Development of the galactic dust emission code based on stochastic heating model and application to the AKARI far-infrared all-sky map

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In 2014, it was announced that cosmic microwave background (CMB) B-mode polarization generated by primordial gravitational wave was detected by BICEP2. However, it has been revealed that the detected B-mode signal had originated from dust emission. It showed that the targeted B-mode signals are embedded in the dust signal. In order to detect the CMB B-mode signal, improvement of all-sky dust emission map is mandatory. In same year, far-infrared all-sky image was revised by AKARI. AKARI has much better sensitivity, spatial resolution and wider wavelength coverage than those of the previous instrument, IRAS. The purpose of this study is revising dust emission map by fitting AKARI data with physical model of the Galactic dust emission.

Interstellar dust grains are heated primarily by absorption of ultraviolet, optical and near infrared photons of the interstellar radiation field (ISRF) which is an aggregation of photon fields emitted from Galactic stars, and loose their thermal energy by thermal emission in mid and far infrared wavebands. For large grains, since time interval between absorbing one photon and next photon is much shorter than radiative cooling time, temperatures of the large grains stay almost constant and their temperatures are defined by energy balance between heating and cooling. In other word, large dust grains stay in thermal equilibrium immersed in the ISRF. On the other hand, for smaller grains, time interval of photon absorption is much longer than radiative cooling time. Therefore, thermal state of small grains is far from thermal equilibrium. Usually, thermal state of the large grains is calculated under thermal equilibrium assumption and thermal state of the small grains is calculated by using stochastic treatment of absorption of ISRF photon. Since the border of the small and the large grains depends on the intensity of the ISRF, self consistent treatment of the border of the small and the large grains depending on the intensity of the ISRF is required.

In this study, we treat heating processes stochastically for all sizes of grains. We are developing the scheme to calculate the spectrum of the dust emission based on the results obtained by the above mentioned full stochastic treatment of thermal states of the dust grains. In order to obtain all sky distributions of dust column density and ISRF intensity, we are fitting these spectra to AKARI FIS all sky maps. In this presentation, we introduce this stochastic calculation method, obtained spectra and fitting results to the AKARI FIS maps. We also report that there is deviation of the dust emission spectrum from a single power law spectrum in mm-wave bands.