

Subaru Spectroscopy of Asteroid (832)Karin

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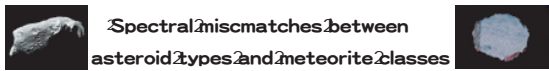
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ABSTRACT

We have conducted a near-infrared (J, H, K) spectroscopy of newborn asteroid (832)Karin with CISCO on the Subaru telescope. We derived different (reddened and un-reddened) spectra of Karin for different rotational phases; which means that Karin has two different (mature and fresh) surfaces and the difference among these spectra reflected the difference of degree of space weathering. The mature surface spectrum matched to the spectrum of S(IV)-type asteroid, whereas the fresh surface spectrum matched to spectrum of L6 ordinary chondrite.

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INTRODUCTION



Spectral mismatches between asteroid types and meteorite classes

- S-type asteroid: the most common in the inner part of the main asteroid belt
- Ordinary chondrite: the most common meteorite fallen to the Earth
- **MISMATCH between these spectra (Fig.1)**
- (The spectrum of S-type asteroid is darkened and reddened relatively)

Hapke old hypothesis

- The mismatch is caused by the "space weathering":
- The spectral darkening and reddening are caused by formation of nanophase iron particles

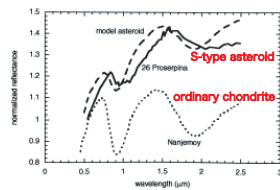


Fig.1 Normalized spectra of S-type asteroid and that of ordinary chondrite [Hapke, 2001]

SASAKI ET AL. 2001

The laboratory experiments confirmed Hapke hypothesis

- Pulse-irradiation experiments simulating micrometeorite impacts
- The reflectance spectra of the altered olivine in which high-energy laser experiments match with typical spectra of S-type asteroids (Fig.2)
- The iron nano-particles were actually formed (Fig.3)

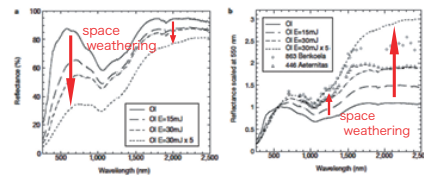


Fig.2 Bidirectional reflectance spectra of olivine samples before and after pulse laser irradiation. (left) Absolute spectra of olivine. (right) Olivine spectra scaled at 550 nm. [Sasaki et al. 2001]

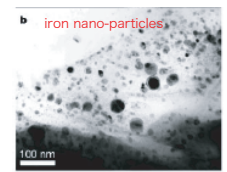


Fig.3 Nanophase iron particles in bright-field TEM images of the rim of laser-irradiated olivine grains, which irradiated 20 times at 30 mJ. [Sasaki et al. 2001]

OBSERVATION

The newborn asteroid Karin [Nesvorný et al. 2002]

- Existence of a newborn group of asteroid: Karin cluster group (Fig.4)
- Remnants of a recent breakup of only 5.8 million years ago (Fig.5)
- The brightest asteroid in this group: Asteroid (832)Karin

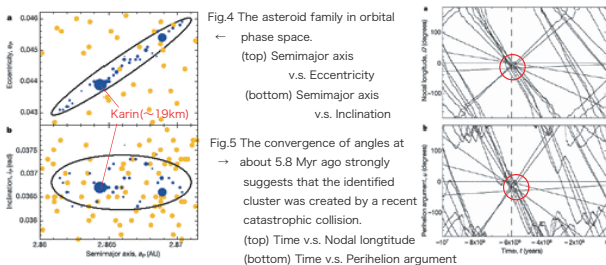


Fig.4 The asteroid family in orbital phase space. (top) Semimajor axis v.s. Eccentricity (bottom) Semimajor axis v.s. Inclination

Fig.5 The convergence of angles at about 5.8 Myr ago strongly suggests that the identified cluster was created by a recent catastrophic collision. (top) Time v.s. Nodal longitude (bottom) Time v.s. Perihelion argument [Nesvorný et al. 2002]

A near-infrared spectroscopic observation of Karin by the Subaru telescope with Cooled Infrared Spectrograph and Camera for OHS (CISCO)

- Subaru with CISCO
- 2003 September 14 (UT)
- Near-infrared (zJ + JH + wK)
- zJ: 0.88 - 1.40 μm
- JH: 1.06 - 1.82 μm
- wK: 1.85 - 2.51 μm
- Integration time: 2400s x 3 set = 7200s
- Seeing: 0.2 - 0.3 arcsec in K band



un-reddened "fresh" surfaces

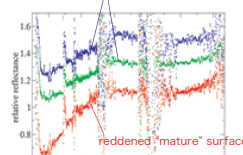


Fig.6 Relative spectra of Karin (top). Light-curve of Karin (bottom). Light-curve: [Yoshida et al. 2004]

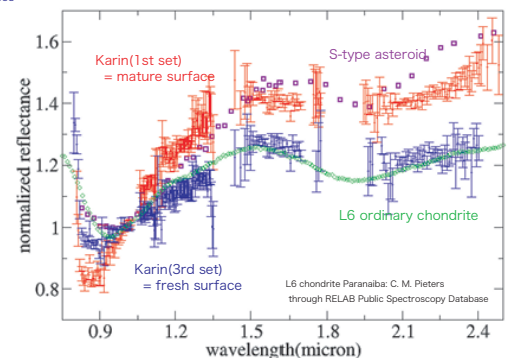


Fig.7 Reflectance spectra of Karin (first set: red points, last set: blue point) along with the previous observations of S(IV)-type asteroid (584)Semiramis (violet squares) and L6 ordinary chondrite Paranaiba (green diamonds) normalized at 1.0 μm .

Reddened spectrum = mature surface = S-type asteroid
Un-reddened spectrum = fresh surface = ordinary chondrite

Our result supports the idea that space weathering is responsible for the spectral mismatch between S-type asteroids and ordinary chondrites

IMPLICATION

- Rotational phase of 0.35: abrupt shift in the degree of space weathering is observed
- Double peak of magnitude: surface around 0.2 is mature while 0.7 is fresh
- Karin is one of cone-shaped fragment at low-velocity impact forming the Karin family?

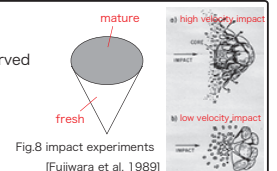


Fig.8 impact experiments [Fujii et al. 1989]