Bouncing Probe Proposal for characterisation of surface stiffness properties

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Experiences from PHILAE mission

ROMAP Magnetometer:
• Attitude
• Acceleration during contact
• Timing
Experiences from PHILAE mission

Investigation of Lander motion (touchdowns, rotation) and Lander orientation

- Input for Lander operation
- Recovering of data during bouncing
- Surface properties particularly at collision and second touchdown
Experiences from PHILAE mission

- MAG data and OSIRIS images allowed flight reconstruction
- TD dynamics based on MAG data
  \[ \rightarrow \text{Determination of energy balance & contact forces} \]
- Collision: \[ \leq 399 \text{ Pa} \]
- Touchdown 2: \[ \leq 147 \text{ Pa} \]
- Scratches: \[ \leq 10 \text{ Pa} \]
Experiences from MASCOT mission
Experiences from MASCOT mission

Upper estimation of the surface strength:
- Over 90% of the MASCOT kinetic energy is converted during the first touchdown. In case of stone-hard surface, much stronger rebounce would be expected.

Lower estimation of the surface strength:
- The jump in the magnetic field caused probably by MASCOT “deformation” (<1mm)
- Therefore, the surface is probably harder as the cometary surface

Energy balance:
Before TD: 0,210 Joule (v_vert: 16,8cm/sec; v_horz: 12,5cm/sec; rotation: 0,5 rpm)
After TD: 0,019 Joule (v_vert: 2,8cm/sec; v_horz: 5,0cm/sec; rotation: 3,0 rpm)
Do it for HERA professionally

How to optimize:

- Bouncing shall be the primary goal of a cubesat
- Equipping the cubesat with a magnetic skin which allows the monitoring of any kind of deformation (temporary or permanent). Designed for being sensitive for surface strange between 0,1kPa … 1MPa
- Adding accelerometer for investigating bouncing behavior and cameras for observing impact depression to the instrument set

It’s collision physics on a smaller scale (dart failing to stick)
Feasibility, TRL?

Cubesat:
- No navigation needed, battery powered, telemetry has to be provided, livetime hours …

Instruments:
- Magnetometer TRL 9
- Accelerometer, is under development for MMX
- Cameras, hardware at different quality levels available, but more important: community has great skills in operating cameras

Magnetic Skin:
- TRL: -1, but a doable challenge …
How to design a magnetic skin

Mash of thin wires

- Stimulated by the magnetometer electronics
- AC signals at different frequencies for each string or each string stimulated sequentially for separating areas of deformation
- Field changes trigger camera

Compressible layer below mash

- Permanent deformation (e.g. of foam) with well tested energy absorption
- Spring like behavior (football) – fast detection needed