A CUBESAT MISSION FOR KOREAN LUNAR EXPLORATION. H.-J. Lee[1], J.-K. Lee[1], S.-M. Baek[1], H. Jin[1], K.-H. Kim[1], D. Hemingway[2], I. Garrick-Bethell[1,2], [1]School of Space Research, Kyung Hee University (1732, Deogyeong-daero, Yongin-si, 446701, Korea), [2]Earth and Planetary Sciences, University of California, Santa Cruz (1156 High Street Santa Cruz, CA, 95064, USA).

Introduction: Two Korean lunar exploration missions are planned by 2020, including an orbiter and a lander. The first orbiter is scheduled for 2017 with international collaboration. The main scientific objectives will be selected by the end of 2014 by a Korean lunar science committee. One of the candidate scientific objectives is research of lunar magnetic anomalies and the associated albedo features known as swirls. For this, we are now developing a CubeSat platform as a scientific payload. This CubeSat will be released from an orbiter and will measure the magnetic field continuously before impact on the lunar surface [1]. In this presentation, we describe a CubeSat as one of the payloads to measure magnetic fields on the Moon.

Mission Objective: There have been several missions to perform lunar magnetic field measurements, such as Lunar Prospector and Kaguya. However, most of these measurements were performed at almost the same altitude along each orbital pass, and at altitudes > 20 km. At these altitudes, it is not easy to observe details of the magnetic field structure near the surface. Such details are important for understanding the nature of the underlying magnetization, as well as the formation mechanism for lunar swirls. For example, we would like to know how the near-surface magnetic field direction and strength correlates with the sinuous albedo markings at swirls. This information could help test the two dominant hypotheses for swirl formation (electrostatic dust lofting [2] and solar wind deflection [3][4]), and provide insight into the origins of lunar magnetism, space weathering processes, and plasma-magnetic field interactions.

To measure the detailed features of magnetic anomalies at low altitudes, a different measurement method is required, as illustrated in Figure 1.

C**ubeSat:** Magnetometers will be installed in both the orbiter and the CubeSat. The CubeSat will be released from the orbiter and will make measurements along an inclined trajectory. It will measure the magnetic field up until the last tens of milliseconds before impact on the surface.

The CubeSat consists of a standard platform with our scientific instrument. Two different modes of communication are being investigated: local area (orbiter-CubeSat) or direct long-distance (the Earth-CubeSat).

We are also investigating the requirements of the magnetometer based on two types of sensors. One is a Magneto Resistive (MR) sensor, and the other is a Miniaturized Flux Gate (MFG) sensor. These two kinds of magnetometer sensors will have been tested by Korean CubeSat programs in low Earth orbit. We are now testing a MR sensor in Earth orbit with CubeSat for Ion, Neutral, Electron, MAgnetic fields (CINEMA) [5-7], which was built in collaboration with UC Berkeley Space Sciences Laboratory, with funding from the Korean World Class University program (2008-2013). In the case of the flux gate sensor, it will be tested by the Scientific CubeSat with Instruments for Global Magnetic field and rAdiation (SIGMA) mission [8], funded by 2013 CubeSat Contest from Korea Aerospace Research Institute. These two types of CubeSat are shown in Figures 2 and 3, respectively.

The size of these CubeSats is 3U (34 cm * 10 cm * 10 cm) and the mass is about 3.2 kg. It consists of the payload (such as magnetometer), computer, communication subsystem and power subsystem. The expected specifications of the magnetometer are as follow: Cadence - 200 vector/s (3-axis), Sensitivity – less than 2 nT.

Discussion: This CubeSat mission requires new techniques to achieve the required scientific objectives, such as release of the CubeSat from the mother ship and effective communications. For this, we plan to carry out orbit simulations of the release of the CubeSat from the mother ship, and will study the most effective modes of communication. However, most importantly, we believe these technical issues can be resolved. In the future, we also plan to demonstrate the reliability of all systems with a technical test in low Earth orbit.

Reference: [1] I. Garrick-Bethell, et al. (2013) Proceedings of SPIE Defense, Security, and Sensing, paper 8739-2. [2] I Garrick-Bethell et al. (2010), *Icarus* 212, 480-492 [3] Hood and Schubert (1980), *Science* 208, 49-51. [4] Hemingway and Garrick-Bethell (2012), *JGR* 117, E10012. [5] Lin, R. P., et al. (2009) AGU Fall Meeting Abstracts. Vol. 1. [6] Y. Lee, et al. (2011) Proc. 62nd International Astronautical Congress, paper IAC-11-B4.2.5. [7] Brown, P., et al. (2012) Measurement Science and Technology 23.2: 025902. [8] S. Lee, et al. (2013) The Korean Space Science Society Fall Meeting Abstracts I-2-3.

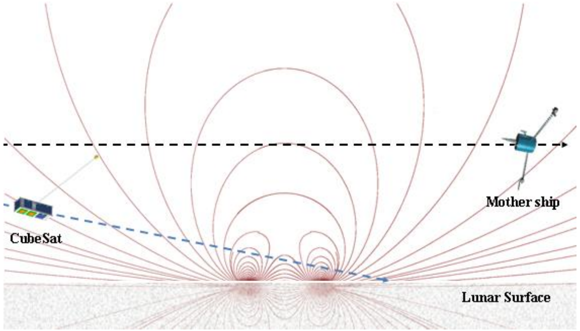
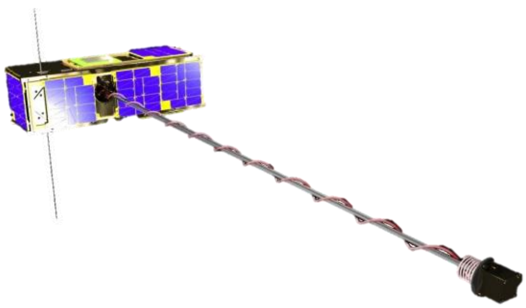
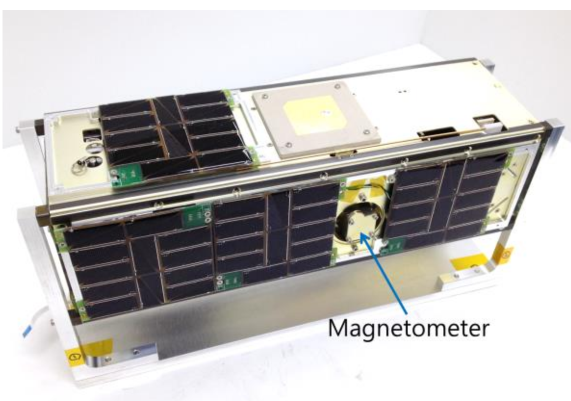


Figure 1. Trajectory of the CubeSat at a lunar magnetic anomaly. This measurement technique is different from previous orbiter missions.



(a) Modeling image



(b) Flight Model

Figure 2. The CINEMA CubeSat (now in Earth orbit), equipped with the MR sensor.

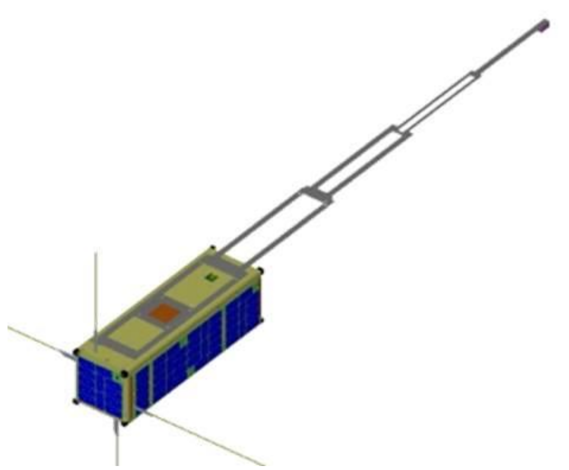


Figure 3. SIGMA modeling image, to be equipped with the Miniaturized Flux Gate sensor.