Comments

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Comment on "Some properties of an eight-mode Lorenz model for convection in binary fluids"

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It is pointed out that a model system for convection in binary fluids studied by Gross [Phys. Lett. A **119**, 21 (1986)] may be considered a special case of a model previously introduced for a laser with a saturable absorber. It is shown that some results previously developed for the laser system may then be carried over to the binary-fluid system after an appropriate transformation.

Recently, a model system of five ordinary differential equations for convection in binary mixtures[1-8] was extended by Cross[9] to eight equations in order to achieve the translational invariance of the fluid. This was done by letting the amplitudes of the lowest modes contributing to velocity, temperature, and concentration be complex. Some properties of this model have been discussed by Ahlers and Lücke.[10] We wish to point out that the model is a special case of one introduced previously for a laser with a saturable absorber,[11-15] and that some of the results obtained for the laser may be carried over to the fluid system after a suitable variable transformation.[6,7,12] The model studied in Ref. 10 is

$$\tau_0 dX_i/dt = -\sigma(X_i - Y_i - U_i) , \tag{1}$$

$$\tau_0 dU_i/dt = -L(U_i - \Psi Y_i) + r\Psi X_i - VX_i , \tag{2}$$

$$\tau_0 dZ/dt = -b(Z - X_1 Y_1 - X_2 Y_2), \tag{3}$$

$$\tau_0 dV/dt = -bL(V - \Psi Z) + b(X_1 U_1 + X_2 U_2) , \tag{4}$$

where τ_0 is a parameter introduced in Ref. 10. Besides, $i=1,2$, and X, Y, and U are complex quantities.

The following change of variables:

$$\tau = t/\tau_0 ,$$

$$X = a ,$$

$$Y = [A + r_1^2(1-C)]p ,$$

$$Z = [A + r_1^2(1-C)]d ,$$

$$U = r_1(1-C)(-r_1 p + \bar{p}) ,$$

and

$$V = r_1(1-C)(-r_1 d + \bar{d}) ,$$

together with the following parameter equivalence between laser and fluid variables:

$$\sigma = \rho ,$$

$$b = \omega ,$$

$$r = A + r_1^2(1-C) ,$$

$$L = r_1 = r_2 ,$$

and

$$\Psi = [r_1(1-C)(1-r_1)]/[A + r_1^2(1-C)] ,$$

where a, p, and $\bar{p}$ are complex quantities, yield

$$da_i/d\tau = \rho[-a_i + Ap_i + r_1(1-C)\bar{p}_i] \quad (i=1,2) , \tag{5}$$

$$dp_i/d\tau = a_i(1-d) - p_i \quad (i=1,2) , \tag{6}$$

$$d\bar{p}_i/d\tau = a_i(1-\bar{d}) - r_1\bar{p}_i \quad (i=1,2) , \tag{7}$$

$$dd/d\tau = \omega(-d + a_1 p_1 + a_2 p_2) , \tag{8}$$

$$d\bar{d}/d\tau = \omega(-r_2\bar{d} + a_1\bar{p}_1 + a_2\bar{p}_2) , \tag{9}$$

which is the system of eight equations studied in Refs. 13, 14, and 15. All quantities $(a,p,d\ldots)$ have been defined in Ref. 13.

Thanks to this transformation we may transfer to binary mixtures those results for lasers with saturable absorbers which pertain to the parameter subspace appropriate to fluids ($r_1 = r_2 = L =$ Lewis number, $\rho = \sigma =$ Prandtl number, $\omega = b = \frac{8}{3}$, $\Psi =$ separation ratio). Examples are the stability of various periodic solutions (waves) which bifurcate from the motionless state—no lasing state ($X = Y = U = Z = V = 0$), and periodic solutions (Q switches) emerging from the steady finite amplitude branch.[12-15]

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