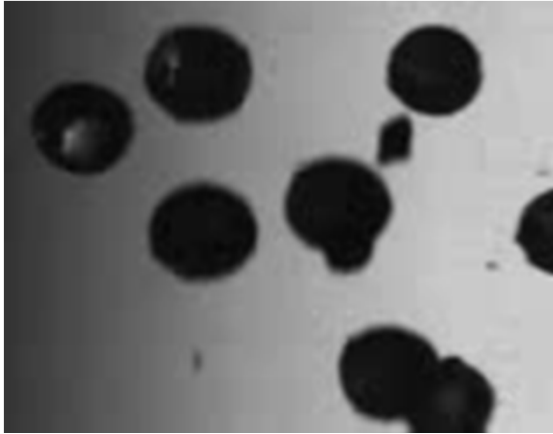
# Cluster – Cluster Collisions



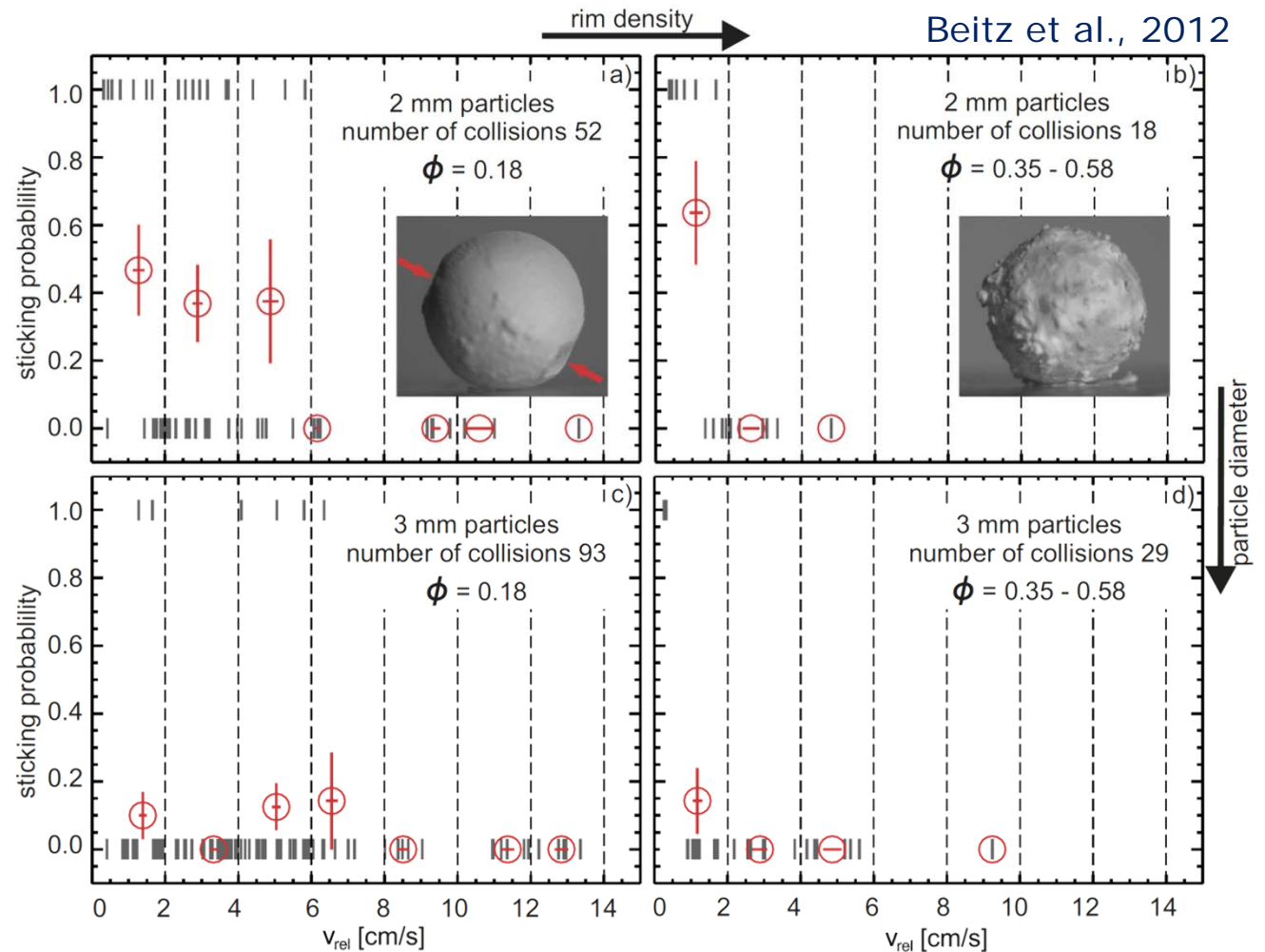
- **formation of fractal-like structures**
- **enhanced sticking probability (see poster by Stefan Kothe)**

Kothe et al., *subm.*

# 2 mm-sized Chondrules



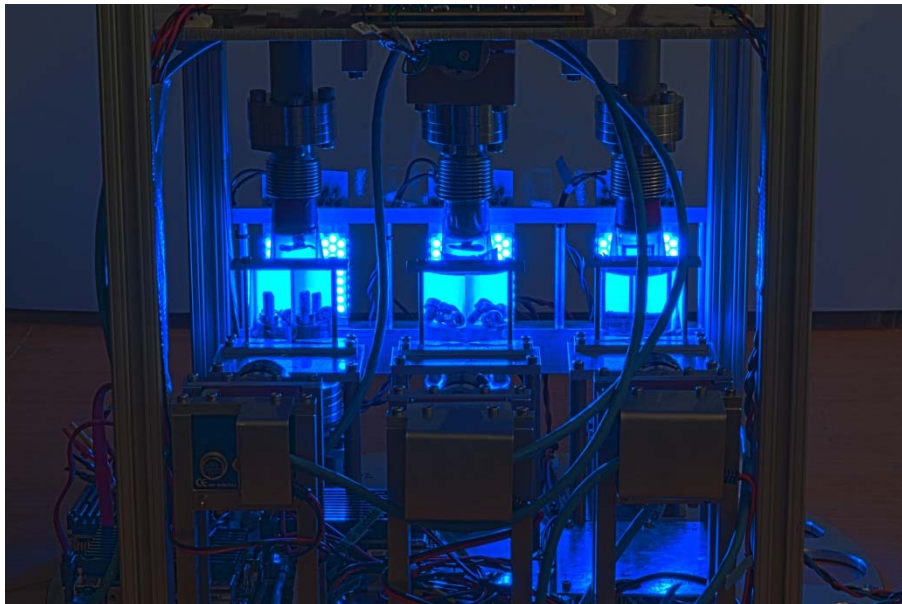
- chondrule analogs (2 mm glass beads with dust rim)



- **mm-sized particles: transition region sticking/bouncing**
- **200  $\mu\text{m}$ -sized particles: mass dependancy of transition region does not follow solid-sphere models**
  - **change of slope and width of transition region**
- **clusters: “aggregates of aggregates of aggregates” stick at higher velocities**
- **chondrules: solid core with thin porous rim also leads to higher sticking efficiency**
  - **structure of the particles does play a role**

# Outlook: Suborbital Flight

- flight on STIG-B in autumn 2012
- 180 s microgravity time
- lower velocities
- collisions of clusters or monomers and clusters



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## Acknowledgments:

E. Beitz was supported by the DFG under SPP1385 („The first 10 Million Years of the Solar system“), S. Kothe, and C.

Güttler were supported by the DFG under grant BL 298/14-1 (FOR 759 „The Formation of Planets: The Critical First Growth Phase“).

We are grateful to the DLR for providing us with drop tower campaigns and for supporting the building of the experiment under grant 50WM0936.

# Thank you for your attention