

Crystallization of dust in astrophysical environments

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Recent observations show the ubiquity of crystalline silicate in various astrophysical objects, among which comets provide the best opportunity to study possible processing of pristine matter during their formation and evolution. While thermal processing of amorphous silicates in the hot inner solar nebula has been invoked, its drawback is a difficulty in explaining the interstellar composition of cometary ices. Here we apply Greenberg's model of core-mantle interstellar grains to propose nonthermal crystallization of the amorphous silicate core due to the energy released by chemical reactions in the organic refractory mantle when moderately heated by solar radiation. By formulating the nonthermal crystallization, we find that the degree of crystallinity is determined by a single parameter that is proportional to the amount of the released energy. We show that the present mechanism of crystallization is capable of reproducing the strengths of crystalline silicate features observed in comets. Our model can reconcile crystalline silicate in the comae of comets with the interstellar composition of ices in their nuclei.