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ANALYSIS OF THE EVOLUTION OF TRAPS FOR PROTOPLANETS CONSIDERING DISK PHOTOEVAPORATION

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Considering planet-disk interaction and photoevaporation of the disk, we show that cavity formation in disks of T Tauri stars does not result in a protoplanetary trap and that planetary migration is only important at earlier times.

We use the hydrodynamic code for planetary migration FARGO (Masset 2000) in the accretion disk of a solar type star with α parameter of viscosity $\alpha = 10^{-2}$ (Shakura & Sunyaev 1973). The initial density surface is in agreement to the solution of the diffusive equation (Ruden 2004),

$$\Sigma(r,t) = \frac{M_d(0)}{2\pi r_g} \cdot \frac{e^{-(r/r_g)/(1+3\cdot(t/t_{\rm vis}))}}{r\cdot(1+3\cdot(t/t_{\rm vis}))^{3/2}}, \quad (1)$$

where $M_d(0) = 10^{-2}M_\odot$ is the initial mass of disk, $r_g = 9$ AU is the gravitational radius and $t_{\rm vis}$ is the viscous timescale at r_g.

We use the photoevaporative flux used by (Hollenbach et al. 1994) $\mathcal{F}_m(r) \simeq \mathcal{F}_0(\frac{r}{r_g})^{-5/2}$ for $r \geq r_g$ (otherwise $\mathcal{F}_m(r) = 0$), where the constant $\mathcal{F}_0$ is a photoevaporative flux at r_g, $\mathcal{F}_0 \simeq 1.9 \times 10^{-12}(\Phi_i/(10^{40}s^{-1}))^{1/2}(r_g/(10^{13}{\rm cm}))^{-3/2}{\rm gcm^{-2}s^{-1}}$, where Φ_i is the ionizing Lyman photons rate, $\Phi_i = 9\times10^{40}{\rm s^{-1}}$, produced by blue veil emission by mass accretion at stellar boundary (Bertout et al. 1988) of 10^{-8} AU/year. The disk is integrated from 1 to 120 AU (with $n_r \times n_\phi = 256 \times 384$ resolution). We considered a planet of $15M_\oplus$ at 16 AU.

At time of gap formation, the surface density has decreased 2 orders of magnitud at gravitational radius r_g (Figure 1) and the outer edge of the gap is not able to stop the migration (Figure 2).

Besides, for chromospherically active M stars, using the observed values (ionizing photons) and the description for migration and trap, by Tanaka et al. (2002) and Masset et al. (2006), respectively, we found that gap is not able to trap a protoplanet with type I migration.

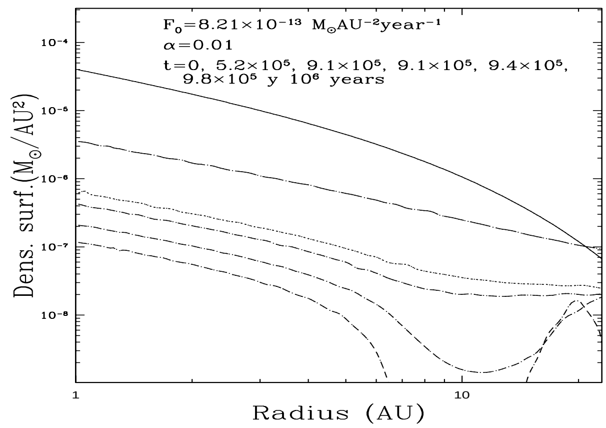

Fig. 1. Surface mass density evolution. $\mathcal{F}_0$ corresponding to $\Phi_i = 9\times10^{-40}{\rm s^{-1}}$. The rate of cavity expansion is 10^{-4} AU/year.

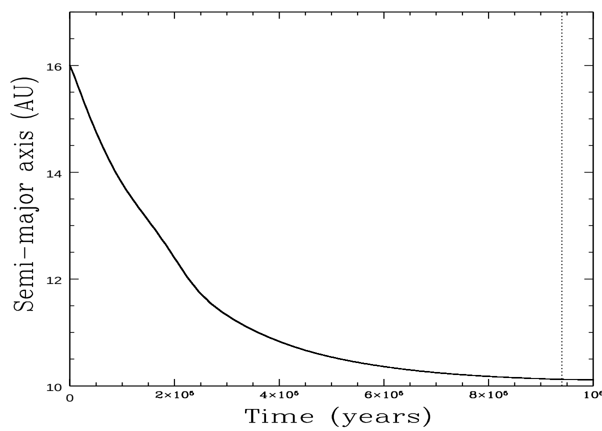

Fig. 2. Planet's semi-major axis of $15M_\oplus$. Vertical line show the time of gap formation, when a decay of migration rate to values $\sim 10^{-8}$ AU/year.

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