Solar Nebula Density derived form Spin of Chondrules

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Chondrules are submilimeter size spherical objects dominantly exist in chondrite type meteorites. From radio-isotope measurements, chondrule formation occured in solar nebula $4.56¥times10^{9}$ years ago. Because of its spherical shapes and petrological textures,
it is considered that chondrules were formed by quick cooling of silicate melt droplets (eg. Hewins1996,Hewins1997,Jones2000).

The three-dimensional shape of chondrules were obtained by X-ray computed tomography and were revealed that it is oblate sphere (Tsuchiyama et al. 2000). The oblate shape can caused by (1) spinning of molten chondrule precursors or (2) deformation after accumulation as a chondrite by shock loading or compaction. Tsuchiyama et al.(2000) found that voids in a chondrule that has porphyritic texture aligned nearly along the minor axis of the oblate shape. This supports the spinning chondrule model. Olivine plates in chondrules that has barred olivine texture are nearly perpendicular to the minor axis of oblate spheres.This may also be related to spinning of chondrules. The spinning rate are estimated to be about 300 - 1300 $¥rm{rad s^{-1}}$. Possible mechanism for chondrule rotation are proposed, (eg. Shu1996), inhomogeneity of the pressure on the droplets in shock wave ¥citep{Susa02}.

The spin rate could decrease due to viscosity of gas in solar nebula. If the spinning chondrule model is ture, the shape of the chondrule is that at solidify temperture of the chondrule. In this paper I will derive the relation between gas density and cooling time in chondrule forming region of solar nebula. Some constraints for origin of the spin of chondrule are also discussed.