Errata for "An Introduction to Granular Flow"

Last updated: 29 October 2008

1. p. xiv, line 4: desribed $\longrightarrow$ described
2. p. xiv, insert after entry for k_x, k_y, k_z, the following:
   k_{B}: Boltzmann constant
3. p. xix, after entry for γ', insert the following:
   $\dot{\gamma}$: shear rate
4. p. xv, after last line, insert the following additional definition for g:
   magnitude of the relative velocity $\mathbf{g}$
5. p. xvii, after entry for $\hat{\mathbf{D}}$, insert the following:
   $\hat{\mathbf{D}}'$: $\hat{\mathbf{D}} - \frac{1}{3}(\hat{\boldsymbol{\nabla}}\hat{\mathbf{u}})\,\mathbf{I}$
6. p. 38, line above (1.60): article $\longrightarrow$ particle
7. p. 118, line 2 below Table 3.1: bulk density $\longrightarrow$ density
8. p. 141, paragraph 4, line 3: $\xi^{\lambda-1} \longrightarrow \xi^{\lambda_s-1}$
9. p. 162, problem 3.2, last line: Add the following sentence: In the r–θ plane, the slope of a curve is given by $\frac{1}{r}\frac{\mathrm{d}r}{\mathrm{d}\theta}$.
10. p. 164, problem 3.9, line 3: (3.109) $\ll 1 \longrightarrow$ (3.109) is $\ll 1$
11. p. 212: Equation (4.53) should be replaced by

$$(\mathbf{n}_* \cdot \boldsymbol{\sigma})_w = \frac{1}{P'} \oint_{P'} \mathbf{n}_* \cdot \boldsymbol{\sigma}\,\mathrm{d}s$$

12. p. 239, paragraph 2 above §5.3, last line: were reported $\longrightarrow$ were not reported
13. p. 277, line above equation (6.57): radial $\longrightarrow$ incompressible
14. p. 301, line 3 from the bottom: $1.365 \times 10^{-10}\,\mathrm{m} \longrightarrow 2.73 \times 10^{-10}\,\mathrm{m}$
15. p. 306, paragraph 2, line 2: $\langle\psi\rangle/\tau_c \longrightarrow \psi_s/\tau_c$, where ψ_s sets the scale of ψ.
16. p. 306, paragraph 2: Replace third sentence, "The other terms ...", by the following:
   The other terms, being gradients in the fluxes, are smaller by a factor of s/H. The scaling of the three terms may be derived in the following

manner. Using v_s as a characteristic grain velocity, we see from (7.65), (7.41) and (7.32) that

$$\chi \sim d_{\mathrm{p}}^2 n^2 v_s \psi_s = \frac{6}{\pi} sn \, \frac{\nu}{d_{\mathrm{p}}} \, \frac{v_s}{s} \psi_s$$

Here, we have used the identity $\nu = n\pi d_{\mathrm{p}}^3/6$. Recognizing that $s \sim d_{\mathrm{p}}/\nu$ (see the text below (7.49)) and $s/v_s = \tau_c$, we get

$$\chi \sim n \frac{\psi_s}{\tau_c}$$

Similarly, it is easily seen from (7.64) that $\boldsymbol{\theta}$ scales as

$$\boldsymbol{\theta} \sim d_{\mathrm{p}}^3 n^2 v_s \psi_s = \frac{6}{\pi} \, sn\nu \, \frac{v_s}{s} \psi_s$$

and hence

$$\boldsymbol{\nabla \cdot \theta} \sim \frac{s}{H} \, n\nu \, \frac{\psi_s}{\tau_c}$$

In the same manner,

$$\boldsymbol{\nabla \cdot} (n \langle \mathbf{c} \psi \rangle) \sim \frac{1}{H} \, n v_s \psi_s = \frac{s}{H} \, n \, \frac{\psi_s}{\tau_c}$$

Thus, we see that $\boldsymbol{\nabla \cdot \theta}$ and $\boldsymbol{\nabla \cdot}(n\langle \mathbf{c}\psi_s \rangle)$ are smaller than χ by the factor s/H. Hence, the balance in (7.66) is between the left-hand side and $\chi(\psi)$.

17. p. 315, (7.125): $\hat{\mathbf{D}} \longrightarrow \hat{\mathbf{D}}'$

18. p. 316, line 1: with the dimensionless rate of deformation tensor $\hat{\mathbf{D}} \equiv \overline{\hat{\boldsymbol{\nabla}} \hat{\mathbf{v}}}$ $\longrightarrow$ with the traceless part of the dimensionless rate of deformation tensor $\hat{\mathbf{D}}' \equiv \overline{\hat{\boldsymbol{\nabla}} \hat{\mathbf{v}}}$

19. p. 317, line 3 below (7.133): that value $\longrightarrow$ the value

20. p. 318, (7.135): $\hat{\mathbf{D}} \longrightarrow \hat{\mathbf{D}}'$

21. p. 319, (7.138): $\hat{\mathbf{D}} \longrightarrow \hat{\mathbf{D}}'$

22. p. 320, (7.142), (7.143), (7.145): $\hat{\mathbf{D}} \longrightarrow \hat{\mathbf{D}}'$

23. p. 320, (7.143) and (7.145): $\boldsymbol{\nabla} \longrightarrow \hat{\boldsymbol{\nabla}}$

24. p. 323, (7.158): $\mathbf{D} \longrightarrow \mathbf{D}'$

25. p. 323, line after (7.158): where $\mathbf{D}$ is the rate of deformation tensor, $\longrightarrow$ where $\mathbf{D}' \equiv \mathbf{D} - \frac{1}{3}(\boldsymbol{\nabla \cdot} \mathbf{u})\,\mathbf{I}$ is the traceless part of the rate of deformation tensor,

26. p. 330, problem 7.3: $\hat{\mathbf{D}} \longrightarrow \hat{\mathbf{D}}'$

27. p. 335, line 4 above (8.11): analogos $\longrightarrow$ analogous

28. p. 345, §8.2.2, line 4: in the hyperbolic $\longrightarrow$ the hyperbolic

29. p. 351, §8.3.1, paragraph 2, line 2: fixed-time $\longrightarrow$ fixed time

30. p. 355, caption of Fig. 8.16, line 1: diameter flowing in a $\longrightarrow$ diameter in a

31. p. 364, paragraph 1, line 2 from the bottom: no matter how large $\longrightarrow$ for the entire range of

32. p. 368, last paragraph, line 6: layers in the x–z plane $\longrightarrow$ layers parallel to the x–z plane

33. p. 368, last line 6: layers are in x–y plane $\longrightarrow$ layers are parallel to the x–y

34. p. 376, 3rd line below (9.5): $r \longrightarrow \mathbf{r}$

35. p. 378, 4th line above (9.13): nearly rough $\longrightarrow$ nearly perfectly rough

36. p. 380, paragraph 2, after (9.27): The body couple, if present ... from the hydrostatic part. $\longrightarrow$ If a body couple of finite magnitude is present, $\overline{\boldsymbol{\omega}}$ is in general not a hydrodynamic variable, but is "enslaved" to $\boldsymbol{\tau}$.

37. p. 386, paragraph 1: the relations for a_1 and b_0 coincide with the solution obtained for a granular gas of smooth particles, given in (7.133). $\longrightarrow$ the relation for Φ_K differs from the one-term solution of Chapman & Cowling (1964) for a granular gas of smooth particles (given by (7.125), (7.132) and (7.133)) only by the the term proportional to a_1' in $\mathbf{A}$.

38. p. 387, (9.67): $\hat{\mathbf{D}} \longrightarrow \hat{\mathbf{D}}'$

39. p. 387, last line: $\hat{\mathbf{D}} \longrightarrow \hat{\mathbf{D}}'$

40. p. 388, (9.68): $\hat{\mathbf{D}} \longrightarrow \hat{\mathbf{D}}'$

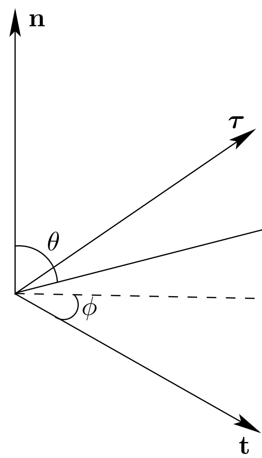
41. p. 389, (9.79): $\mathbf{D} \longrightarrow \mathbf{D}'$

42. p. 389, line below (9.79): where $\mathbf{D} \equiv -\mathbf{C}$ (see (2.49)) is the rate of deformation tensor defined in the tensile sense. $\longrightarrow$ where $\mathbf{D}' \equiv \mathbf{D} - \frac{1}{3}(\boldsymbol{\nabla}\cdot\mathbf{u})\,\mathbf{I}$ is the traceless part of the rate of deformation tensor.

43. p. 394, paragraph 2, last line: grains.3 $\longrightarrow$ grains.

44. p. 448, line below (G.54): $[Q]_* \rightarrow [Q_*]$

45. p. 450: Fig. H.1 should be modified as below:



46. p. 450, §H.2: is evaluated by writing **k** in terms of ⟶ is evaluated by writing **k**, **i**, and **j** in terms of

47. p. 452, (H.15): $\mathcal{J}$ ⟶ det(**J**)

48. p. 457, line 3 from the bottom: roman ⟶ Roman
In the same line: greek ⟶ Greek