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# Formation of ice poor comets in the protosolar disk

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The Rosetta mission has revealed various features of comets that had not been recognized before, among which the extremely low abundance of ice contrary to nearly equal amounts of dusts and organics is exciting. The information presented a fundamental question where and how comets were formed in the early solar system. Combining with the information about large scale radial mixing of dusts obtained by the Stardust mission, we need to understand physical and chemical evolution of the protoplanetary disk consistently.

We have developed a numerical model to describe physical and chemical evolution of the protoplanetary disk, which is basically an advection-diffusion equation described by the Lagrangean expression originally developed by F. Ciesla and which is equated with chemical equilibrium calculation. The model enables to trace the movement of individual grains and the chemical composition of the disk at a certain time is calculated by summing up chemical composition of grains with various trajectories, that is, various thermal histories. Because inward transportation of materials is due to advection and outward transportation is due to diffusion, the time scale and the amount of materials transported are different between the two processes, which results in temporal and spatial chemical change of the disk.

We have found that the chemical evolution of the disk is strongly dependent on the initial disk size. If the disk was as small as 10 au, materials beyond ∼50au after hundred thousands years is highly depleted in ice with almost equal amounts of dusts and organics, which is quite consistent with the observation for Comet 67P/Churyumov-Gerasimenko. However, initially large disk (∼100au) leaves a large amount of ice beyond several au after hundred thousands years. We conclude that our solar system was initially small, which extended to ∼100au or beyond afterward.