Astrophysics of Dust
in H II regions, galaxy evolution, and intergalactic medium

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Abstract in the Ph.D dissertation:

"Astrophysics of dust" is one of the hottest fields in the current investigations of astrophysics and astronomy because dust grains exist everywhere! Although the unique solution of the dust model has not been found yet, some models satisfy the observational constraints very well. Applying the reasonable dust models, I investigate astrophysical consequences of the dust grains in H II regions, galaxies, and intergalactic medium. This thesis consists of five parts: The main achievement, which has been already published in the refereed journals by only myself, is presented in the second and third parts. The first part starts from a brief history of the establishment of the interstellar dust grains (chapter 1). Then a review of the interaction processes between the grains and radiation (chapter 2) is followed by an overview about the physical properties of the grains (chapter 3). In the second part, the effect of the dust grains in H II regions is discussed. I construct a diagnostic method for estimating quantitatively what fraction of Lyman continuum photons are absorbed by dust. The absorption fraction reaches 50% or more in many H II regions of the Galaxy, M31, and M33. This Lyman continuum extinction directly and significantly affects on the estimation of the star formation rate by the Lyman continuum photon counting such as the method using Hα line (chapter 4). Solving the Lyman continuum photon transfer in a dusty nebula, I show that the absorption fraction of Lyman continuum photons becomes too large to reproduce the fraction estimated from the observed data via the above method if the nebula is filled with dust uniformly. The presence of the central dust cavity, which is suggested by some theoretical and observational investigations, is expected, although the cavity has not been detected directly yet (chapter 5). In the third part, the effect of dust in a galactic-scale is investigated. I establish a theory of the conversion law from the dust infrared luminosity into the star formation rate. It is shown that the infrared luminosity traces the bolometric luminosity of the very young (age $\lesssim$ 10 Myr) stars quite well and that the infrared luminosity is really equal to the luminosity of such young stars within a factor of 2 for the observed nearby galaxies. Therefore, I conclude that the infrared luminosity is one of the best indicators of the current star formation rate of galaxies (chapter 6). In the forth part, the intergalactic dust is discussed. I put on a constraint on the amount of the intergalactic dust by comparing the observed thermal history of the intergalactic gas with a theoretical one taking into account the photoelectric heating by the intergalactic grains. The allowed dust-to-gas ratio in the intergalactic medium at $z \sim 2$–3 is less than 1/100–1/1000 of the Galactic value depending on the typical size of the intergalactic grains (chapter 7). The final part is devoted to a summary of the conclusions achieved in this thesis (chapter 8), future prospects (chapter 9), and my research activity (chapter 10). I try to show that there remain still large and fruitful research frontiers of the astrophysics of the comic dust grains. Further investigations of the topic, *dustrophysics*, are necessary.