Granular avalanches in reduced gravity during parabolic flights

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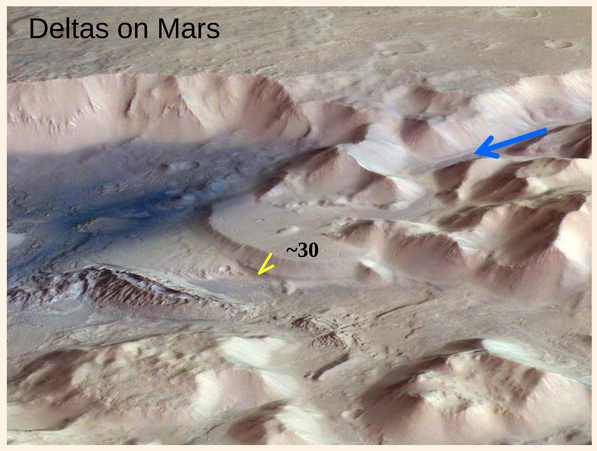
1. The phenomenon

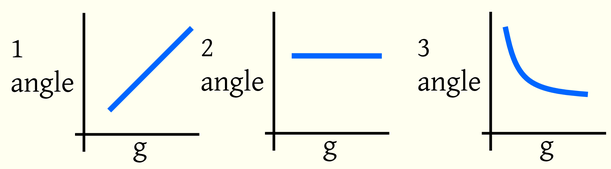
- angle of repose: steepest angle of granular material
- static angle: just before movement;
  dynamic angle: just after end of avalanche



2. Problem definition

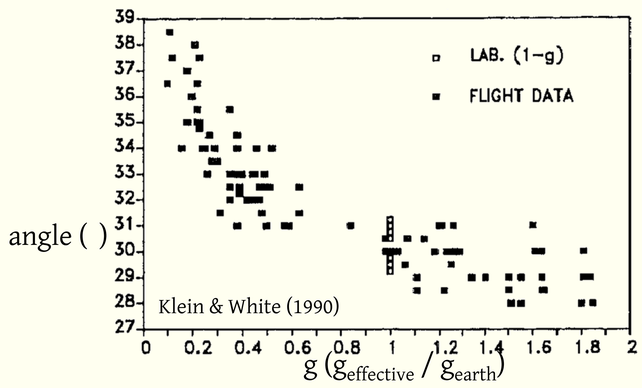
Hypotheses:

1. rolling particles:
   overcoming friction easier in low *g*
2. mass flow in avalanche:
   driving force ~*mg and* friction ~*mg*
3. earlier work in parabolic flights



Known about friction:

- angle = *f*
  - angularity
  - wall friction
  - interstitial fluid
  - runout length
  - particle size
  - static electricity

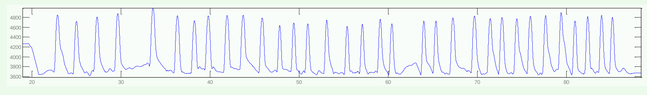


Objective

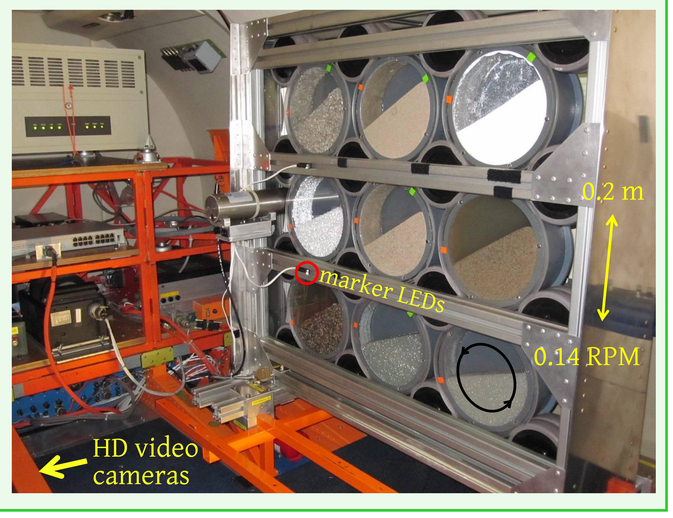
Our aim is to determine angles of repose of granular material in reduced gravity.

3. Methods and materials

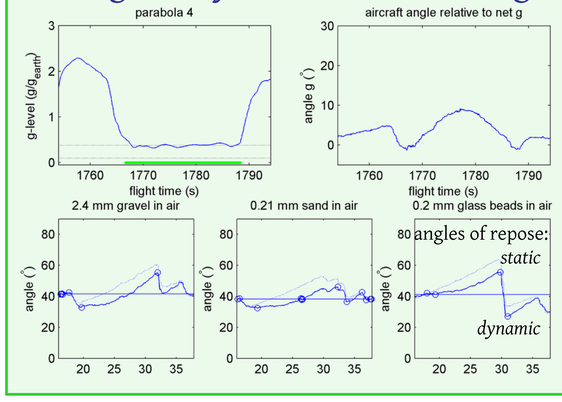
- Parabolic flights to reduce gravity
- microgravity flight director
  for $g_{reduced}$ 0.05*g*
- conditions *g*=0.1 and *g*=0.38



- rotating drums with materials:
  - rounded / angular
  - fine / coarse
  - air / water

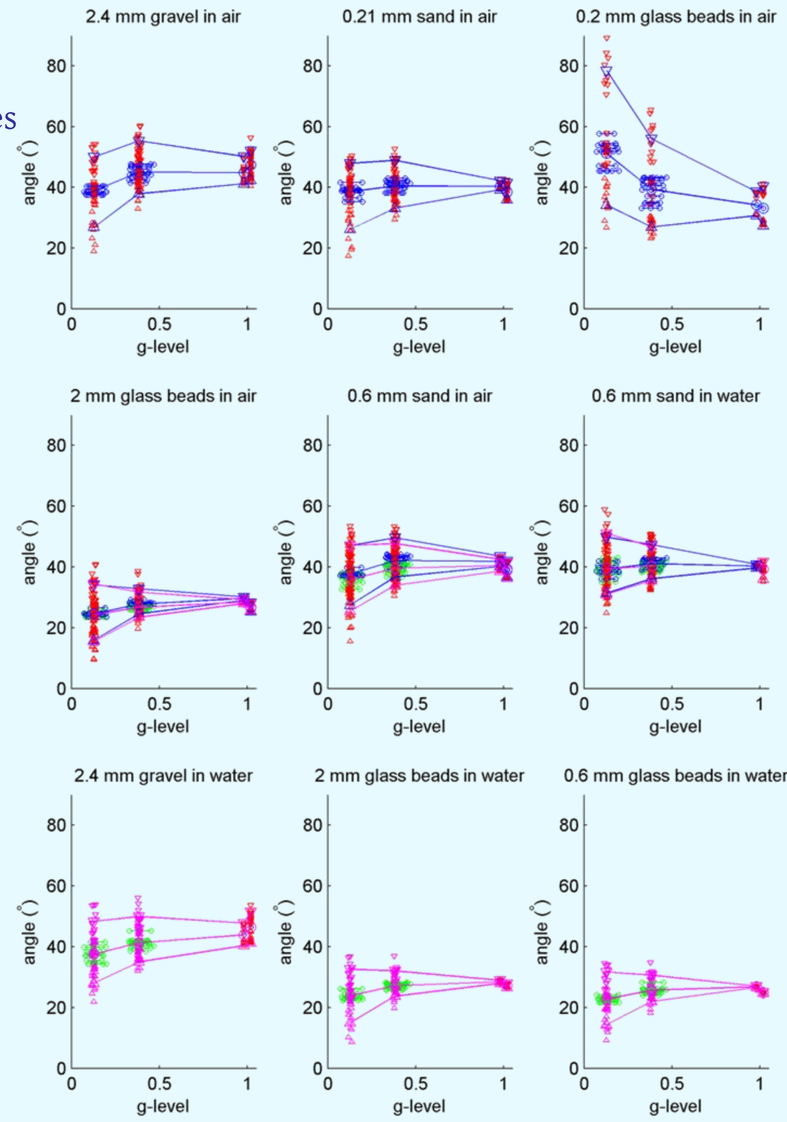


- image analysis and data filtering

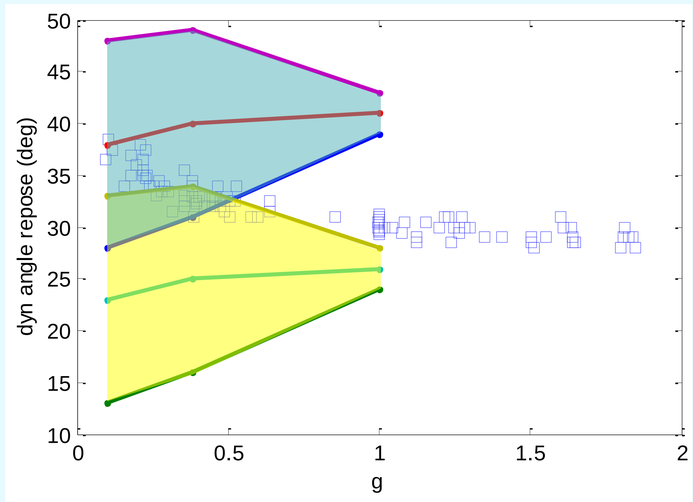


4. Results

- for reduced gravity:
  - static angle increases
  - dynamic angle decreases
  - average angle
    f (angularity)
- excluded effects:
  - interstitial fluid
  - particle size
  - aircraft motion
  - static electricity
    (except top right)
  - drum rotation



- comparison to literature:
  - opposite trend!
    explained by static electricity in Klein-White experiments?



5. Conclusions

- Average angle of repose independent of gravity
- static angle of repose *in*creases and
  dynamic angle of repose *de*creases in reduced gravity
- effect: larger avalanches
- prelim explanation:
  - friction threshold to overcome for initial motion
  - larger mass starts flowing so runout length larger and angle lower

6. Acknowledgements

- Financial support by Netherlands Space Office and
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