Physical Properties of Zodiacal Dust Estimated from AKARI Observations and Orbital Calculations

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In our solar system, there are many interplanetary dust particles (IDPs) originating mainly from asteroid collisions and activity of comets. These particles gradually decrease its angular momentum and drift radially due to the absorption and re-radiation of the sunlight (Poynting-Robertson effect; e.g. Burns et al. 1979). Investigating the properties of the zodiacal dust particles may reveal the properties of parent bodies and the creation process of them.

The thermal emission from the IDPs is called the zodiacal light. AKARI, the first Japanese infrared astronomical satellite, has observed the zodiacal light in the leading and trailing direction of the Earth orbit during a period from 2006 May 8 to 2007 August 28. From analysis of AKARI data, we found that the observed surface brightness in the trailing direction of the Earth orbit is greater than that in the leading direction by 3.7% in band at 9μm and 3.0% in band at 18μm. This result is consistent with previous observations with IRAS (Dermott et al. 1994). This asymmetry is thought to come from the asymmetric dust distribution made by the IDPs trapped by MMRs of Earth orbit.

In order to reveal dust properties resulting in the asymmetry of dust distribution, we numerically integrated dust orbits for restricted three body problem of Sun, Earth and a dust particle. The orbital evolution can be characterized by the parameter β which represents the strength of the radiation force compared to the gravitational force from the Sun. The parameter β can be defined as a function of dust properties such as dust radius s and material density ρ. In our calculations, particles are set to be 0.001-0.1 in β (corresponding to 3-300μm in radius with $\rho = 2$g/cc) and their initial orbits are determined according to the origins of main-belt asteroids and Jupiter-family comets.

We found that larger particles are easier to be trapped by MMRs and make high density region in the dust distribution. However, larger particles are easier to be trapped by outer resonances which hardly contribute to the asymmetry in the surface brightness. In consequence, the observational asymmetry can be explained by particles with radius $s \lesssim 2.9\mu$m for main-belt origins and with $s \lesssim 7.2\mu$m and $s \gtrsim 285\mu$m for cometary origins.

In this poster, we show the results of analysis of AKARI observations and orbital calculations and discuss the origin and typical size of zodiacal dust. We also would like to discuss the effect of the gravity from other planets such as Jupiter using additional calculations.