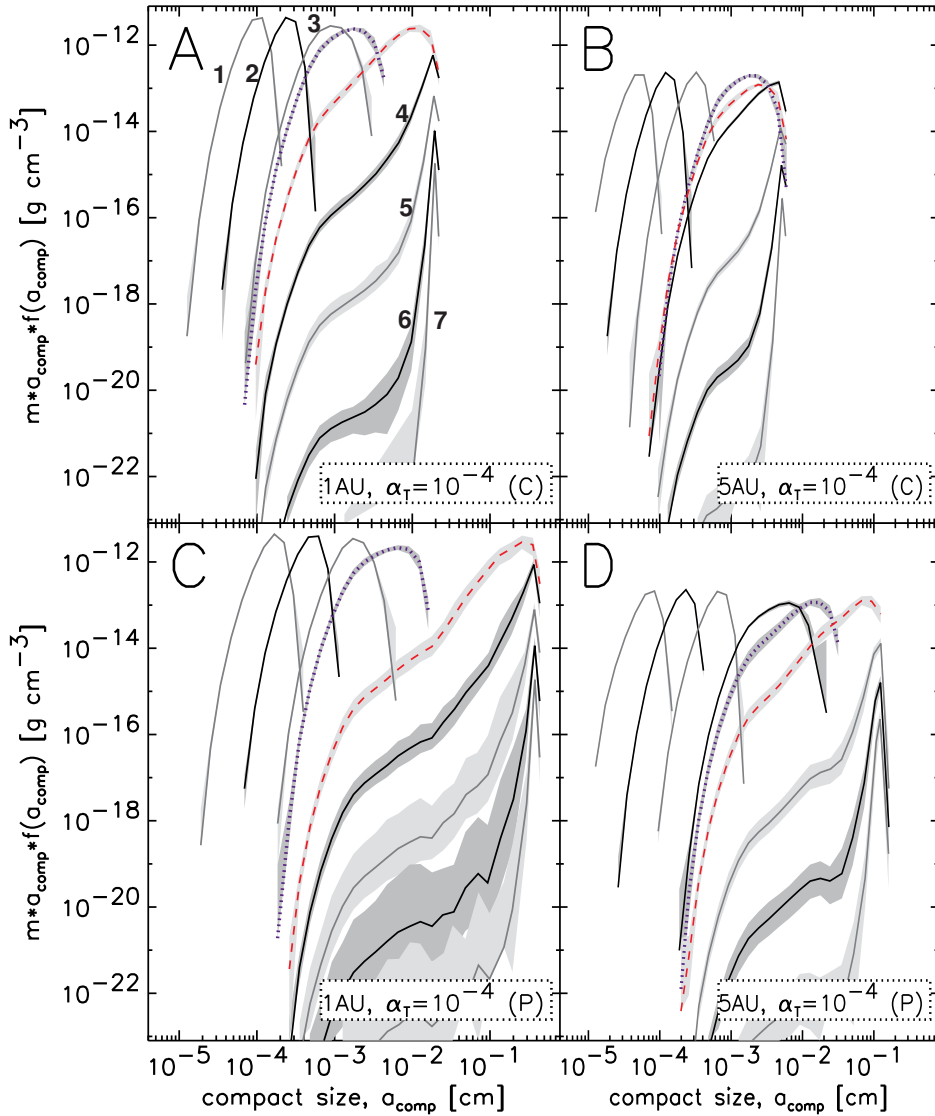
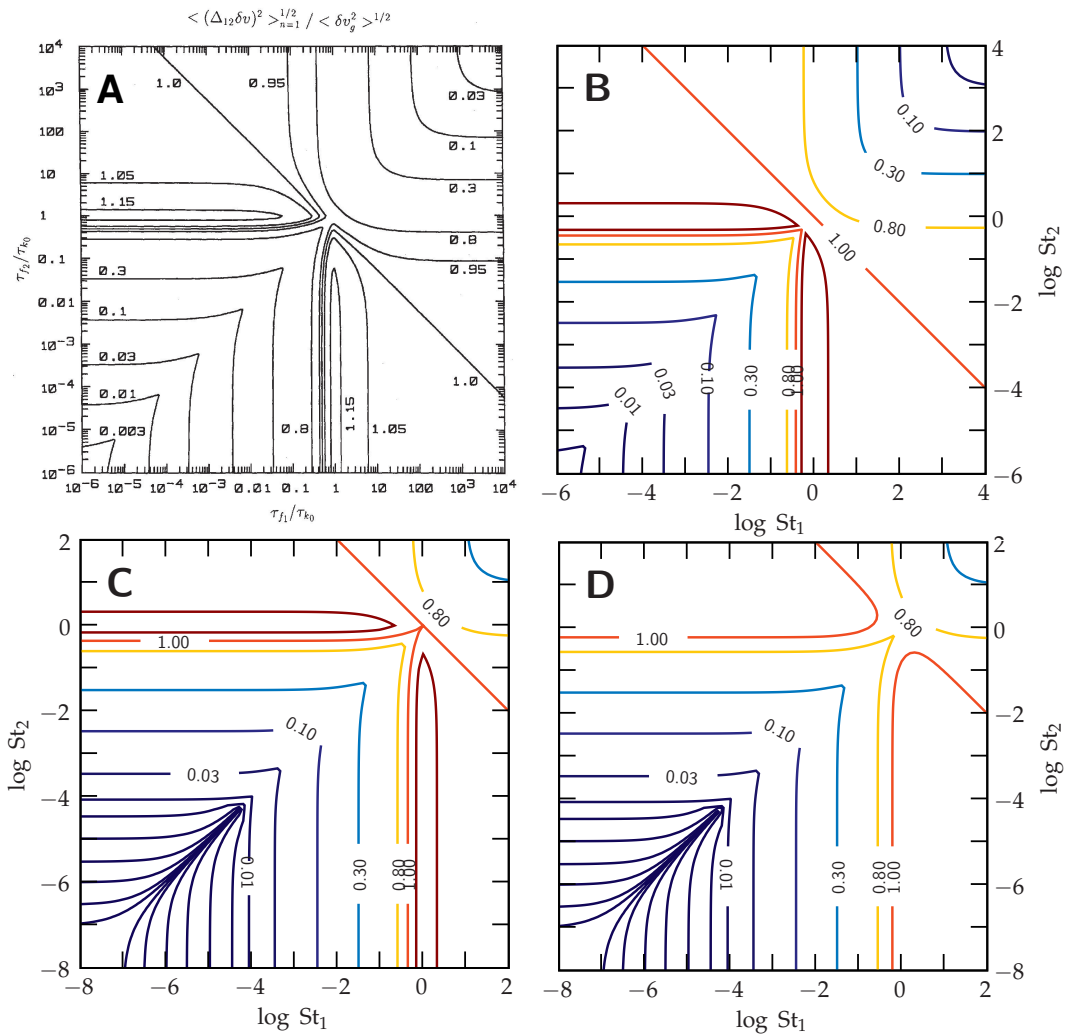


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## Color figures



**Fig. 2.10:** The mass function plotted at various times for the  $\alpha = 10^{-4}$  models. The panels compare the coagulation of the compact models ( $\psi = 1$ , *top* panels) with those where porosity effects are included (*bottom* panels). *Left* (*right*) panels show the coagulation of quartz (ice) particles at 1 AU (5 AU). Each plot shows the mass function at every logarithmic interval in time from  $t = 10$  yr until  $t = 10^7$  yr. In the first  $\sim 10^2$  yr Brownian motion dominates the coagulation. Subsequent evolution is driven by turbulence-induced velocity differences and includes the moment of first compaction (*blue, dotted curve*) and first rain-out (*red, dashed curve*). After rain-out ( $t \gtrsim 10^4$  yr), the mass density in the gaseous nebula decreases and the mass function collapses. In the compact models the blue, dotted curve also corresponds to the first time that  $E > E_{\text{roll}}$ . Greyscales indicate the spread in the 50 realizations of the simulation.



**Fig. 3.4:** (Chapter 2) Contour plots of particle-particle, turbulence induced, relative velocities  $\Delta v_{12}$  normalized to  $v_g$ . (a) Numerical results of Markiewicz et al. (1991), without inner scale ( $Re \rightarrow \infty$ ). (b) Analogous result from our closed-form expressions with the fixed  $y^* \approx y_a^* = 1.6$  approximation (§ 3.3.2). (c) Like (b), but with an exact solution for  $y^*$  and with  $Re = 10^8$ . (d) Using the CH03 formula for  $k^*$ ,  $k^*/k_L = 0.5St^* + 1$ , and also with  $Re = 10^8$ . Contours are drawn twice per logarithmic decade (at  $\Delta v_{12}/v_g = 3 \times 10^i$  and at  $10^i$ ) with an additional contour at 0.8 and 1.15.

