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Lunar Science by Kaguya

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Abstract

The Kaguya mission completed by impact on the Moon in last June. The Kaguya team is studying the lunar science on origin and evolution of the Moon using new data and findings by Kaguya. I and co-authors will summarize science achievements in EPSC 2010 meeting.

1. Introduction

The Kaguya impacted the Moon on June 10, 2009 after successful observation of lunar surface for twenty-one months. The Kaguya operation was completed on June 29, 2009 by termination of telecommunication with VLBI satellite Ouna. On November 2 the Kaguya team released science data stes of 1st version to the public from the Kaguya data archive system in one year after closing nominal observation term. The team is also publishing science achievements in international journals

2. Kaguya Science

Kaguya data have already improved previously reported ones by Clementine and Lunar Prospector missions. Multi-band Imager provides new and detail information of lunar crust by reflectance image of central peaks of craters[1]. Spectral Profiler definitely measures mineral composition of characteristic feature of lunar surface such as central peaks of craters[2][3]. High resolution images of Terrain Camera show volcanic activity of lunar farside to younger age by crater counting to smaller size of craters of 100 m in diameter [4]. The crater counting also used to estimate formation ages of youngest craters such as Giodano Bruno crater [5], and to estimate lava thickness of Mare Moscovience [6]. Direct measurements of gravitational field of farside are carrying out using RSAT onboard subsatellite Okina. It reveals gravity anomaly of farside basins is very different from nearside ones which shows simple positive anomaly ‘mascon’. In Apollo basin coaxial distribution of positive and negative anomalies are definitely observed by reflecting the difference of subsurface structure and material [7]. Lunar gravity anomaly model are improved using new orbital data [8]. Lunar Altimeter LALT makes high resolution topography map of STM359 model [9][10]by measuring altitudes by every 1.6 km interval including polar regions, where Clementine mission never measured directly and photograph were used to estimate the topography of polar area higher than 75 degrees in ULCN2005.This map indicates highest point of southern rim of Dirichlet-Jackson basin and lowest bottom of Antoniadi crater in South Pole Aitken basin. The difference of altitudes attains 19.8 km in lunar farside. Center of figure of the Moon is offset to be 1.93 km to the Earth side from center of gravity. Using new data of gravity field and topography crustal thickness model is improved[11]. Rader sounder LRS are successfully sounding the lunar surface and subsurface. Especially in mare regions of nearside subsurface discontinuity are identified to be permeability boundary of geological strata [12][13][14]. Rader echoes in farside are much contributed by reflection from rough surface such as craters of highland. So subsurface echo can be identified after applying information of surface topography. The result of LRS observation also makes possible to compare with Apollo ALSE results for subsurface of Mare Serenitatis. Apollo sounder indicated deep discontinuity of 3 to4 km depth. On the other hand Kaguya LRS identified the shallow discontinuity at 500 m depth. Reanalysis of Apollo data by using the same method is necessary to settle this controversy. Gamma-ray spectrometer GRS identifies global distribution of radioactive elements, U, Th, and K [15]. Uranium distribution must be higher reliable than previous estimation, where energy of gamma ray from uranium is limited by detector energy range. Plasma analyzer PACE can analyze mass and energy of solar wind

[16][17][18][19]. Electron and proton are detected in the wake of the Moon. PACE also observes the reflected protons from lunar surface. Magnetometer LMAG identifies magnetic anomaly in northwest part of South Pole Aitkin basin by reducing electromagnetic noise employing twelve meter mast. Several anomalies reported by 30 km altitude observation of Lunar Prospector are identified by Kaguya LMAG of 100km altitude.[20]

3. Summary

As we described above section, the Kaguya mission brings many new findings and definite improvements on previously acquired data. These data and science must contribute to create new lunar paradigm by integrating collaboratively science data by 21st century exploration of SMART-1, Chang'E-1, Chandrayaan-1, and LRO/LCROSS.

Table1: Kaguya Science Instruments and Experiments

Elemental distribution measurements
X-ray Spectrometer (XRS) Gamma-ray Spectrometer (GRS)
Mineralogical distribution measurements
Multi-band Imager (MI) Spectral Profiler (SP)
Topography of lunar surface and subsurface
Terrain Camera (TC) Lunar Radar Sounder (LRS) Laser Altimeter (LALT)
Precise gravity field measurements
Differential VLBI Radio Source (VRAD) Relay Satellite Transponder (RSAT)
Plasma environment study
Lunar Magnetometer (LMAG) Charged Particle Spectrometer (CPS) Plasma energy Angle and Composition Experiment (PACE) Radio Science (RS) Upper-atmosphere Plasma Imager (UPI)
Public outreach
High Definition TV Camera (HDTV)

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