DOUBLE-DIFFUSIVE CONVECTION WITH FINE DUST

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1. In Abstract, second and third sentences (lines 2–4) should be replaced by “The solute gradient introduces oscillatory modes in the system in contrast to the validity of principle of exchange of stabilities in its absence”.

2. In equations (12), (16) and (38); $\Delta^2 \Gamma$ should be multiplied by $1/\lambda$, where $\lambda = k/k'$, the ratio of thermal diffusivity and solute diffusivity.

3. In equations (28), (30), (40) and (41), N_s should be replaced by λN_s .

4. In equations (32) and (43), dN_R/dN_s should be $+\lambda$ instead of 1.

5. Equations (17), (19), (22), (23), (39) and the text from eq. (24) onwards (upto end of section 3) should read as below:

$$(17) \quad (L_1 - L_2 \nabla^2) \left(H \frac{\partial}{\partial t} - \nabla^2 \right) \left(H \frac{\partial}{\partial t} - \frac{1}{\lambda} \nabla^2 \right) \nabla^2 w = \\ = \left(\tau \frac{\partial}{\partial t} + H \right) \nabla_1^2 \left[N_R \left(H \frac{\partial}{\partial t} - \frac{1}{\lambda} \nabla^2 \right) - N_s \left(H \frac{\partial}{\partial t} - \nabla^2 \right) \right] w,$$

$$(19) \quad (D^2 - \alpha^2 - Hn)(D^2 - \alpha^2 - \lambda Hn) [L_1 - L_2(D^2 - \alpha^2)] (D^2 - \alpha^2) W = \\ = \alpha^2(\tau n + H) [N_R(D^2 - \alpha^2 - \lambda Hn) - \lambda N_s(D^2 - \alpha^2 - Hn)] W,$$

$$(22) \quad (D^2 - \alpha^2 - Hn)(D^2 - \alpha^2 - \lambda Hn) X = \alpha^2(\tau n + H) [N_R(D^2 - \alpha^2 - \lambda Hn) \\ - \lambda N_s(D^2 - \alpha^2 - Hn)] W,$$

$$(23) \quad \int_0^1 X^* (D^2 - \alpha^2 - Hn)(D^2 - \alpha^2 - \lambda Hn) X \, dz = \\ = \alpha^2(\tau n + H) \int_0^1 X^* [N_R(D^2 - \alpha^2 - \lambda Hn) W - \lambda N_s(D^2 - \alpha^2 - Hn) W] \, dz,$$

$$(39) \quad (D^2 - \alpha^2 - Hn)(D^2 - \alpha^2 - \lambda Hn) [(L_1 + L_2 \alpha^2 - L_2 D^2)^2 (D^2 - \alpha^2) \\ + L_2^2 T_A D^2] W = \\ = \alpha^2(L_1 + L_2 \alpha^2 - L_2 D^2) (\tau n + H) \\ \times [N_R(D^2 - \alpha^2 - \lambda Hn) W - \lambda N_s(D^2 - \alpha^2 - Hn) W],$$

$$(24) \quad I_1 + (H + \lambda H) n I_2 + \lambda H^2 n^2 I_3 = \\ = \alpha^2(\tau n + H) [(N_R - \lambda N_s) (L_1^* I_4 + L_2^* I_6) + \lambda H n (N_R - N_s) (L_1^* I_5 + L_2^* I_4)],$$

where

$$\begin{aligned}
 I_1 &= \int_0^1 (|D^2 X|^2 + 2\alpha^2 |DX|^2 + \alpha^4 |X|^2) dz, \\
 I_2 &= \int_0^1 (|DX|^2 + \alpha^2 |X|^2) dz, \\
 I_3 &= \int_0^1 |X|^2 dz, \\
 I_4 &= \int_0^1 |(D^2 - \alpha^2) W|^2 dz, \\
 I_5 &= \int_0^1 (|DW|^2 + \alpha^2 |W|^2) dz, \\
 I_6 &= \int_0^1 (|D^3 W|^2 + 3\alpha^2 |D^2 W|^2 + 3\alpha^4 |DW|^2 + \alpha^6 |W|^2) dz,
 \end{aligned}
 \tag{25}$$

which are all positive definite. Putting $n = in_0$, where n_0 is real, into equation (24) and equating the imaginary parts, we obtain

$$\begin{aligned}
 (26) \quad n_0^2 &= - \frac{H(1 + \lambda) I_2 + \alpha^2 (N_R - \lambda N_s) (FHN_p^{-1} I_4 + \tau h I_6) - \alpha^2 H^2 \lambda (N_R - N_s) I_4}{\alpha^2 \tau^2 N_p^{-1} (N_R - \lambda N_s) I_4 - \alpha^2 H \tau \lambda (N_R - N_s) \{N_p^{-1} (F - H) I_5 + \tau I_4\}}
 \end{aligned}$$

or

$$(27) \quad n_0 = 0.$$

In the absence of solute gradient, equation (26) yields n_0^2 to be negative, which is impossible as n_0 is real, and so $n_0 = 0$ meaning thereby that the principle of exchange of stabilities is valid (Scanlon and Segel [1]). The presence of solute gradient introduces oscillatory modes in the system, as n_0^2 may be positive.

References

- [1] Scanlon J. W., Segel L. A.: *Phys. Fluids* 16 (1973) 1573.