122. Jahrestagung der DGaO
21.-23. September 2021 in Bremen
Poster Nr. P1

CZECH TECHNICAL UNIVERSITY IN PRAGUE

TH Aschaffenburg
university of applied sciences

CubeSat mission for the observation of meteoroid impacts on Moon

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Summary: Recent progress in nanosatellite technologies allows to consider innovative new CubeSat missions for scientific purposes. We present and evaluate the design of a small and cost effective CubeSat mission to monitor lunar meteoroid impacts by detecting their optical flashes. The poster summarizes the results of a comprehensive survey of past and recent ground based and satellite based projects focussing on lunar impact monitoring and discusses important aspects of the proposed mission and various alternatives for their solutions. Several spacecraft orbits around Moon and their usefulness for lunar impact observation are studied. In addition, we discuss the environmental risks and challenges, which such spacecraft needs to face, mainly thermal management and radiation tolerance. Finally, we present and discuss the design an optical camera suitable to detect meteoroid impacts on the lunar surface.

The recent progress in cubesats technologies allows various scientific missions based on these nanosatellites to be considered. This poster presents the results of student study within the KIN Space Engineering Course at the CTU in Prague. The presentation is made in collaboration with the Technische Hochschule Aschaffenburg.

Introduction

- Meteor impacts on the Moon produce bright flashes
- Observation provides information about the presence of Near-Earth objects
- Important for predicting Earth impacts, collisions with spacecrafts, protecting future lunar bases
- **Aim of this work:** feasibility study of a cost-effective CubeSat mission for impact observation

Figure: Lunar impact concept art [1]

Observed impacts

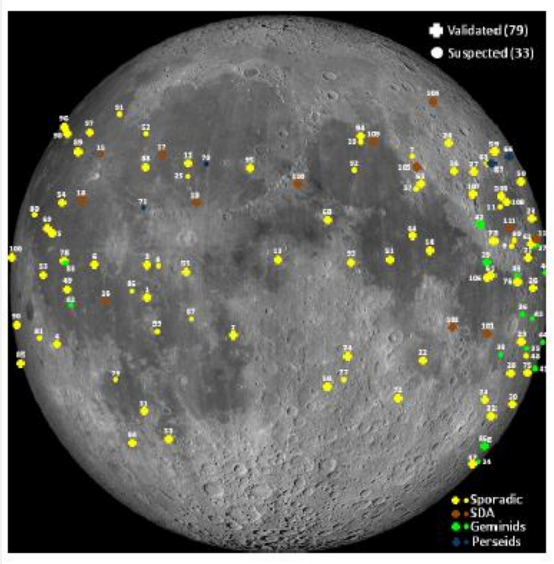

Figure: Impacts on the moon detected and suspected in the NELIOTA project [3]

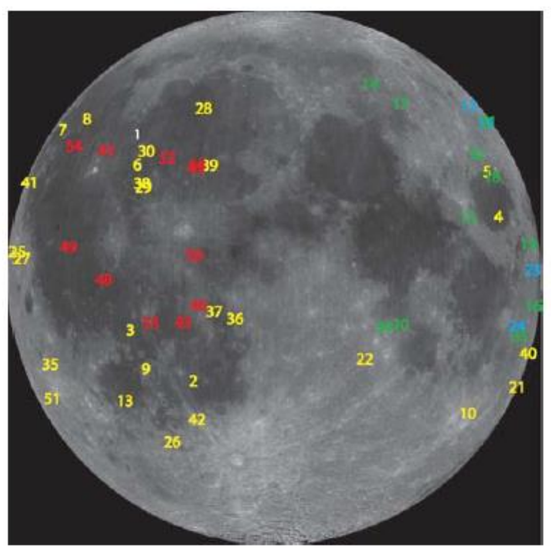

Figure: Impact flashes observed between November 2005 and May 2007 by NASA project [4]

Environmental Risks - Radiation

- Long exposure to radiation shorten lifetime of a satellite
- Modern electronics are often not radiation-hardened
- Radiation from the Sun – energy up to units of GeV
- Cosmic Rays radiation – energy from 1 MeV to 10 GeV

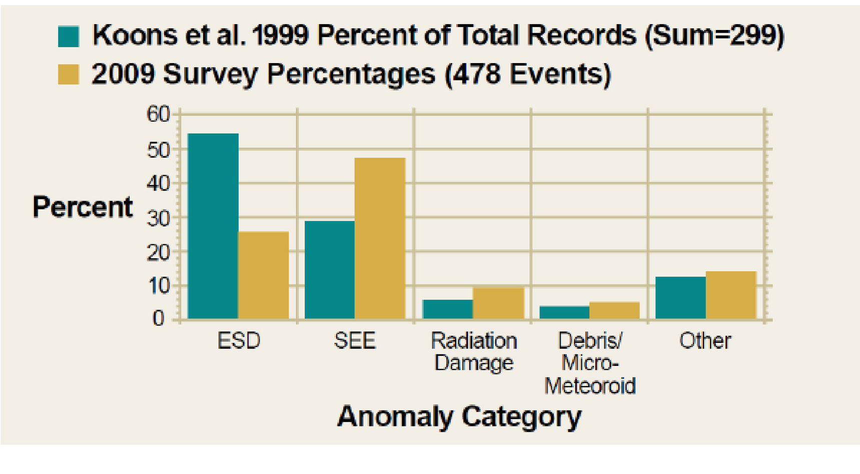

Figure: Statistics of satellite anomalies from 2 different databases [6]

Impact Example

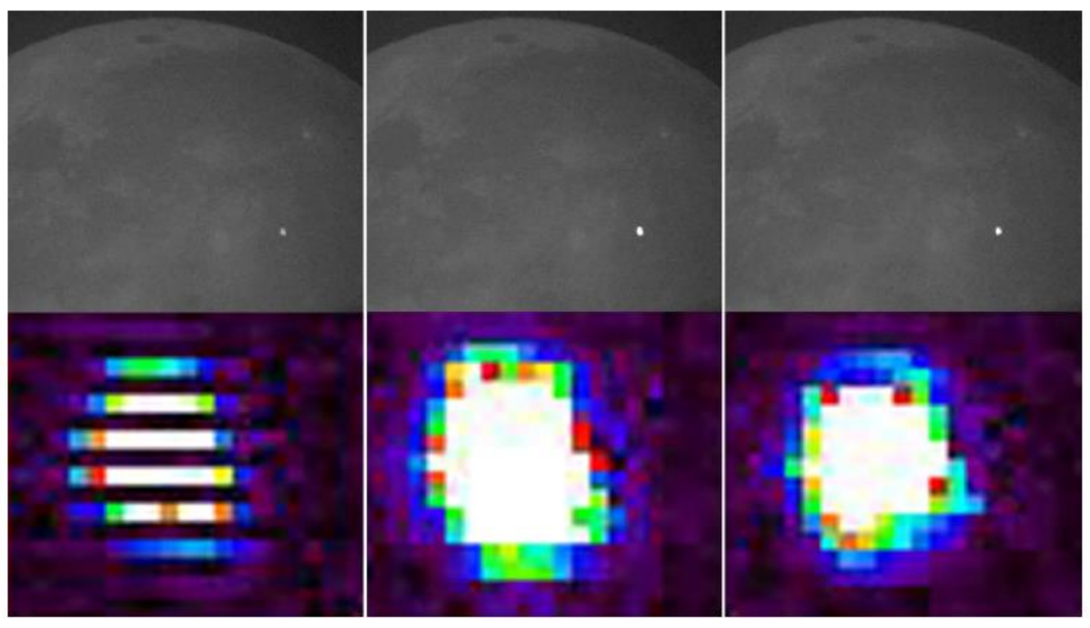

Figure: Example of impact detected by NASA [1]

Reason for observation from space

- Earth atmosphere can attenuate the light from the impact
- The weather makes the observation impossible
- Cannot observe illuminated Moon

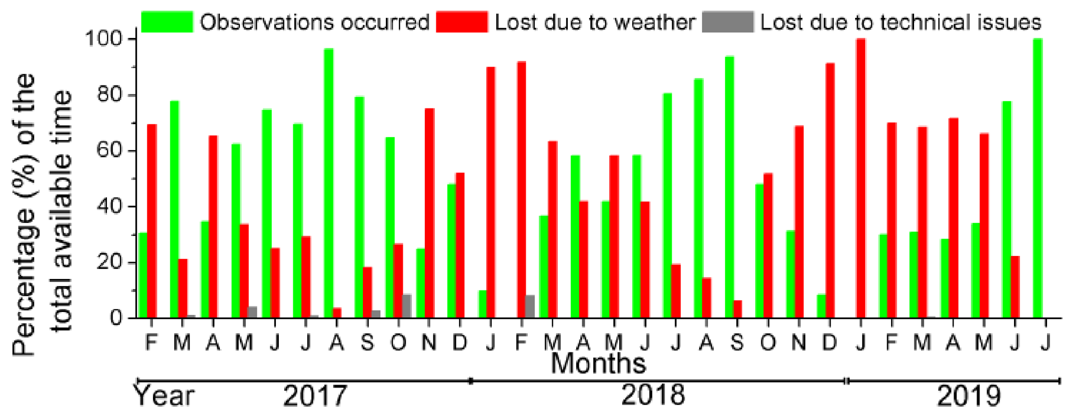

Figure: Total available time for observation in NELIOTA project [3]

Camera Design

- Chosen detector - Teledyne e2v CCD201-20
- Designed optics parameters for orbit at 5000 km altitude
- Compared with LUMIO mission

	Our mission	LUMIO
Altitude	5000 km	35525 - 86551 km
FOV	30°	6°
Focal length	24.8 mm	127 mm
Aperture	12.4 mm	55 mm
Ground resolution	2.6 km/pixel	3.5 - 8.7 km/pixel
Lunar surface view	32%	≈ 50%

Table: Comparison between our mission and LUMIO

Environmental Risks - Thermal Control

- The Sun is major source of heating (up to $1370 \pm 10\,W/m^2$ at 1 AU)
- Possible to shield up to 99.9 % of heat
- Need to equalize received heat and radiated heat
- IR cameras need a low temperature (∼ 100 K)

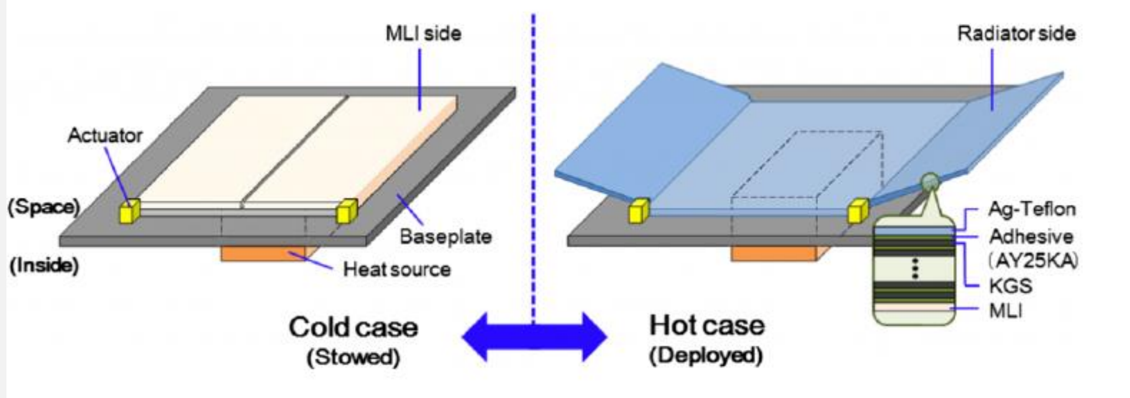

Figure: Flexible radiator conceptual diagram. Source: [7]

Existing Missions - LUMIO

Lunar meteorite impact observer

- 12U CubeSat
- Camera in visible spectrum with extension to near infra-red spectrum
- Places to Earth-Moon L2 Lagrange point

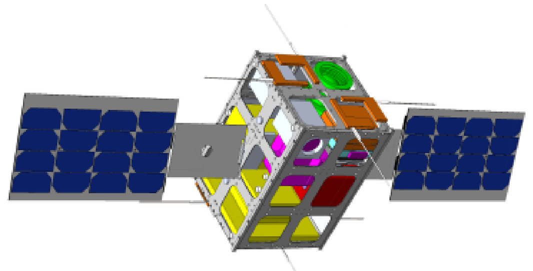

Figure: LUMIO satellite configuration [2]

Orbits

Possibilities:

- Lagrange point L2
- Low lunar orbit
- Higher lunar orbit
- Other

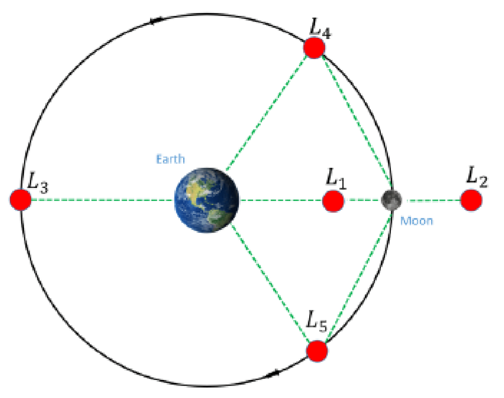

Figure: Lagrange points in the Earth-Moon system[5]

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DGaO-Proceedings 2021 – *http://www.dgao-proceedings.de* – ISSN: 1614-8436 – urn:nbn:de:0287-2021-P001-4
eingegangen: 14.10.2021
veröffentlicht: 01.12.2021