# On the mass transport and mixing processes in the solar nebula

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The solar system bodies have various elemental compositions. The origin of their variety still remains an unresolved issue. It should be closely related with the processes of mass transport and mixing within the solar nebula. In this presentation, I provide current understandings about these physical processes.

A star, including the Sun, is formed by gravitational collapse of a dense region of interstellar gas. Since the interstellar gases have random motions, the collapsing gas generally has the finite angular momentum with respect to the collapse center. Thus, the collapsing gas cannot directly reach to the collapse center but forms a gaseous disk.

The central star grows owing to the inflow, or mass accretion, toward the disk center within the gaseous disk. Associated with the mass accretion, gravitational energy is released and converted to heat. Actually gaseous disks observed around young stars radiate thermal emission attributed to mass accretion.

To flow toward the disk center, gas should lose its angular momentum. Its most important mechanism is believed to be the exchange of angular momentum with the outer region of disk due to turbulence. In this case, inner gas flows toward the central star, but outer gas expands outside owing to the angular momentum acquisition. Note that the total angular momentum is conserved as long as a small fraction of nebula gas acquires the angular momentum. Therefore the inflow is the dominant motion within an active gaseous disk.

The solar nebula contains solid component with mass fraction of about 1%. Since the gas pressure acts little on solid particles they have motions relative to surrounding gas. For this reason, the mixing ratio of gaseous and solid components becomes inhomogeneous within the nebula. The solid component tends to concentrate onto the equatorial plane of gaseous disk and migrate toward the disk center more rapidly than the gas component.

On the other hand, the turbulent mixing of gas not only homogenizes the gas composition locally but also induces the mass accretion. Because of the inflow associated with the mass accretion, the materials cannot diffuse upstream freely even taking long time enough. In other words, the homogenization due to the turbulent mixing is limited to a finite scale within the solar nebula. Coupled with the relative motions between gas and solid components, the mass accretion induced by turbulence possibly acts as another process producing compositional heterogeneity.