Chapter 8

Conclusion

Even if someone found the ultimate truth, he would not know.
Everything is interspersed with assumptions.   K. R. Popper

Now I discuss some open questions and give suggestions for future research. The main unresolved issue with the WEM is the unknown value of τ_{rec} which must be rather long (of the order of 10 seconds). A direct determination of both τ_{rec} and the mobilities is desirable, e.g., by measuring the transient current response to various voltage signals in cells with well-defined boundary conditions (blocking electrodes) [84, 86, 83]. Furthermore, one would like to know, at least for one material, the complete set of the SM parameters, together with measurements of the threshold $(q_c, p_c, \overline{V}_c, \omega_H)$, of the frequency decrease $d\omega/d\epsilon$, and of all CGL parameters.

On the theoretical side, a (numerical) weakly-nonlinear analysis of the full set of WEM equations is needed. In further steps, one could generalize the resulting two-dimensional CGL to include the coupling to the other critical modes (e.g., couplings between the amplitudes of right and left travelling rolls), and also to include couplings to slowly-relaxing modes that are excited in higher order by the nonlinearities.

As discussed in Chapter 5.6, the role of the *linear* charge-carrier modes for producing a *Hopf bifurcation* is reminiscent of the role of the concentration field for the Hopf bifurcation in binary fluid convection. There, the *nonlinearly excited* concentration modes were found to be important for the production of *pulses* [145, 146]. I expect, that coupled equations for the amplitudes of critical and slow nonlinear modes will be similar to the "extended CGL", which was derived by Riecke [146] to describe the dynamics of the pulses. Are these pulses related to the "worms" observed for low temperatures in I52 [30, 42]?

Finally, a nice feature of EHC is that the Hopf bifurcation is continuous and that one observes spatio-temporal chaos (STC) right at onset [30]. It would be fascinating to explain this in the framework of CGLs by the Benjamin–Feir instability [11] enabling quantitative experimental tests of the predictions of one of the most simple and generic equations producing STC.