List of Symbols

Symbol	Description
$\mathcal{E}^*$	reduced modulus of elasticity
Δv or Δv_{12}	relative velocity
Σ	surface density
Ω	angular (Keplerian) rotation frequency
Φ	gravitational potential
A	geometrical cross-section (1 particle)
C_ϕ	change in geometrical filling factor, $C_\phi = \phi/\phi^{\mathrm{ini}}$
C_{ij}	collision rate between particles i, j
D_f	fractal dimension
E	collision energy
E_restr, $E_\mathrm{max\text{-}c}$, E_frag	energy limits for particle restructuring/ maximum-compression/ fragmentation (§ 2.2.3)
$E_\mathrm{roll}, E_\mathrm{br}$	monomer rolling/breakup energy (§ 1.2.2)
G	Newton's gravitational constant
H_g	scale height of gas disk (Eq. (1.15)
K_{ij}	coagulation kernel or rate coefficient [$\mathrm{cm}^3\ \mathrm{s}^{-1}$] (velocity $\times$ collisional cross-section)
M_k	k-th moment of mass distribution
M_{L1}, M_{L2}	first, second most massive particle
$\mathcal{N}$	initial number of particles, $N_p(0)$ (chapter 5)
N	(mostly) total number of monomers within aggregate
N_ϵ	group splitting factor (Eq. (5.12))
N_μ	reduced number of monomers in collision $N_\mu = N_1 N_2/(N_1 + N_2)$
N_c	total number of contacts
N_f	number of big fragments
N_g	number of groups, $\sum_{i=1}^{N_s} w_i$

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Symbol	Description
N_p	number of total particles in simulations
N_s	number of species (distinct particles)
N_{tot}	total number of monomers in aggregates
M_{pwl}	mass in power-law component
R	heliocentric radius
$\mathcal{R}_{\text{gd}}$	spatial gas-dust ratio by mass
$\mathcal{R}_{\text{gc}}$	spatial gas-chondrule ratio by mass
$\mathcal{R}_{\text{cd}}$	spatial chondrule-dust ratio by mass
$\mathcal{V}$	simulation volume
Re	Reynolds number
S_{f}	spread in number of fragments of big component
St	particle Stokes number
P	pressure
T	temperature
V	geometrical volume (§ 2.2.2)
α	turbulent strength parameter (§ 1.2.1)
β	mass dependence of kernels as in $K \propto m^{\beta}$
γ	specific surface adhesion energy (surface energy density)
δ	exponent in surface area-mass ($A \sim m^{\delta}$) in fractal regime
ϵ	size ratio ($\epsilon \leq 1$)
η	nebula pressure parameter, number of particles or groups (§ 6.4.1)
$\phi, \phi_{\text{PCA}}, \phi_{\text{pd}}$	filling-factor (PCA/porous dust)
κ	number of coagulations
ℓ_{mfp}	mean free path of gas molecules
λ_{ij}	collision rate [s^{-1}] between species i and j (including duplicates)
ν_1/ν_2	Poisson ratios
$\nu_{\text{m}}/\nu_{\text{T}}$	molecular/turbulent viscosity
μ	molecular mass in units of unified atomic mass ($\mu \approx 2.34$)
ψ	enlargement parameter
ρ_{X}	gas density over MSN
$\rho_{\text{d}}, \rho_{\text{g}}$	spatial dust/gas density
$\rho_{\text{c}}^{(\text{s})}, \rho_{\text{d}}^{(\text{s})}$	specific material chondrule/dust density (bulk densities)
ρ_1, ρ_2	internal particle density
σ_{ij}	collision cross-section
τ_{f}	friction time
τ_{rain}	friction time at which particles are removed from simulation due to rain-out (chapter 2)
ξ_{crit}	critical displacement to initiate rolling of a contact area
a	geometrical radius (surface area equivalent radius)
a_{σ}	aggregate geometrical radius (projected surface equivalent radius)
a_{μ}	reduced radius
a_0	monomer radius
a_{c}	chondrule radius
a_{e}	equilibrium contact radius

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Symbol	Description
$a_{\rm dust}$	dust aggregate radius
$a_{\rm out}$	aggregate outer radius
b	impact parameter
$c_{\rm g}$	thermal sound speed
f_ϵ	maximum allowed fractional mass change of a particle during group collisions (chapter 5)
$f(m)$	particle distribution function (number density spectrum)
$f_{\rm comp}$	required dust fraction at collision for sticking (Eq. (4.16))
$f_{\rm d}$	compound dust fraction by mass (Table 4.2)
$f_{\rm geo}$	geometry factor (§ 4.2.3)
$f_{\rm miss}$	fraction of collision misses
$f_{\rm pwl}$	fraction of mass in power-law component
$f_{\rm p}$	compound porous dust fraction with respect to total dust mass (Table 4.2)
g_i	occupancy number of species i; number of duplicates
$h_{\rm p}$	particle (or dust) scale height
$k_{\rm B}$	Boltzmann constant
ℓ	eddy length scale
m	mass
m_μ	reduced mass
$m_\star$	characteristic mass of distribution determining the $\{z_i\}$ (§ 5.2.3)
$\langle m \rangle$	mean mass of the distribution M_1/M_0
$m_{\rm H}$	hydrogen mass
$m, m_{\rm d}, m_{\rm ch}$	(dust/chondrule) mass
m_p	peak mass of the distribution M_2/M_1
mw-.. or $\langle .. \rangle_m$	mass-weighted averages (see Eq. (2.26))
n	particle density (gas)
$\bar{r}$	random deviate
q	power-law exponent (size distribution)
t	time
$t_{\rm dd}, t_{\rm dc}, t_{\rm cc}$	dust-dust/dust-chondrule and chondrule-chondrule collision times (§ 4.2.4)
$t_{\rm L}/t_{\rm s}$	large/small eddy turn-over time (§ 1.2.1)
$v_{\rm K}$	orbital (Kepler) velocity
$v_{\rm rd}$	particle radial drift velocity (Eq. (1.25))
$v_{\rm K}$	orbital (Kepler) velocity
$v_{\rm s}/v_{\rm L}$	velocity smallest/largest eddies
w_i	group number; number of groups for species i
z_i	zoom number of species i